

Marc Brunel's engine house at Rotherhithe

by R. G. Barnes

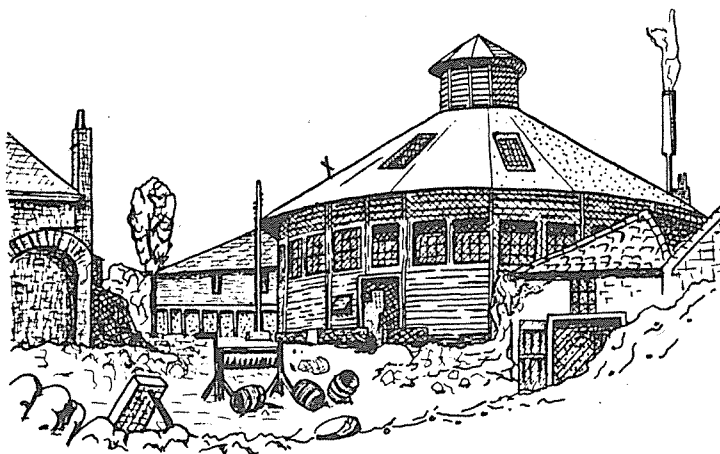
The Thames Tunnel between Rotherhithe and Wapping was the greatest civil engineering work to be directed by Marc Isambard Brunel (1769–1849) and was a profound influence on the career of his son Isambard Kingdom Brunel (1806–59). The tunnel was a wonder of its time and its construction was a triumph against adversity, remarkable even by the standards of early 19th century engineering projects. It was opened in 1843 as a pedestrian thoroughfare and is still regularly used by London Transport for the Underground service between Whitechapel and New Cross. The original access shafts at Rotherhithe and Wapping survive and at Rotherhithe there remains a small engine house which probably dates from the early years of the tunnel.

The engine house and the area around the Rotherhithe shaft have been the object of recent conservation and restoration work by the Brunel Exhibition Project (Rotherhithe). The engine house is now within the London Borough of Southwark (TQ 352799). This article describes the history of the Rotherhithe site and attempts to reconstruct the history of the engine house.

works were open to sightseers but the through route from Rotherhithe to Wapping was not opened to the public until March 1843.

The 1200' tunnel is built of brick and consists of two parallel roadways connected by transverse arches at 18' intervals. Although the tunnel was designed for use by wheeled traffic the planned spiral approaches were never built and during the lifetimes of Marc and Isambard Brunel it was used only by pedestrians. As a footway the tunnel was unprofitable and in 1865 it was sold to the East London Railway Company (ELR) for their line between Liverpool Street and New Cross. Deep cuttings were made for the approaches and a track was laid in each archway. The ELR never owned any rolling stock or operated trains; their line however linked the Great Eastern, South Eastern and London Brighton and South Coast networks and was used for numerous cross-country passenger and freight routes. The line was electrified as far as New Cross in 1913 using the conductor rail system of the District and Metropolitan Railway. The line remains as part of the London Underground system and is the most easterly part of that network south of the river.²

Fig. 1. Rotherhithe works in 1829 showing the temporary shaft superstructure with the adjacent boiler house (?) and the windlass over the 1825 trial bore. (Sketch taken from original in Southwark library.)



The Thames Tunnel

The construction of the Thames Tunnel has been very well documented¹ and the relevant facts need only to be outlined here. Work started on the tunnel in 1825 with the sinking of the Rotherhithe shaft. A massive brick cylinder, 40' high and 50' in diameter, was built and sunk into the ground to form the walls of the shaft. The excavation was continued downwards for another 20' or so and then began the 17 year advance of the tunnelling shields. It was Marc Brunel's invention of the tunnelling shield that made the excavation of a large bore tunnel in the soft river bed possible; even so, the works were often flooded and were totally engulfed on five occasions. The cost of the work soon exceeded original estimates and as a result work was suspended entirely between 1828 and 1833. All excavation was carried out from Rotherhithe until the Wapping shaft was sunk in 1840 to meet the virtually completed tunnel. Throughout construction the

The Rotherhithe shaft and superstructure

The London Transport station at Wapping uses the original shaft (and indeed part of the original staircase) but the Rotherhithe station is situated about 50 yards from the original tunnel entrance. The Rotherhithe shaft has not been used for regular access to the tunnel since 1869. The area around the top of the shaft has been derelict for many years, but part of the shaft superstructure is a 16-sided brick cylinder (50' diameter x 6' high) which is capped by a substantial steel and concrete roof. The brickwork is revealed where parts of the rough concrete rendering have spalled away. There appears to be part of the original cylinder, of round cross-section, visible at the level of the new (1976) brick paving.

