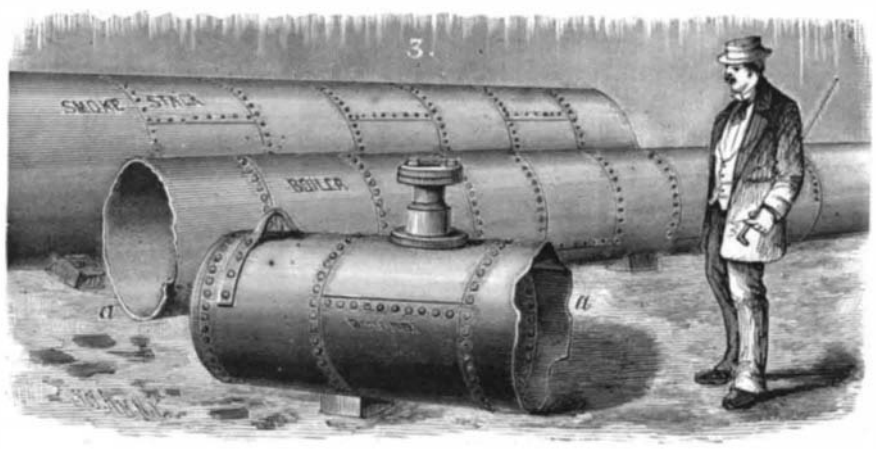
EXPLOSION OF A ROLLING MILL BOILER IN POTTSVILLE, PENNSYLVANIA.

BY S. N. HARTWELL.

The subject of this report was a plain cylinder boiler with cast iron heads, a type much used in almost all kinds of manufactories. Hundreds of them may be seen of about the same dimensions and construction set in triplets, etc., in the steam cotton mills of Fall River and Lowell, Mass., and Providence, R. I., and they are very common in iron mills in all parts of this country. The sample now illustrated exploded on the 10th of June, 1881, and killed three men. It was somewhat shorter than most of its kind, and was the right-hand one of a pair placed over a puddling furnace, known as No. 4, in the Fisbach Rolling Mill, owned by Mr. C. M. Atkins, and located about a mile from Pottsville. This boiler was 30 inches diameter by about 26 feet long, made, in 1870, of a good quality of iron plates; 11 single-riveted rings composed the cylinder. The brand "C. H., Pottstown, Pa.," is seen on the plates, but no figures indicating their tensile strength were found. The heads were flat cast iron disks, about 1¾ inches thick, the front one having a man-hole in its center of the usual size. The rear head had no man hole. The flanges of the heads turned inward to receive the shell plates. The boiler had the usual water gauges and a 3 inch diameter lever safety valve. The pair of boilers were supplied with water through a cast iron T-pipe attached to the nozzles cast on the lower part of each front head. This exploded boiler and its mate were suspended by hook bolts and riveted staples, A, beneath cast iron arched girders placed upon the side walls at each end of the boilers. They were also united by a cross pipe or small steam drum of cast iron having a nozzle for the safety valve and the steam pipe by which they were connected to the system of nineteen pairs of similar boilers and four upright ones.



BOILER EXPLOSION, POTTSVILLE, PA.

Except the uprights and one pair of "starting" boilers they were all similarly heated by waste gases from puddling and reheating furnaces. The combustion of the fuel is urged by a large fan-blower, that delivers cold air, through a suitable system of suspended iron blast pipes, B, into the several furnaces, whence the gaseous products of combustion pass through the reverberating chamber, and rising through a flue at the extremity they return through the chamber beneath the boilers, traversing once their length in contact with their lower half, to the brick lined iron stack, C, supported on columns above the stoker's pit, as shown in Figs. 1 and 4. Steam in this system of boilers is maintained at from 60 to 70 pounds, blowing off at 70, as indicated by gauges at each of the three large engines. The steam thus generated is used to drive the works through a 44″ x 44″ upright engine for a 22 inch beam train, making 82 revolutions per minute; a 24″ x 60″ horizontal engine for the puddling machinery, 55 revolutions per minute; an upright 36″ x 36″ engine for the rail mill, making 85 revolutions per minute; together with several smaller lifting engines and the fan-blast engine.

THE HISTORY

of this boiler is fully given by Mr. Atkins, the owner, who has been many years in the iron business, and uses a great number of boilers, and he is very particular to procure the best of C. H. No. 1 plates for them. He testifies, referring to his admirable record books, that this boiler was made for him in March, 1870, put to work on the 28th of April, 1873, used interruptedly, the months and days in each year being designated, in all a total of 76 months, something over half the time since 1870 till the 10th day of June, 1881, when, according to the evidence, it exhibited its first symptom of weakness, a leak on the bottom, and within a half hour after it was discovered it broke in two, as shown at *a* in the engraving, Fig. 1, near the beginning of the third plate from the front end, where the hot gases from the furnace below first impinge on the iron shell.

