

the bore remained in this state was about 880,000 imperial gallons per day, at a temperature of $82\frac{1}{2}^{\circ}$ Fahrenheit; the expense incurred up to this time being upwards of £12,000 sterling.

Sir John examined the theoretical reasons which had been given for the contortion of the tubes, which had been attributed to violent pulsations in the flowing water acting upon the outside of them, crushing them inwards; he objected to this reasoning as not being in accordance with the laws of hydrostatic pressure, and attributed it rather to mechanical causes arising from the force used in forcing the tubes down the hole, and even more to the violence they were subjected to in being withdrawn from it.

The letter was illustrated by a lithographic section of the well, which was presented by William Cubitt, Assoc. C.E.

Mr. Cubitt had recently visited the well, and found the water flowing with considerable force through an orifice in the vertical pipe about 8 feet beneath the level of the ground; the nozzle of the orifice, which was 10 inches diameter, was about half filled, and the stream was reported to be supplying about 2500 litres per minute, at a temperature of 82° Fahrenheit. The water was not clear; it deposited a considerable quantity of fine sand, and occasionally stones of about 2 inches cube were brought up. He was informed that the water had at one period ascended to between 70 and 90 feet higher than the ground.

Mr. W.
Cubitt,
Assoc.

Mr. Taylor observed, that the temperature of the water nearly coincided with that of the United Mines in Cornwall, which were 295 fathoms, or 1,770 feet, deep. The highest temperature recorded there was, he believed, 96° Fahrenheit. It was well ascertained now, by the experiments of Mr. Fox, that the heat was not increased either by the decomposition of the pyrites, or the number of men and horses employed in the mines.

Mr. Enys said, that the experiments by Mr. Fox, as published in the report of the seventh meeting of the British Association,* gave a temperature of 92° in the lode at a depth of 290 fathoms, where it was first reached in the cross-cut; but on proceeding along the same cross-cut, at 10 fathoms from the lode, the temperature decreased to $86^{\circ} 3'$, and at 24 fathoms distant it was $85^{\circ} 3'$: this would give a close approximation to the temperature quoted by Mr. Cubitt.

Mr. Braithwaite inquired at what depth the temperature began to increase; landsprings were generally at about 52° , and he found the

Mr. F.
Braith-
waite.

* Vol. vi., p. 133.

water in wells 600 feet deep usually at 53° or 54° . He had understood that the temperature increased 1° for every 65 feet after a certain depth.

Mr. Enys. Mr. Enys said, that Mr. Fox's experiments gave a ratio of increase of 1° of temperature in 48 feet, calculated from the surface. He thought that the close approximation of the temperature of the land-springs, and that in the wells mentioned by Mr. Braithwaite, might be accounted for by the rapidity with which the water filtered through the strata of the London basin.

Mr. Taylor. Mr. Taylor agreed that the heat of the water was influenced by the nature of the strata; the Cornish miners, when they were taken to the North Welsh mines, were much inconvenienced by the coldness of the water in the latter, although the depths of the mines in both districts were identical.

Mr. F. Braithwaite. Mr. Braithwaite believed that his view of the temperature of wells would be corroborated by the coldness of the water in the new well at Southampton, which had now arrived at a very considerable depth, and he understood that the temperature of the water was about 54° .

Mr. Simpson. Mr. Simpson said, that the well at Southampton had been sunk and bored to the depth of 1,063 feet: the supply of water was not considerable, and he was not aware that any observations had been made as to the temperature. A well at Chichester had now arrived at the depth of 1,013 feet, and was still being carried lower.

Mr. Sopwith. Mr. Sopwith contended for the accuracy of the investigations of Count Brenner on the temperature of two German mines, and of Messrs. Fox, Buddle, and others in England; the difference between the results obtained were so trifling as to induce confidence in the conclusion they had arrived at, which was, that after allowing for the radiation of heat at a certain distance from the surface, the temperature increased 1° for every 50 feet in depth. This law might not hold good in certain local basins, where from the nature of the strata the percolation of surface water was rapid, but in the extensive mining districts it certainly was correct.

Mr. W. Cubitt, Assoc. Mr. Cubitt suggested that the close approximation of the temperature of the water in the well at Paris, and that observed by Mr. Fox at the same depth in Cornwall, might arise in some measure from the large volume of water in the former, and the rapidity with which it arrived at the surface; whereas in the deep wells which had been mentioned, the water had probably been allowed to cool before the temperature had been ascertained.

Mr. Clarke. Mr. Clarke corroborated the opinion entertained by Mr. Cubitt: in a well which he had sunk to the depth of 540 feet at St. Alban's, he obtained, by an apparatus constructed for the purpose, some water

from the bottom of the well, and found it 4° hotter than that which was pumped up from the same well. At the bottom of a well at Messrs. Barclay's brewery, 367 feet deep, the water was 3° hotter than at the water-level in the same well. Local causes frequently affected the temperature of water in wells; he had seen instances of the water being warmer at 60 and 70 feet deep than at 300 feet, but these cases would not influence the general law.

Mr. Vignoles considered the facts mentioned by Mr. Clarke to be very valuable, and as bearing out Mr. Cubitt's idea; there could be little doubt that if, by means of self-registering thermometers, the temperature of the water was ascertained, at the issue of the springs, at the bottom of deep wells which were not influenced by local causes, the result would prove in accordance with the observations of Fox and others. By the laws of the circulation of fluids the heavier water, which had been cooled at the surface, mingled with the lighter and warmer water as it rose; the sides of the well also tended to abstract the heat: therefore the temperature should be obtained at the greatest depth in order to make any correct experiment.

Mr. Braithwaite agreed in the influence of local circumstances: in a well at Cheshunt, at a depth of 40 feet, a sulphureous spring issued, the vapour of which almost killed the workmen; and when at last it was built out, the bricks continued so hot that the hand could scarcely be borne against them. Below that point very cold water was met with.

Mr. Vignoles.

Mr. F. Braithwaite.

No. 556. "Description of the Water-pressure Engine at Freyberg, Saxony." By William Lewis Baker, Grad. Inst. C.E.

The machine described in this communication was designed by Water-Herrn Brendel in 1823, and constructed in 1824, for draining the "Alte Mördrgrube" mine, one of the largest silver mines in the neighbourhood of Freyberg, in Saxony. pressure Engine.

This engine, which is fixed at a depth of 360 feet below the surface of the ground, has two single-acting cast-iron cylinders, each 18 inches in diameter, and 9 feet stroke, to the pistons of which are fixed strong timber piston-rods, each attached at their upper ends by a flat iron rod and chain, to the opposite segments of a horizontal working beam, thus connecting the pistons of the two cylinders, so that, when one is being moved upwards by the pressure of water underneath it, the other is depressed by the weight of all the pump-rods and other moving parts to which it is connected.

The admission and eduction of water from the cylinders is regulated