and the action was so perfect as to drain the blocks of sand, and enable the headings to be completed.

Accounts were given of the numerous ingenious contrivances resorted to for overcoming difficulties, and also of the effects of the drainage upon the springs and wells in the neighbourhood. The various machines and devices employed, in connection with all the tunnels, were described; in fact, the Paper was, as it professed to be, a detail of the casualties of tunnelling under circumstances of considerable difficulty.

The paper was illustrated by a series of diagrams, showing the works in all stages of their progress.

Mr. PENISTON said, that the Paper was written with the view of pointing out the difficulty of sinking in sand, and the great care which was required in conducting the operations. The ground was perfectly dry when the timbers were set, but water soon made its appearance, and with it, large quantities of sand, which caused the shaft to deviate from the perpendicular. The difficulties which had to be encountered, were chiefly owing to a vertical fault very near the shaft.

Mr. F. BRAITHWAITE said, that in order to prevent the sand being drawn up with the water, the best plan was to excavate by means of the 'miser.' Similar cases to that recorded in the Paper, had occurred in France, and at the Kilsby Tunnel. In sinking a well at Messrs. Hanbury and Co.'s Brewery, of which an account had been laid before the Institution,[1] sand was pumped up, and eventually caused the fracture of the cylinder. It was almost impossible, under such conditions, to extract the water by pumping, without bringing away, at the same time, large quantities of sand.

Mr. N. WOOD had constructed a tunnel, three-quarters of a mile in length, through sand, in a range of hills towards Bolton: in this case a heading was driven from the lower end, and straw and litter were placed behind the poling-boards, in order to separate the sand from the water.

Mr. ERRINGTON inquired why, under the circumstances, open cuttings were not advised.

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[1] *Vide* "Minutes of Proceedings Inst. C. E.," vol. ii., 1842, p. 192, and 1843, p. 57.

Mr. PENISTON said, that there were no engineering difficulties, but there were obstacles of a personal nature, which prevented an open cutting being made. A heading was commenced from the lower side, but the influx of water soon became overpowering, and the workmen were compelled to retire. It was found, that the water was drawn away by the syphon more securely than by the pumps: it flowed away by the syphon, whereas it was jerked away by the pumps.

Mr. SIMPSON,—President,—said, it appeared to him, that in the case under discussion, money was wanting to overcome the land-owner, rather than to conquer the water. In all hydraulic works, the difficulties were increased by the paucity of the means for overcoming the water, usually at the disposal of the Contractors. In the case of the Victoria Sewer, it was difficult to ascertain from whence the water proceeded; means were taken to divert the influx, whilst engine-power was used to conquer the flow in the sewers, augmented by the rain-fall. Straw and litter would not always suffice for separating the sand from the water. Indurated sand might resist at first, but after a time, it became saturated with water, and, eventually, a burst and disruption occurred. With regard to the case of the well at Messrs. Hanbury and Co.'s Brewery, which had been mentioned, he did not take a very serious view of the matter, as would be seen by reference to the Paper upon that subject. He had advised the proceedings followed by the New River Company in sinking their well; in that case, he had found indications of movement at a distance of 200 feet from the shaft.

May 30, 1854.

The Session was concluded by a Conversazione, at which the President received the Members of the Institution, and a large circle of distinguished visitors, when the rooms were profusely decorated by works of art, with a good collection of interesting mechanical models.