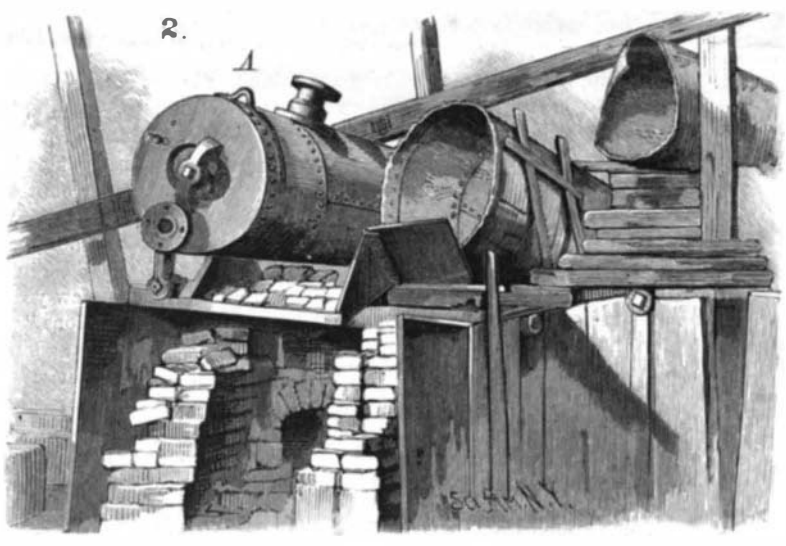
Some evidence before the coroner goes to show that the bottom of the shell was only three-sixteenths of an inch thick, and that the top was scant a quarter of an inch thick. This is probably an error, since each ring of the cylinder is composed of a single plate, as shown at *a* in Fig. 3, and it was observed by the writer to be of uniform thickness throughout. The iron measures 0·2100″ just at the edge of the ruptured plate on the bottom.

THE COURSE OF THE EXPLOSION

is indicated by the illustrations; the irregular line, Figs. 1 and 3, is the location of the rupture. Here the leak on the bottom was discovered a few minutes before the boiler broke in two. The fire bars were promptly ordered out by the master mechanic, Mr. Sharpless, but the man who attempted to do it was driven from the stoker's pit beneath the stack by the steam formed of the water blown from the rapidly increasing leak into the white hot puddling chamber, whence a "heat" had just been drawn. The man left the pit (to shut off the blast which he thought had been turned on by some one), and saved himself from a horrible death in the pit, for just then the boiler broke down, and the parts separated and took directions indicated by the angle at which they were acted and reacted on by the expanding water. (See dotted lines, Fig. 1.) The shorter piece took an upward and westward course, making several back somersaults among the steam pipes, blast pipes, and timbers, and fell within 25 feet of its starting point. The main portion not having so great inclination from the horizontal, after breaking down recoiled horizontally eastward against the stack, C, which in falling to an inclined position among the timbers broke and knocked down the main blast pipe, B, and a large shaft that ran north and south across the mill.

The upper part of the furnace or boiler setting was demolished, and the boiler fell and remained upon the damaged lower portion not far from its original place, as shown in Fig. 2. A large area of roof was blown off and destroyed Pipes and timbers in the track of the flying piece of the boiler were broken and thrown down, and steam, bricks, and splinters filled the air.

The water from the main portion of the boiler was projected by its own expansion, carrying bricks and pieces of iron with it down the "race," a thoroughfare between the furnaces, where the three fatally injured men had been at work.



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That the weakness that distinguished this boiler among its numerous fellows was the accidental location in its construction of an obscure or entirely hidden defect in a most trying spot, is a fair hypothesis. It is said that a flexible horse-nail was forged from a piece of iron cut from the plate *near* the fracture, but it is certain that *at* the fracture the iron was crystalline and brittle. No notable defects, either original or acquired, were found in the boiler. There were marks inside, not in the line of fracture, showing that scabs of deposit had recently been detached, and slight bulging appeared, but they were unimportant, and the boiler was practically clean and appeared to have been well cared for. It had never been patched or otherwise repaired, and no blame can justly be charged to its makers, owners, or managers.