Electric pumps for draining the tunnel are housed at the foot of the shaft and there is a control room above

the railway tracks. The pedestrian staircase has been removed but the outline of the staircase is still visible from inside the shaft. This cannot be seen from ground level.

While the tunnel was being constructed there was a steam engine mounted on timber staging across the top of the shaft. The engine, which was built by Maudslay Sons & Field to Marc Brunel's design, was used for raising spoil and for driving the pumps and ventilation apparatus. A temporary wooden engine house, roughly conical in shape, was erected over the shaft. There are some contemporary illustrations of this structure, one of which is in the Southwark collection (Fig. 1)³.

In 1842 the pumping apparatus had to be moved to one side: the temporary engine house was removed and the permanent shaft superstructure was erected by the contractors, Grissel & Peto. A contemporary drawing showing the shaft superstructure with the engine house behind it is reproduced in Fig. 2⁴. The conical roof over the shaft is similar to that of the temporary engine house of 1825–42 but the 1842 building was much more substantial. Thomas Page, the resident engineer from 1837 onwards, mentions that the brickwork at the top of the Rotherhithe shaft required cutting away to a polygonal shape for the superstructure which was presumably built directly onto the original cylinder⁵. There are rather more substantial remains of the contemporary Wapping shaft superstructure than of that at Rotherhithe; the Wapping building has been incorporated in the London Transport station.

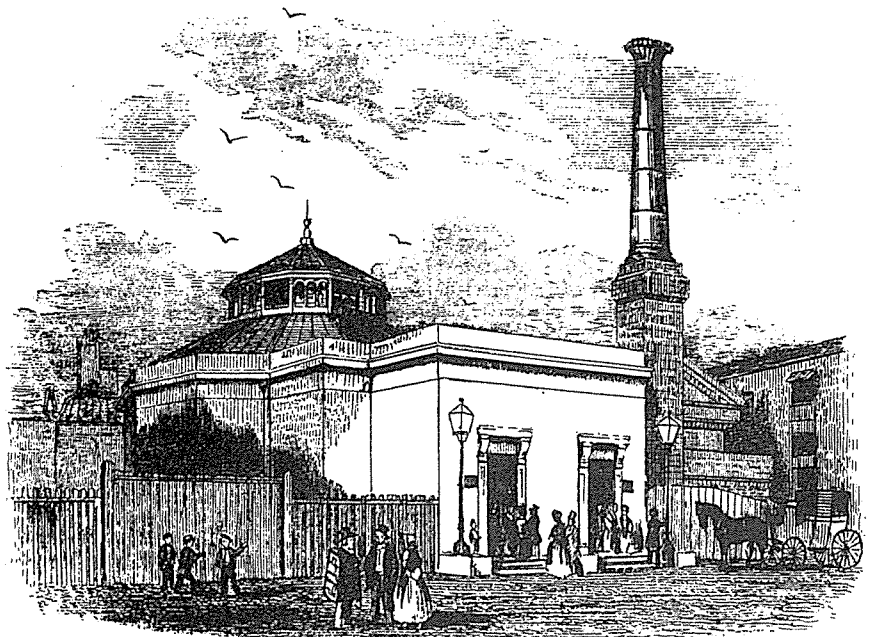
alterations including several bricked-up openings in the walls: of these the most interesting is an irregular elliptical opening of about 6' x 12' in the wall facing the shaft. In this wall there is also a substantial piece of timber which was apparently a lintel with an opening about 9' wide underneath.

