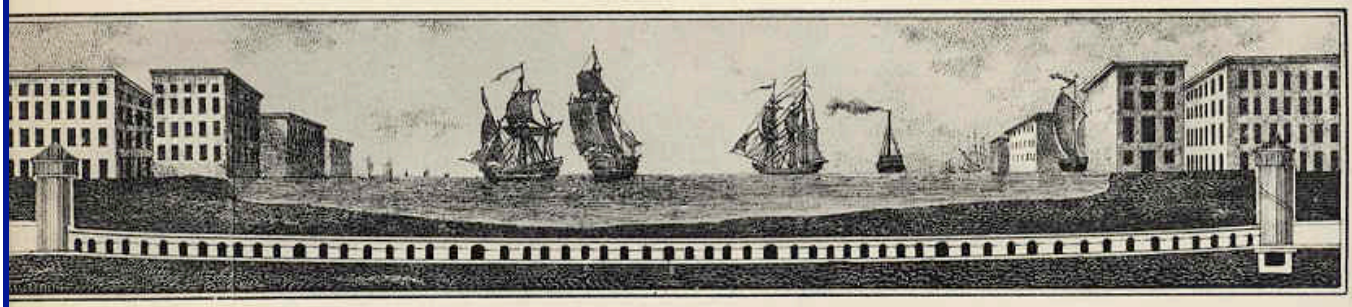
EARLY TUNNELS & UNDERGROUND RAILWAYS - 1



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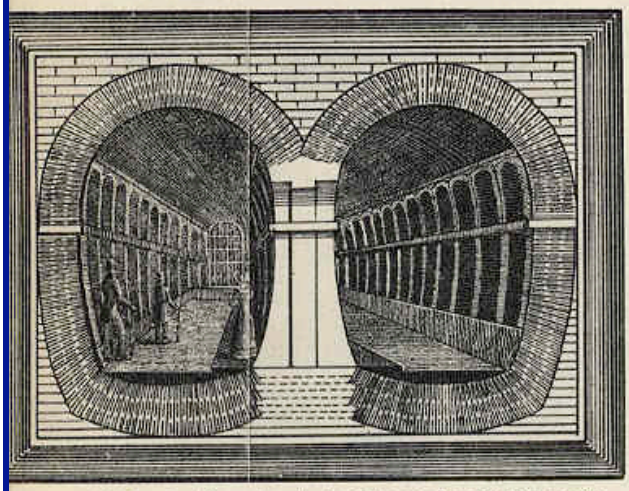

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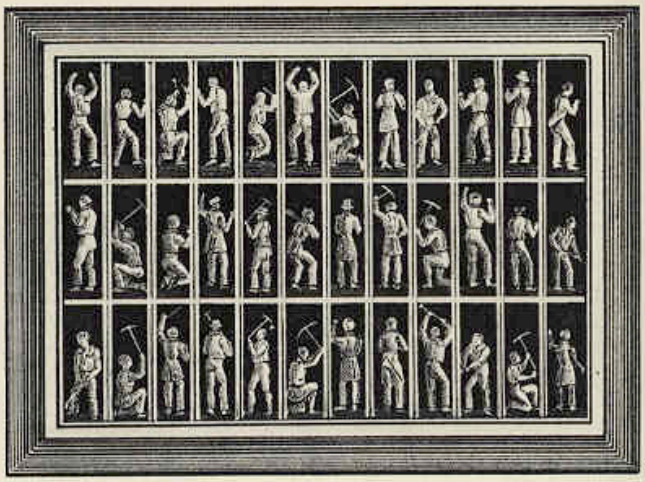

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299 London. Tunnel under the Thames. Longitudinal section. 300 Caisson used in boring the tunnel. 301 Framework used in tunnelling.

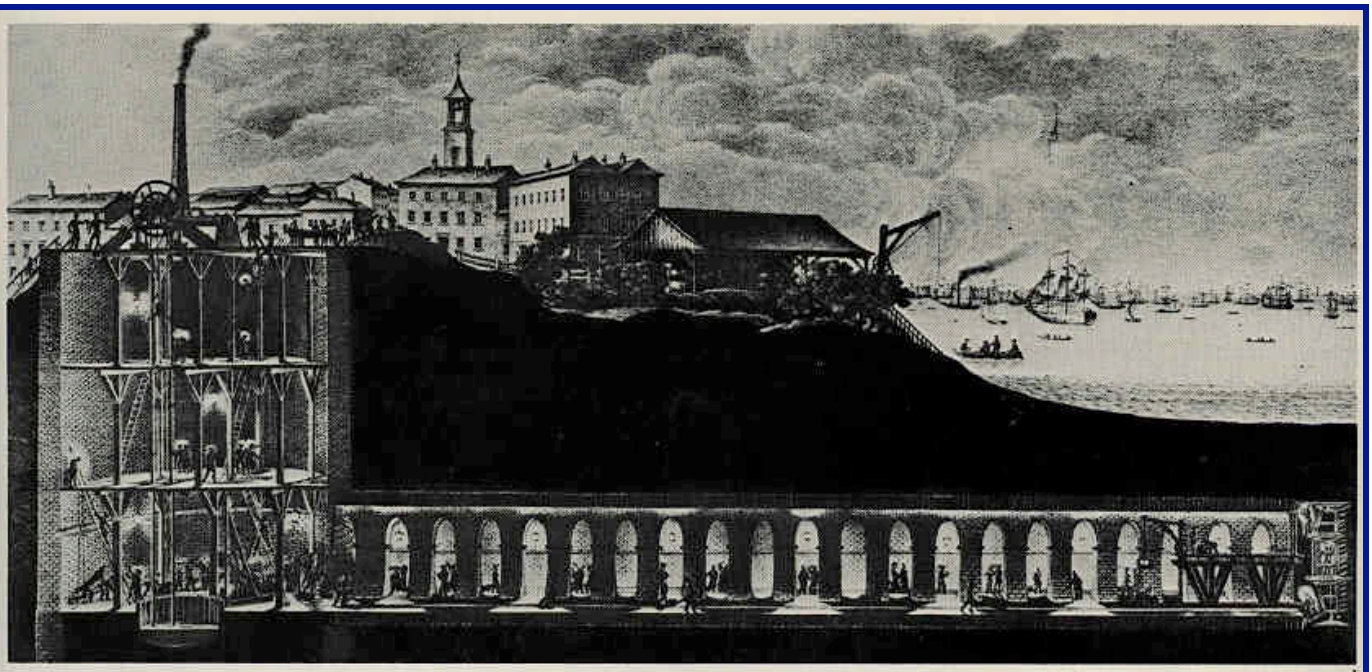
In 1825, the same year as the first railway was opened, another enterprise was begun in England which seemed at the time to verge on insanity. The idea of linking the two banks of the Thames by a tunnel in the eastern district of London had been mooted for almost a century, because the movement of shipping in the busy port of London made the building of another bridge in this sector appear out of the question. The first tunnel project was suggested and discarded as early as 1798. It was followed by others and there were even attempts to put the idea into practice, but these were quickly abandoned under the combined pressure of practical difficulties and public opposition. The idea of attempting to travel underneath the river provoked an almost superstitious fear in the popular mind.

