5th. A set of three-throw pumps, 5 inches in diameter, raising 80 barrels per hour, to a height of 54 feet, = 1 horse.

By calculation, as before, the friction amounted to $12\frac{1}{2}$ per cent.

6th. A set of three-throw "starting" pumps, pumping 250 barrels of beer per hour, to a height of 48 feet, = 4.87 horses.

By calculation as before, the friction amounted to $15\frac{1}{2}$ per cent.

7th. Two pair of iron rollers and an elevator, grinding and raising 40 quarters of malt per hour, = 8.5 horses.

8th. An ale-mashing machine, made by "Haigh," of Dublin; mashing at the time, 100 quarters of malt, = 5.68 horses.

9th. Two porter-mashing machines, made by "Moreland," mashing at the time, 250 quarters of malt, = 10.8 horses.

10th. 95 feet of horizontal "Archimedes screw," 15 inches diameter, and an elevator, conveying 40 quarters of malt per hour, to a height of 65 feet, = 3.13 horses.

Mr. Davison promised to continue these experiments, and to communicate the results to the Institution.

Poling-boards of the Thames Tunnel.

Sir M. Isambard Brunel presented a design intended to illustrate the mode of securing the poling-boards of the shield of the Thames Tunnel.

The poling-boards shown in the drawing, he described, as being intended to close the whole area of the excavation in the front, as the side and top staves were intended to secure the sides and top of it.

The shield (weighing nearly 180 tons), in passing over the ground, served materially to compress it, and make a firmer foundation for the tunnel. When it was considered that the mass of ground removed weighed 63,000 tons, while the brick structure by which it was replaced weighed only 26,160 tons; some idea might be formed of the difficulties which had been encountered in the progress of this undertaking.

It would be seen by reference to the early reports, that 540 feet of tunnel had been made in the course of sixteen months, *viz.*, from the 1st of January 1826, to the 27th of April 1827. At that period the miners and bricklayers struck, without even securing their work. In this emergency, after standing still a week, new hands were engaged; the result was, that on the 18th and the 12th of May, the ground showed symptoms of giving way, and on the 18th the river broke in and completely filled the tunnel; the length of brickwork then completed was about 550 feet.

He was convinced that no irruption would have occurred but for

the desertion of the men, for at no previous period had so much work been done; the average progress being 12 feet per week for sixteen weeks, and having at that time the advantage of his son's services and those of experienced assistants, the work might have continued, and the tunnel would have been finished in about four years.

After this irruption, an advance of only 50 feet was made within the period of the year 1827, and in consequence of a second irruption, the work was totally abandoned.

In the year 1835, after a lapse of seven years, being liberally assisted by the Government, a new shield was provided, and the work was resumed in the beginning of March 1836.

The work however, proceeded very slowly as contrasted with former periods. On the 11th of June the water broke in and continued to trouble the works for six weeks. Having succeeded in repelling this attack, the progress for the whole year amounted to 117 feet.

Foreseeing that he should at some future period, have to account for the causes of these delays, Sir Isambard instituted, in the course of the year (1836), distinct sets of records for every branch of the service, afloat as well as underground, in order to place beyond doubt, the circumstances which might not otherwise be credited. These registers enabled him to give the minutest details of the work, and would, he hoped, be found useful in any future similar undertaking.

Through the whole of the year 1837, the progress was only 28 feet 4 inches, a rate which hardly exceeded that of a fortnight of the year 1827. Two irruptions took place within the range of eight feet, owing to the looseness of some portions of the strata, which were so fluid, that the only expedient for advancing, was by forcing forward some of the polings with the screws. The frequent bursts of gas at that period, and in 1838 and 1839, had moreover such an effect upon the men, that some of them fell senseless at their post. There was therefore great risk of the poling boards falling down, as had been the case before, and causing a total disruption of the ground.

In this dilemma, the expedient of connecting the poling boards with each other by hooks was resorted to, forming by this means a complete panel in the face of each of the 36 cells of the shield; the top poling being suspended to the head of the cell, the panel could not be disturbed even with a cavity in front of it; there was likewise an additional means of supporting the polings, by iron spurs resting upon the floor-plates and going into the ground.

Notwithstanding the apparent increase of labour occasioned by this addition to the poling-boards, good progress was made, amounting to 249 feet in the course of twelve months, and the hooking was found so safe in its service and its results, that were another tunnel to be

constructed, Sir Isambard stated, that he would make the system of attaching the poling boards, an essential part of the organisation of the shield, being convinced that it might by this means, be worked through the worst ground, with a certainty of safety and success.

February 14, 1843.

The PRESIDENT in the Chair.

No. 593. "Description of Mr. Clay's new Process for making Wrought Iron direct from the Ore; as practised at the Shirva Works, Kirkintilloch, Scotland." By William Neale Clay.

Clay's process for making Iron.

In this communication, the author first describes the various stages through which the metal passes, between the reduction of the ore and its arriving at the state of malleable iron, by the ordinary mode of manufacture; and then he explains the process which he has invented, and introduced practically at the Shirva Works.

By the ordinary system of iron-making, the ores are reduced into the state of carburet of iron, and then, by refining and puddling, the metal is de-carburetted, thus making it into malleable iron by a number of processes, which are recapitulated:—

1st. Calcining the ore.

2nd. Smelting in a furnace, by the aid of blast, either cold or heated, with raw coal, or coke, for fuel, and limestone as a flux.

3rd. Refining the "pig" into "plate" iron.

4th. Puddling, shingling, and rolling, to produce the "rough," "puddled," or No. 1 bars.

5th. Cutting up, piling, and rolling, to produce "merchant," or No. 2 bars.

6th. A repetition of the same process, to make "best," or No. 3 bars.

Seeking to diminish the number of manipulations, by the new process a mixture of dry Ulverstone, or other rich iron-ore (Hæmatite), is ground with about four-tenths of its weight of small coal, so as to pass through a screen of one-eighth of an inch mesh. This mixture is placed in a hopper, fixed over a preparatory bed, or oven, attached to a puddling furnace of the ordinary form. While one charge is being worked and balled, another gradually falls from the hopper, through the crown, upon the preparatory bed, and becomes thoroughly and uniformly heated; the carburetted hydrogen and carbon of the coal, combining with the oxygen of the ore, advances the decomposition of the mineral, while, by the combustion of these gases, the puddling furnace is prevented from being injuriously