The square chimney at the north-east corner of the building is made from fire brick. Two bricked-up openings in the north wall of the engine house open onto horizontal brick flues leading to the base of the chimney. The flues — which have now collapsed — were built of a single layer of fire brick covered with rubble. The floor of the flues consisted of a layer of ash which was difficult to distinguish from the rotten brickwork underneath. The two openings on the sides of the chimney (that on the west face was made in 1976) both reveal a confusing mass of rubble. The opening facing the building in particular reveals several pieces of brickwork which look interesting but are not immediately explicable. These openings are some 5' higher than the existing flues.

The flues are protected on the outside by a curved brick wall which has partly been restored. The dentil course on this wall is similar to that around the top of the chimney. There is a concrete moulding on top of the chimney which appears to form the base of an extension which has been demolished.

The building is marked as an engine house on the first large scale Ordnance Survey map of the area (1870). Comparison between this map and later surveys reveals

Fig. 2. *The permanent shaft superstructure in 1843, with the engine house behind it (from The Mirror of Literature, Amusement and Instruction, November 4th, 1843).*



The engine house

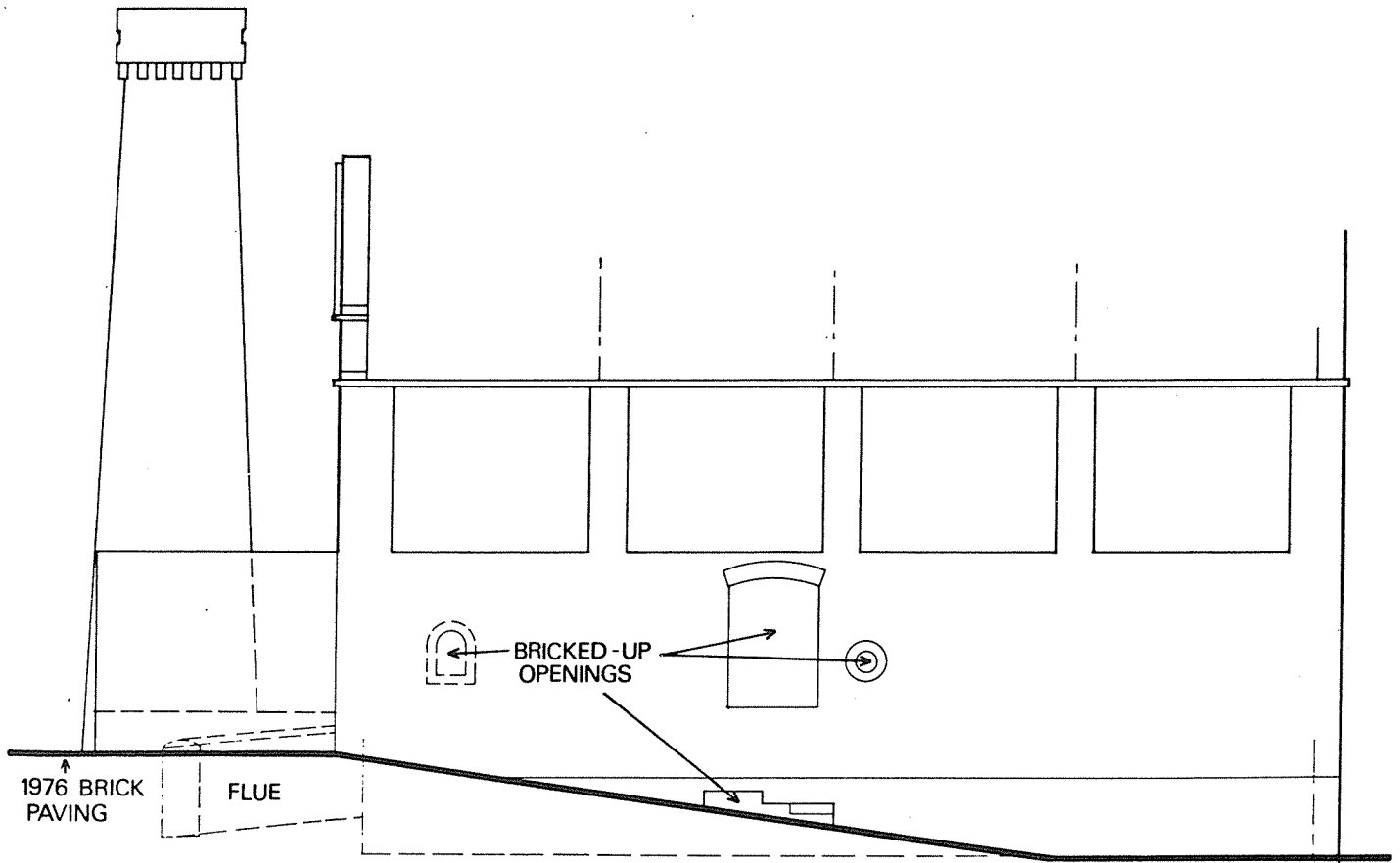
The building known as Brunel's engine house stands adjacent to the shaft. It is a single compartment building with a floor area of about 20' x 40'. It is not in direct alignment with the shaft but is slightly displaced to the north (towards the river). A plan and elevations of this building are reproduced in Fig. 3.