At last an engineer appeared on the scene who embodied all that was boldest and most adventurous in the spirit of the age. Marc-Isambard Brunel was a Frenchman by birth, a naturalised American, and, at the time of his death, the possessor of an English knighthood. His 299 tunnel* under the Thames was begun on February 16th, 1825, and not opened to the public until February 1843, after eighteen years of continual setbacks. Brunel's idea was to construct thick 300 shafts of brick*, sixty-five feet wide, the first of which was sunk some fifty yards from the bank. By means of these it was possible to dig winding-shafts and then proceed to cutting the actual tunnel underneath the river bed. Brunel personally supervised work in the shafts which was carried out with the help of 301 shields, platforms and derricks*.

Water was continually leaking into the tunnel; the men working on it took fright and there were a number of strikes; twice the tunnel was flooded and the work had to be begun all over again. Brunel did not give up. The London public, sceptical at first, became excited about the project. A writer in one newspaper hailed it lyrically as 'the wonder of all civilised Europe. . . .' Finally the tunnel was completed, the prototype of all the great tunnels built during the Nineteenth Century and the ancestor of the underground railway.

In the years between 1810 and 1850 England was well in the vanguard of the technological progress that was to alter the face of Europe. But not only Europe was on the move. On the other side of the Atlantic the American continent was in a ferment of expansion. In forty years its population had grown from four to twelve million. 'We are still growing', wrote one American in 1817, 'at a great, I might almost say a terrible rate.' Over the half century which followed, the wave of emigrants was to continue, surging ever westwards by easy stages. Thousands of covered wagons streamed to the west whenever an economic or political crisis brought a recession in the

Marc Brunel's Tunnel under the Thames, 1843; now part of the London Underground System
The Great Works of Mankind (from the French), Bodley Head, London, 1962
(The tunnel and its towers have been visited by the CIBSE Heritage Group)

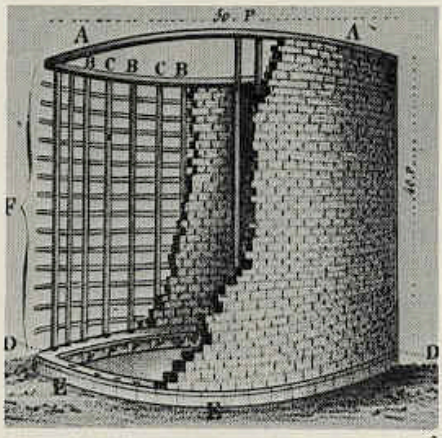


1. The tunnel being built – from the southern end on the Rotherhithe shore.

2. Section view of the vertical shaft sunk at Rotherhithe. Brunel's approach was typically unorthodox. Instead of digging a vertical shaft, and lining it down to the depth at which the tunnel proper would branch out horizontally under the river bed, he built upwards. A tower of bricks, forty-two feet high was erected on a circular metal hoop, fifty feet in diameter. Digging then began inside the tower, and, as the wooden under-pinning of the hoop was removed, the hoop and the whole tower sank into the ground a few inches at a time under its own weight. The sixty-four-foot shaft was thus sleeved against subsidence all the way down.

3. The Wapping entrance as it looked shortly after it was opened as a pedestrian thoroughfare under the Thames in 1843.

4. Brunel waves to the crowds at the opening.



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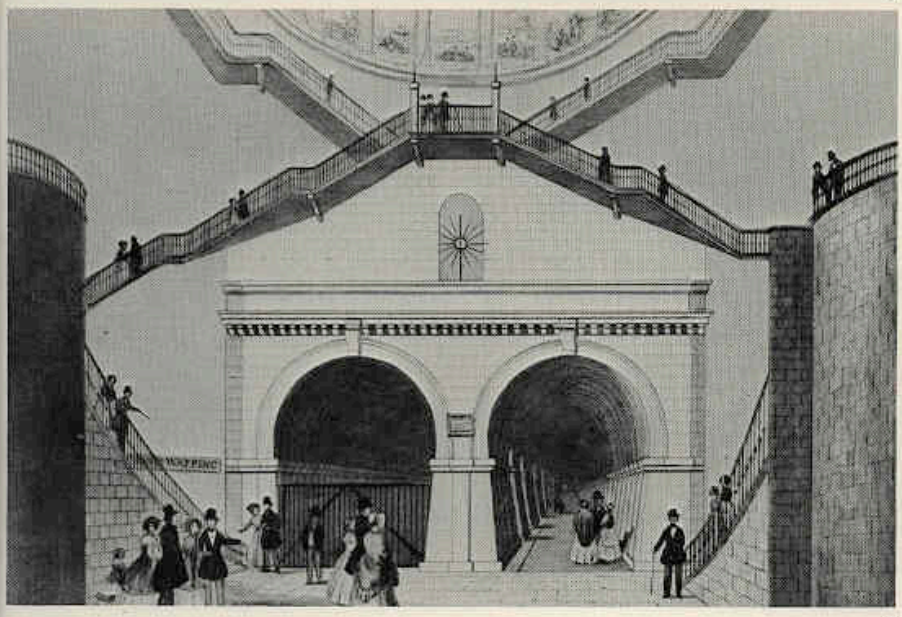

