however, with such rapidity that they were compelled to retreat, and were near being jammed against the crown of the tunnel. For a considerable time all the pumping apparatus appeared insufficient; so much so that the Directors almost determined to abandon it, but the perseverance of Stephenson prevailed, and he had at length the satisfaction of seeing the water recede before the power of his engines.

The tunnel is 2,400 yards in length, or nearly a mile and a half; it is 25 feet wide and 28 feet high, and is ventilated by two large shafts, each being 60 feet in diameter—one being 120 feet deep, and the other 90 feet; they effect so perfect a ventilation, that within a few minutes after the passage of a train, the smoke and vapour is carried off, so that the opposite end may be distinctly seen.

The time employed in constructing this stupendous work was thirty months; there were 36,000,000 of bricks used in it, and it cost £300,000—nearly three times what it would had the difficulties been of an ordinary character. This line of railway has eight tunnels of similar dimensions, that is 25 feet by 28 feet.

The most important bridge on the line is the Wolverton Viaduct, it is erected over the Ouse, near Stony Stratford, and consists of six semi Eliptical Arches, each 60 feet span, the roadway being elevated about 50 feet above the ordinary level of the Country. This Viaduct (except the coping which is of stone) is entirely composed of brick. The aggregate amount of excavation on the whole line amounted to about 15,000,000 of cubic yards, being equal to an average of 142,000 cubic yards per mile, and was completed in the short space of four years from its commencement.

The above figures indicate an expensive line, and accordingly we find that the favourable grades and curves have been obtained at a cost of about £42,000 per mile!

During the construction of the London and Birmingham line, the Belgian Government consulted Messrs. George and Robert Stephenson, as to the best system of railways to be adopted in that country. On their advice a cross of Trunk lines, extending from Ostend to Liege on the one hand, and on the other, from Antwerp through Brussels, to be connected with Mons and Valenciennes (making in all 347 miles) was adopted, and authorised by law in 1834. The Stephensons were both decorated by the King of the Belgians with the Ribbon and Cross of the Legion of Honor. These lines were completed and opened in 1844.

After completing the London and Birmingham line, Robert Stephenson, in conjunction with his Father, undertook the construction of various lines of railway, embracing a length of about 1800 miles, and for ten years were incessantly engaged in the Parliamentary Contests, originating the great net work of lines extending over all parts of the Kingdom.

The Birmingham and Derby, the North Midland, York and North Midland (to which the elder Stephenson chiefly devoted himself), the Manchester and Leeds, and the Northern and Eastern, were all constructed under Robert Stephenson and his Father; and during the same period the former as Chief Engineer, constructed the great Iron Cross of Roads which connect London with Berwick on the one hand, and Yarmouth with Holyhead on the other.

The York, Newcastle and Berwick line is one of the greatest of Stephenson's works, and in its length is the magnificent High Level Bridge over the Tyne, at Newcastle, and the beautiful Viaduct of twenty-eight arches of 125 feet in height, and 61 feet 6 inches span across the Broad Valley of the Tweed at Berwick, connecting the North British line with the York, Newcastle and Berwick, and completing a continuous railway route from London to Aberdeen.

Though not personally superintending his engine manufactory at Newcastle, Mr. Stephenson still continued to design and introduce various improvements into the locomotives there manufactured; amongst them the most important is the "Link Motion." It is probable that he was not the originator of this beautiful piece of mechanism, though it was first applied to his engines. Various arrangements of the valve-geering had been used for introducing the expansive action of steam, and for reversing the engine—while the working of the simple slide-valve was effected in almost as many different modes as there were makers of engines. Generally, their plans were so complicated as to cause very serious expense in maintaining them in repair, and the ordinary wear in so many working parts produced a derangement in the valves, necessarily resulting in a serious loss of power. It was therefore an important matter to simplify these parts, and still more important to preserve and improve the means of adjusting as circumstances required. the amount of expansive action given to the steam.

To Mr. John Gray is due the merit of the first application of the expansive principle by varying the travel of the valve, a principle of primary importance, though originally embodied in a complicated and inconvenient piece of geering.

Mr. Cabrey, of the North Midland Railway, accomplished the same effect in a more convenient form, and following up the same idea, Mr. Williams, at one time of Newcastle, suggested the germ of the link motion in a form, which, though rude and impracticable, still embodied the principle: and that principle, when further perfected, became in conjunction with the "lap" of the valve, the most important acquisition to the locomotive since the introduction of the blast-pipe and the multitubular flue.*

Since the application of the link motion to Stephenson's Engines in 1843, by Mr. Howe, but little has been done to improve its action—substitutes for the "link" have been proposed with no very tangible object except the saving of an eccentric—and though from not having been properly investigated, the correctness of its action has been denied by some; it has been gradually adopted by nearly all English manufacturers, and is now generally used by manufacturers in America.

No improvement has done more to economise the cost of working a railway than the introduction of the expansive principle into the Locomotive, and no contrivance so perfectly accomplishes that object as the "link motion."

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* In order to exhibit the value of the lap of the valve, we introduce a tabular statement of the result of experiments made on the Liverpool and Manchester Railway, in 1842-3, with a view to test the value of the changes made in the valves,—as affecting the consumption of fuel.

Gross consumption of Coke per mile.

49 lbs. average consumption of Company's Engines in the summer of 1839, with old Valve.

40 lbs. average consumption of Company's Engines, after the introduction of the new mode of Coke deliveries,—old Valve.

36 lbs. new Valves with ¾ inch cap.

32 lbs. new Valves with ½ inch cap.

28 lbs. new Valves with 1 inch cap, as applied to old steam and exhausting passages.

22 lbs. same Valves and same Engines, with increased care in firing, so as to avoid all unnecessary waste of fuel.

15 lbs. Valves with 1 inch cap, as applied to the new Engines, with enlarged exhausting passages, larger tubes, and closer fire bars, and greater accuracy of construction.