Until recently there was a tiled roof supported with roughly constructed timber queen-post trusses. The brickwork (London stock brick) bears the scars of many

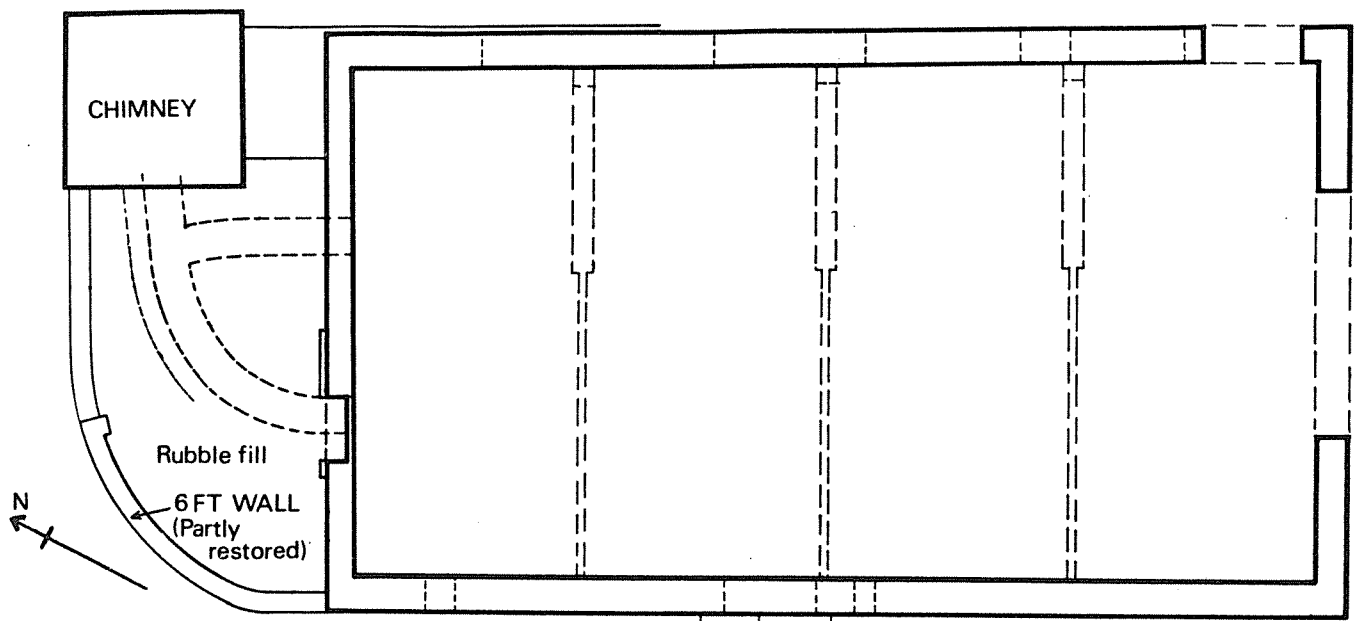
some changes in the plan of the building as indicated in the sketches in Fig. 4, although perhaps not too much significance can be attached to this. It is interesting to note that the building immediately to the north of the engine house, which before its recent demolition was known locally as Brunel's workshop, does not appear on the Ordnance Survey until the turn of the century.