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The Tunnel

The Thames watermen hung out black flags. Who now would need to be ferried between Wapping and the Surrey shore? On the March day in 1843 when the first tunnel under the river was opened, they saw it as the end of their livelihood.

But to the crowds lining the streets of Rotherhithe this was an historic occasion. A practical necessity was at last answered. The tunnel was a link with the docks across the water and would cut down by nearly a day the time it took goods to reach south London in a detour over London Bridge. It was an engineering miracle–the first tunnel ever built under a navigable river. After twenty years of waiting, they were seeing yet another achievement in a century of great mechanical progress.

So there was a special cheer for the little old man in gaiters who, waving his top-hat, was part of the procession to the entrance. In honour of Sir Marc Brunel the military band played 'See the Conquering Hero Come!' Brunel had succeeded where all other engineers had failed. He had overcome dangers, flooding, lack of money, and a scoffing press.

At seventy, Brunel had got up from his sick bed to see the opening of the tunnel on which he had laboured since 1825 when 300 navvies had started work at Rotherhithe. With the originality that marked everything he touched, the French-born engineer had devised a special tunnelling shield. This enabled miners, each in separate alcoves on a large iron frame, to concentrate on a small area at a time. Every few inches they burrowed

London: 2000 Years of a City and its People, Felix Barker & Peter Jackson, Cassell. London, 1974

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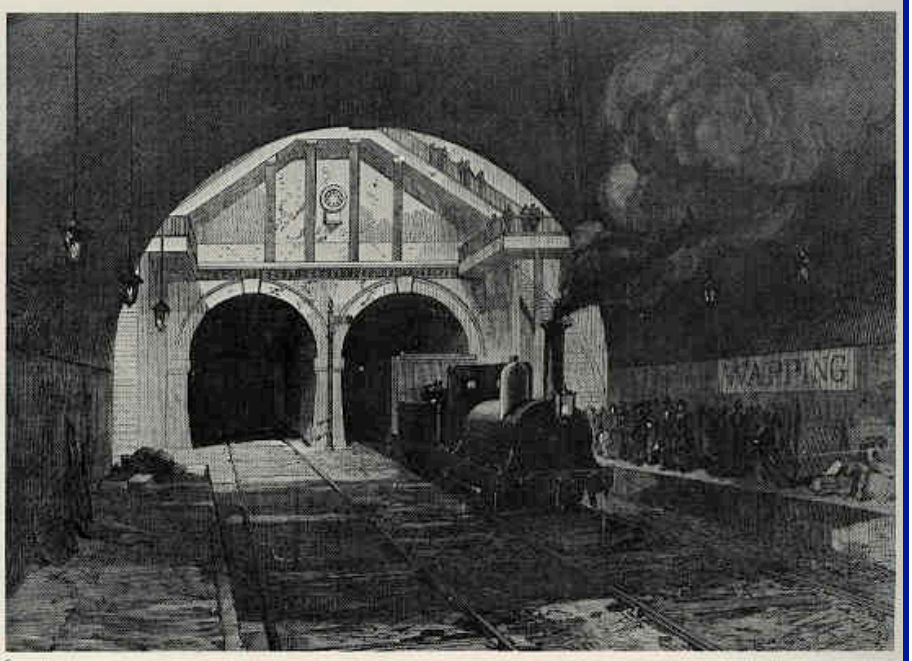
forward were secured against inundation before they went on. Breakthroughs of water could be isolated and, he hoped, contained.

In these alcoves, the miners worked thirty at a time–side by side, ten men on three levels. Progress was slow on the tunnel-face which was 15 feet high and 36 feet wide, to allow two carriages and a footpath. The rate of progress was only eight to twelve feet a week, and every foot was barrel vaulted with 5,500 bricks. Even with this cautious method, water came through. Working by the light of candle lanterns, the miners were in constant terror of a sudden inundation. Several times a warning shout of 'The Thames is in!' sent them rushing from the tunnel face to the entrance shaft.

At some points the tunnel passed less than six feet below the river bed, and at high tide when the water pressure was at its greatest, the shield had to withstand a weight of 600 tons. One night, when the tunnel was a little more than half-way under the Thames, water burst through with the force of a mill race. The whole tunnel flooded, and by morning the water level was within three feet of the top of the vertical shaft. 'A just judgment on the presumptuous aspirations of mortal man,' was how a Rotherhithe clergyman described the setback. 'Poor man!' was all Brunel said when he heard the comment, and he promptly went out into midstream and was lowered to the river bed in a diving-bell to investigate the damage. He plugged the hole with tons of clay and rubble, pumped out the tunnel, and work was resumed. After this, the weak part of the river bed was strengthened by a tarpaulin ninety feet long which was lowered and chained down over the area threatened with the greatest pressure. But there were to be two more serious inundations and seven drownings before the tunnel under the river was completed.

In 1840, Brunel, over seventy and fighting ill-health, was knighted by the Queen. On a November day two years later, Sir Marc with his son and chief assistant, Isambard Kingdom Brunel, were down in the shaft on the Wapping side when contact was made with tunnellers from the opposite shore. With them was Isambard's son and Marc's grandson. The child was the first to walk through the hole into the arms of a Rotherhithe miner.