The mildness of the accident is due to the direction of the weak line and the consequent gradual character of the break. Had the boiler opened instantaneously by the bursting out of a head or the breaking of the shell on a longitudinal line, from grooving, corrosion, or a ripped longitudinal seam, and had the three tons of superheated water been suddenly set free from the pressure due to its confinement, it would have expanded something as powder burns, and a greater effect would have been produced.

So far as the writer has observed during several years of study of this subject explosions from transverse defects have been confined to boilers in iron works, all similarly set and exposed to great and sudden changes of temperature. Some of the causes are obvious, but there may be others not yet traced.

It is believed that some safer method of setting gas-heated boilers can and ought to be devised. For example, a fire-brick arch or shield might be constructed to receive the first impact of the hot gases and the succeeding colder currents of air, protect the iron from the damaging thermal changes, and distribute the heat over a larger area of the boiler.

A jury of competent mechanics assisted the gentlemanly and zealous coroner, Dr. Will. C. J. Smith, of Pottsville, in examining this case. They rendered the following sensible

VERDICT:

"After visiting the mill at which the disaster occurred, and hearing the evidence relating to the death of Daniel Moran, Henry Lansberger, and James O'Neil, the jury find that the deceased came to their deaths from injuries received by the bursting or rupture of the boiler at Atkins' Fisbach Rolling Mill, on Friday, the 10th day of June. The jury are of the opinion that the accident resulted from the constant expansion and contraction to which all cylinder boilers are subject, destroying the fiber of the iron, reducing its normal strength to such an extent that when the fracture took place on the bottom of the boiler the metal remaining in the line of fracture was not of sufficient strength to resist the pressure to which it was exposed. These are circumstances over which neither owners nor employes have any control in this class of boilers. In our examination we found the iron to be of No. 1 character, with nearly its original thickness."

HATTERS say that the size of the human head in England and Scotland has been gradually diminishing in size within the last quarter of a century.

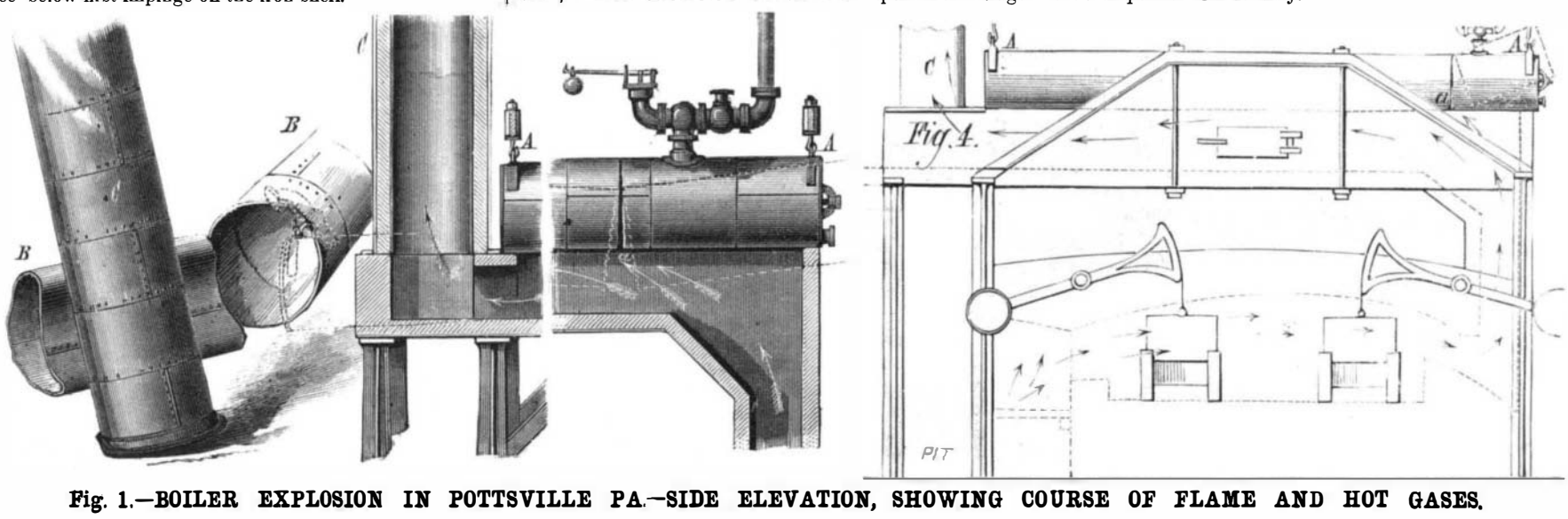

Fig. 1.—BOILER EXPLOSION IN POTTSVILLE PA.—SIDE ELEVATION, SHOWING COURSE OF FLAME AND HOT GASES.