Draining the Thames Tunnel

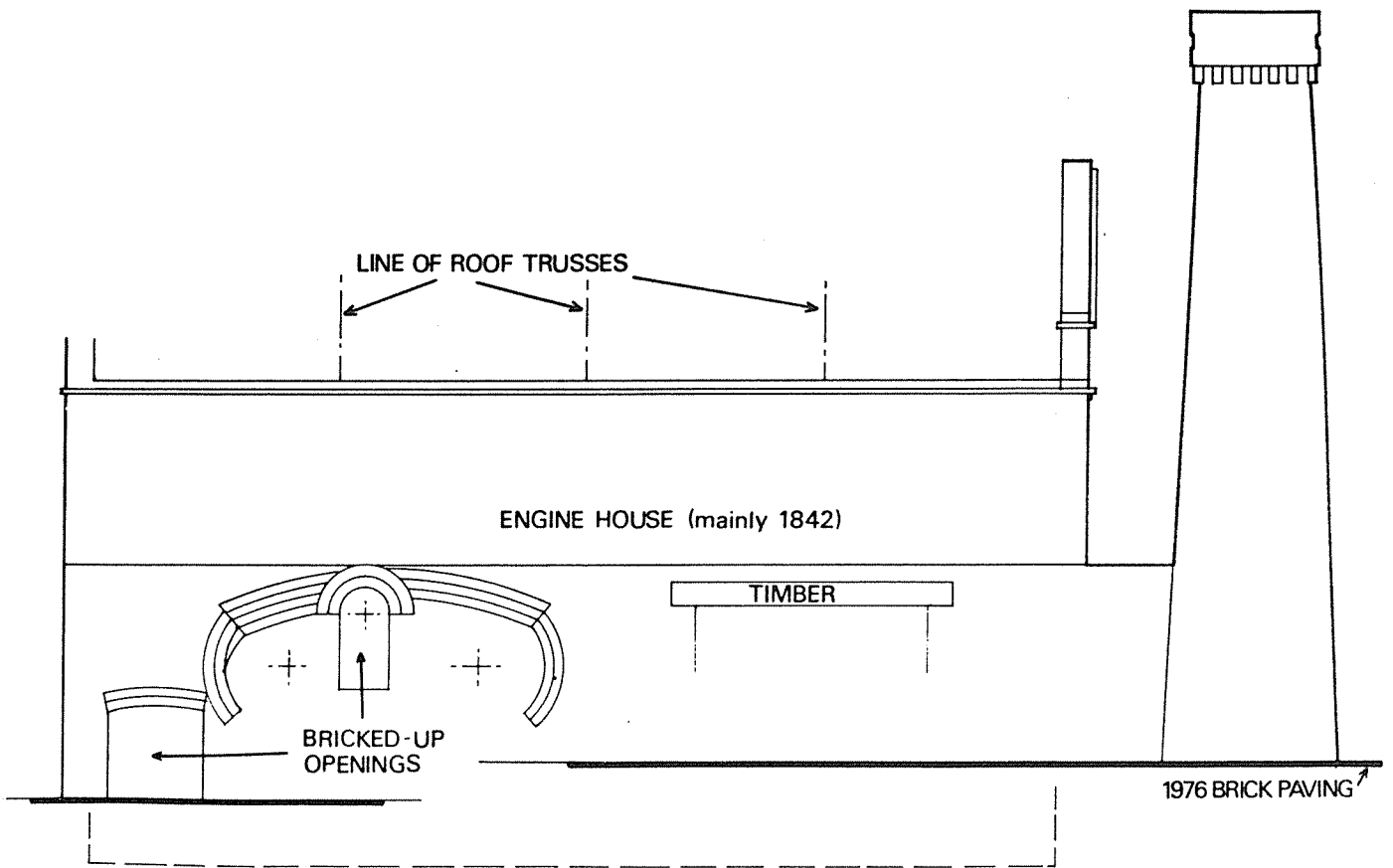
In order to describe the historical background to the Rotherhithe engine house it is first necessary to go into some detail about the problem of draining the tunnel.