5. The tunnel (precursor of Blackwall, 1897, and Rotherhithe road tunnel, 1909) was never used as planned, or fulfilled its grand conception, largely because of insufficient money to build approach ramps for carriages. Thanks to Wellington, a Government grant of £250,000 was advanced to finish it; but there was no more money to build the ramps which were so essential. It became a tunnel for foot passengers (toll 1d.), one of the 'sights' of London visited by about a million people a year to attend bazaars and illuminated anniversary fêtes, like the one above in 1858. 'An admirable prison', thought Nathaniel Hawthorne, who saw it neglected and gloomily lit with gas jets. In 1864 the East London Railway Company bought it to link north London with Brighton, as seen below (6). Then it was absorbed by the Underground, and now serves the Whitechapel-New Cross line.



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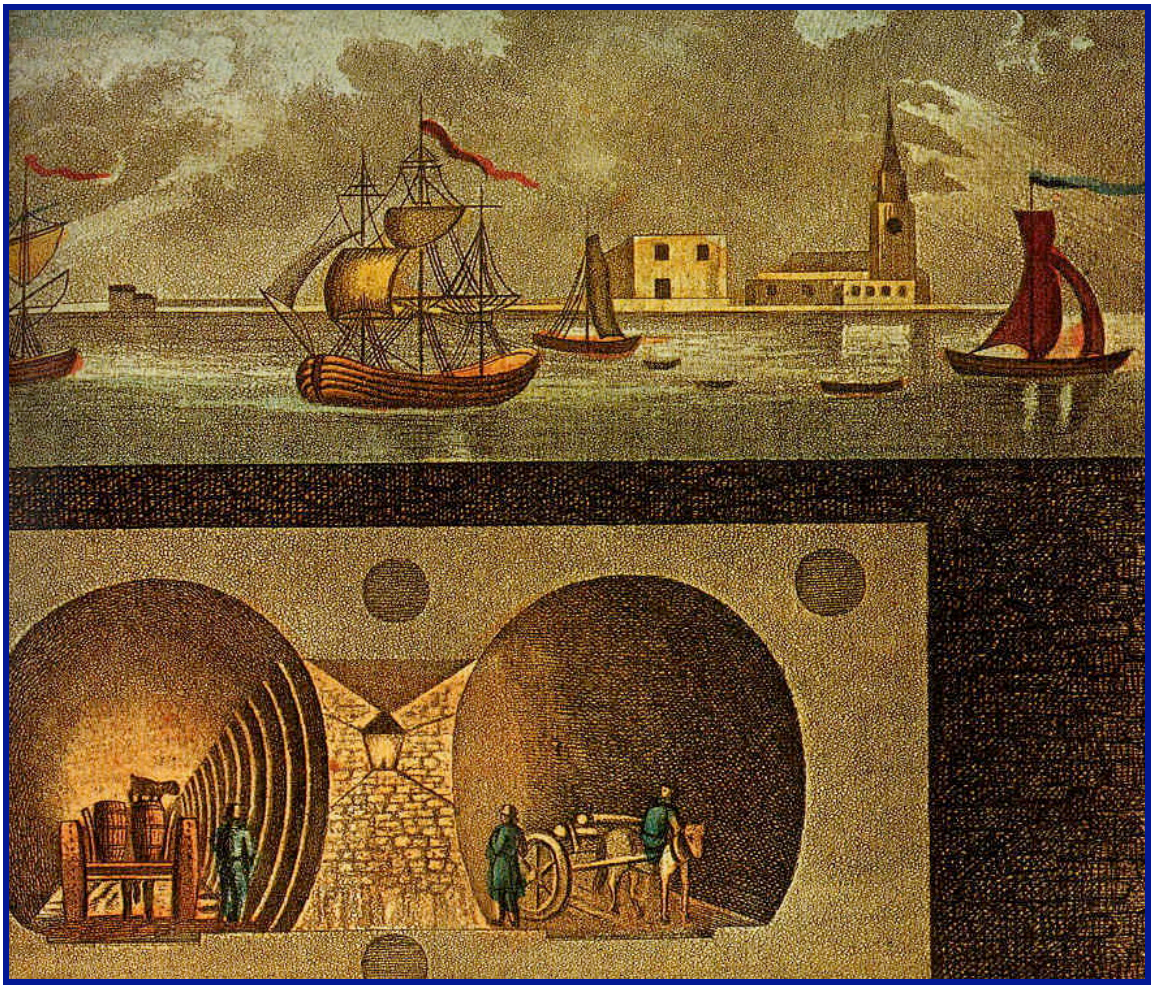
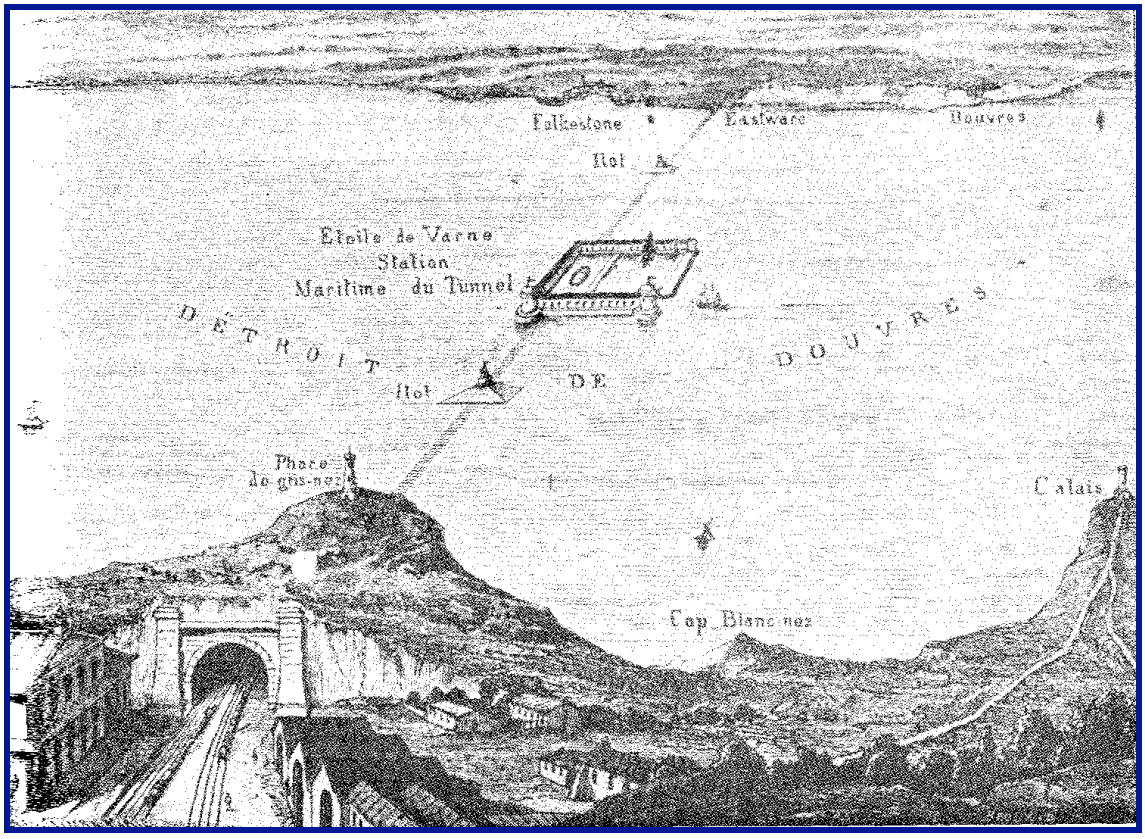


Detail from an early print of Brunel's Thames Tunnel



Gamond's idea for a Channel Tunnel with a centre island and vent shafts, 1856

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Sea of troubles

Why has the Channel Tunnel taken so long to be built? *Roderic Bunn* studies a recently unearthed engineering drawing of 1914, which shows the military precautions that had to be faced by the Edwardian "chunnellers".

For nearly 1000 years the channel has protected the UK from foreign invasion; where William the Conqueror once succeeded, the King of Spain, Napoleon and Adolf Hitler have all failed. However, in the current climate of peaceful coexistence, the military objections to the building of a tunnel linking England and France have all but disappeared.

It is easy to regard the Channel Tunnel as a recent invention, but it has an ancestry going back to 1802, when the idea was first raised. Very little happened until the 1850s, when it was proposed by some British and French engineers that a tube be laid along the sea bed. Among them was English engineer William Low, who thought that two single line tunnels with passages to connect them could be engineered. An Anglo-French committee managed to interest the respective governments and at the Paris Exhibition of 1867 a model of the tunnel was shown by Thome de Gamond.

In 1872 the English Channel Company was set up, with British Parliamentary approval, to begin tunnelling. Operations were begun at Sangatte, near Calais, and at Shakespeare's Cliff, near Dover. Headways were bored for 1800 m under the sea at each end, but opposition to the idea of a tunnel linking England with mainland Europe was growing, and Queen Victoria, William Gladstone and the military lobby were all voicing disapproval.

Finally, a War Office committee decided that a tunnel would not meet defence requirements, and a parliamentary committee of 1884 voted against parliamentary sanction for any tunnel. As a consequence, tunnelling operations ground to a halt.

In 1907, with renewed warmth of Anglo-French relations, the idea of a tunnel was revived but again it was turned down by Parliament, as were attempts in 1913 which were vetoed by the Committee of Imperial Defence.

Exactly what threat a Channel tunnel was thought to pose can only be guessed at, but an engineering drawing dating from the period hints at attempts by the tunnel's designers to persuade the military that all suitable precautions were being taken to limit the danger a tunnel might afford in easy access to a prospective invader.

The 1914 drawing shows how the designers had to make sure that the mouth of the tunnel was able to come under direct fire from both Dover Castle and the Western Heights Forts. It also had to be able to come under shell fire from naval vessels patrolling in the harbour.

The next requirement was that the tunnel had to be in direct communication with both fortresses and to have sluices provided entirely under the control of both commmandants. By means of these sluices a mile of the tunnel known as "the dip" could be filled with water up to the roof. Such water could not be removed except at the forts, and then only with the knowledge and approval of the military authorities. No means were to exist at the French end of the tunnel to enable this water to be pumped out.

The military authorities also insisted that the electrical power station necessary for working the ventilation and pumping machinery should be on British soil and be placed 10 to 15 miles inland. This was on the basis that without power the tunnel would be unworkable and impassable. Presumably the thought was also in the military mind that this power station could be the first target in an invasion attempt. By 1914 of course, the aeroplane was only just becoming a weapon of war, much less a strategic bomber!

Even with all these defence considerations, the military still felt it necessary to add the rider that, should the precautions be considered insufficient, arrangements should be made similar to those in the case of Mont Cenis, the Simplon and "other important tunnels" by which a portion of the actual tunnel could be destroyed by the commandants of either fortress and that repairs could not be effected without their consent.

The drawing is signed Douglas Fox & Partners, engineers to the Channel Tunnel Company.

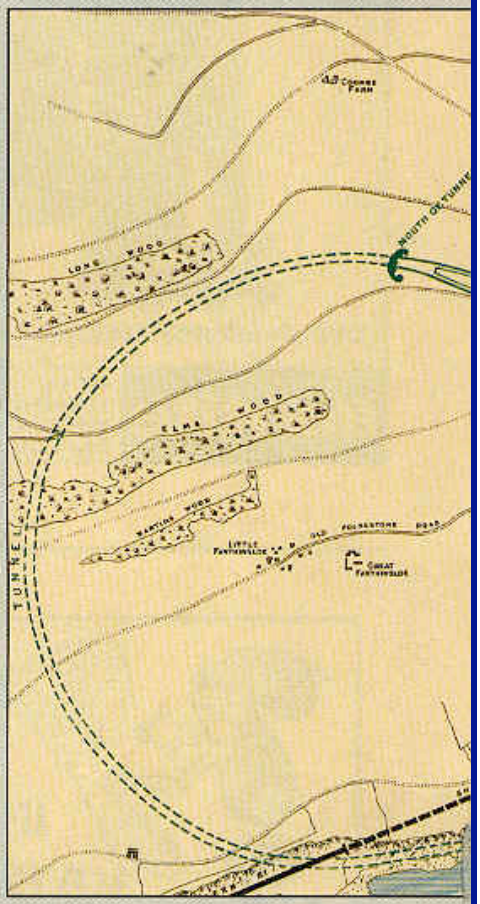
Building Services would like to thank Ron Baker of the HVCA and A J S Golding of Rivalbridge Ltd for their help in bringing this drawing to light.

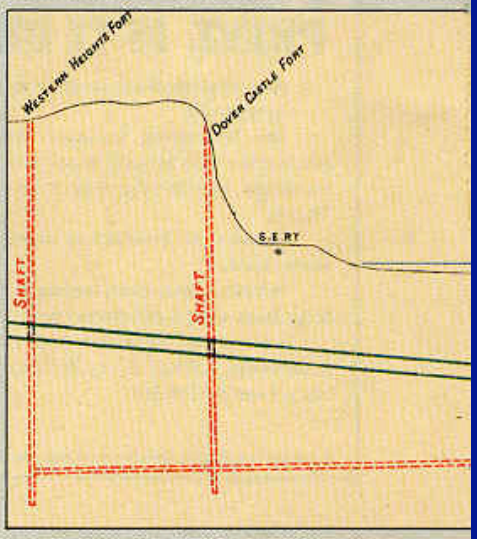
Bottom left: Site where shaft was to be sunk at Dover.

Right: Beaumont and English's compressed air tunnelling machine.

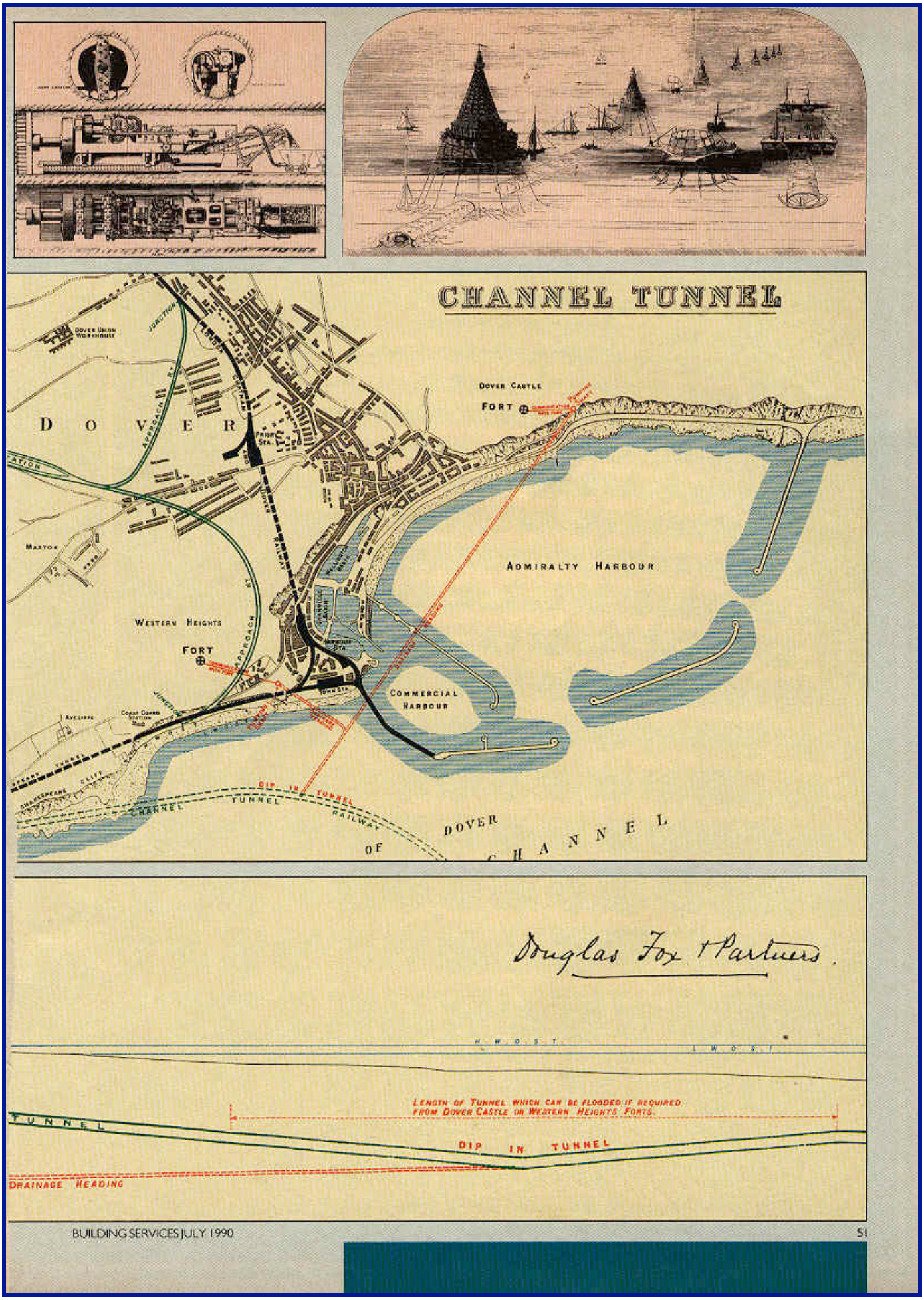
Far right: Submarine railway between France and England, projected by Hector Horeau.

Below: Plan and longitudinal profile of tunnel showing lowering of rails and drainage headings for flooding in case of necessity.





Early history of Channel Tunnel proposals



Channel Tunnel design of 1914

The First Underground

Traffic congestion on roads leading into the City was relieved in the south by the river boats. But another solution was needed for the north side of London. It came in the revolutionary idea of an underground railway put forward in the 1830s by a City solicitor, Charles Pearson. He was concerned not so much with traffic as with the difficulties faced by people who were forced to move out of central London when their homes were converted into business premises. Pearson argued that by building an underground railway between the City and Paddington, these people could travel in and out of London daily for a nominal fare. His proposal included a specially planned estate of 10,000 cottages seven miles out.

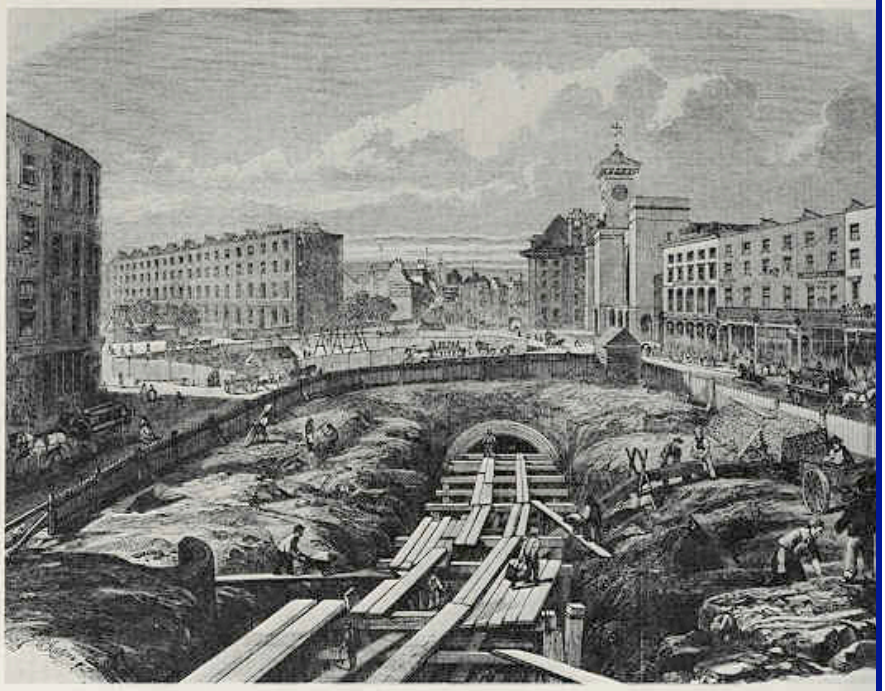
The estate was never built, but thirty years later he saw his scheme materialize as the Metropolitan Railway. Just under four miles long, it linked Paddington, Euston, and King's Cross stations with the City Terminus near Smithfield. It was the world's first underground railway.

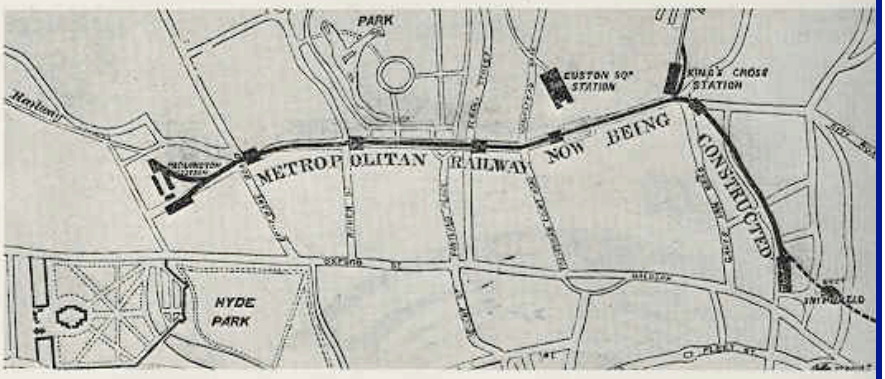
To prevent costly demolition, the line followed the New Road, and at King's Cross turned south-east along and under Farringdon Road. For once, Parliament raised no objections, and New Road residents agreed, influenced by the plausible argument that it would reduce surface traffic past their doors. Costs were further kept down by 'cut and cover' construction. Instead of tunnelling (as for the Tube later), a trench between 25 and 59 feet deep was cut, the sides revetted with bricks, arched over, and the road replaced.

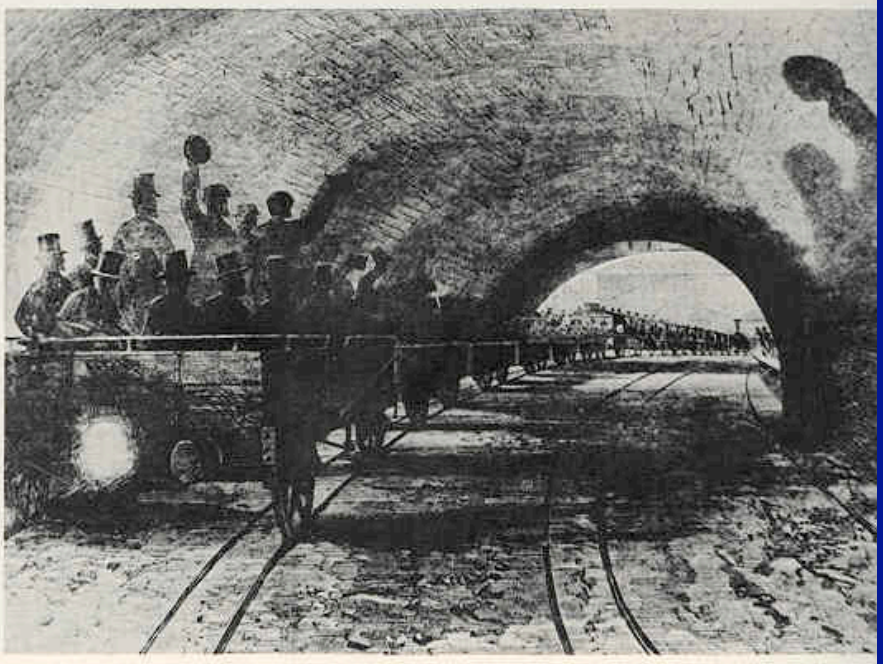
Work, which started in 1860, took three years. West of King's Cross, the work was easier as the tunnel ran through gravel, and there was only one main sewer, the Tyburn, to be negotiated. But to the east, it ran through clay, and the Fleet Sewer had to be crossed three times. During building the sewer burst, and serious flooding delayed completion. But all was ready for the opening in January 1862.

From the start, the Metropolitan was an immediate success. In the first six months 26,500 people used it daily. With a threepenny fare for the 18-minute Paddington-City journey, the horse-bus was outrivalled. And there were cheap fares for workmen, too. The visionary Pearson died three months before the opening.

The way was now open for the whole complex network of lines – the District, Inner Circle, City and South London, and Central – which was to burrow under London in the next fifty years.

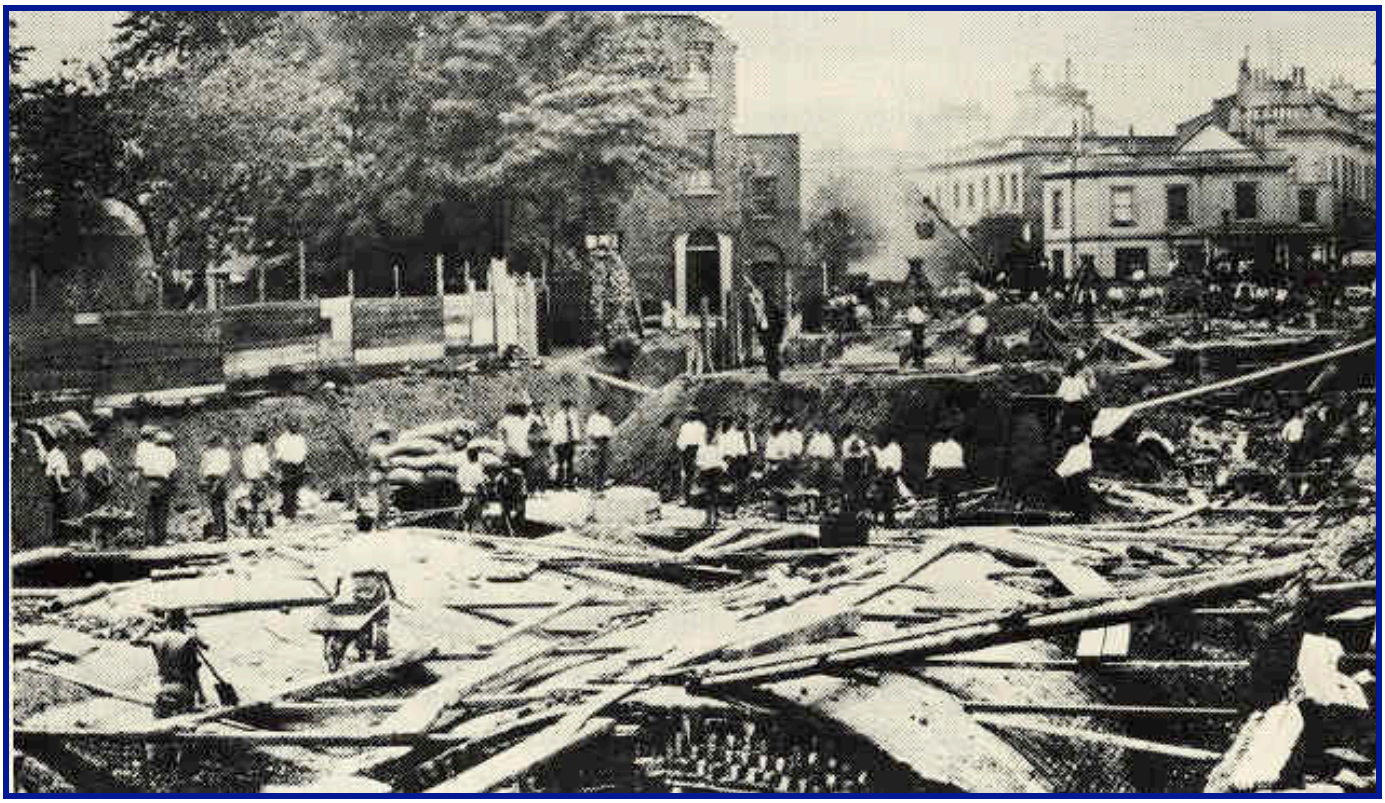






1. Work in progress on the Metropolitan Railway – view from Pentonville Road looking west towards King's Cross.
2. Plan for the Metropolitan Railway, 1860.
3. After this trial trip – immediate success.

The Metropolitan Line (engraving by Gustave Dore) 1872



The Twin Tunnels of the District Line at South Kensington
London under London, Richard Trench & Ellis Hillman, John Murray, 1984