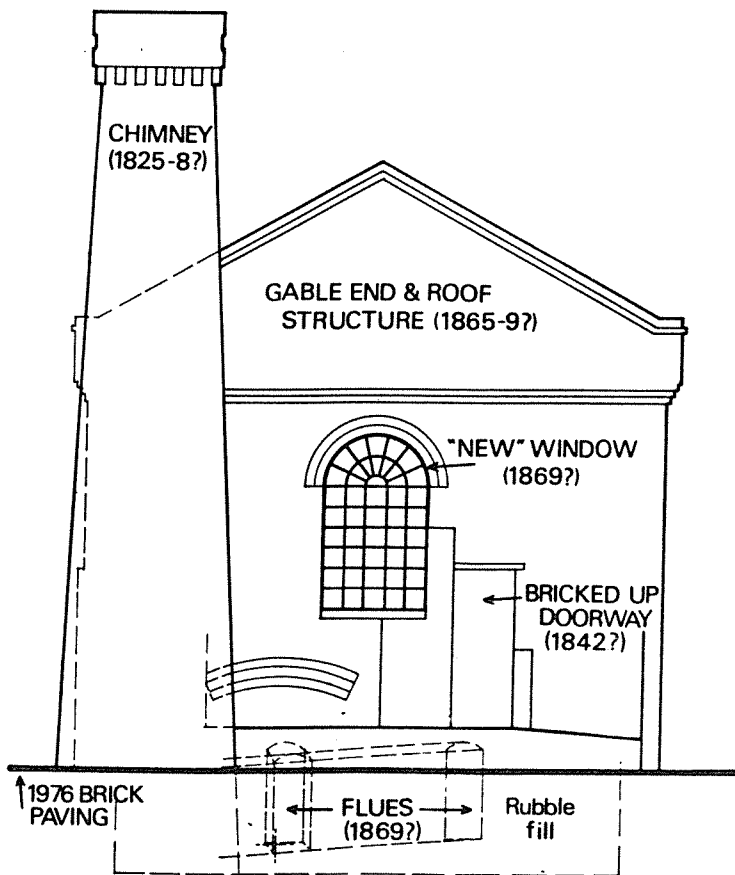
West elevation



Plan



East elevation



North elevation

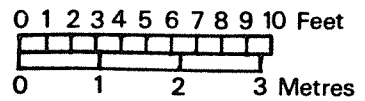


Fig. 3. Drawings of the engine house in 1976.

The tunnel follows the profile of the river bed closely and slopes away from the foot of the Rotherhithe shaft on a declivity of 2' 3" per 100'. During the excavation a water chute was erected in the east archway: water was raised to the top of the chute by a scoop wheel and from there it flowed downhill to a sump under the Rotherhithe shaft. Steam-driven pumps at the foot of the shaft forced the water up to ground level. Once the lowest point of the excavation had been reached a second sump was built in mid-river: a suction pipe in the east archway carried water from here to the Rotherhithe sump. Both force pumps and suction pumps operated at the foot of the shaft. This arrangement has only recently been altered with the installation of submersible pumps both in mid-river and at Rotherhithe by London Transport.

machinery as this might undermine the confidence of people using the tunnel. In a list of tasks to be done in January 1842 Thomas Page described

- completing the intended pumping shafts to the required diameter
 - and
 - cutting through Invert of Tunnel for bedding the pumps.
- Brunel, writing a month earlier about his proposals for the pumping arrangements, stated that the small well that has hitherto been used for the ventilating apparatus will be, or may be made to answer the purpose with a distant power.

The well-referred to may have been the trial excavation that was carried out in 1825 to test the ground in advance of the main Rotherhithe bore. This trial bore was 12' to the north of the main shaft and thus directly over the tunnel.

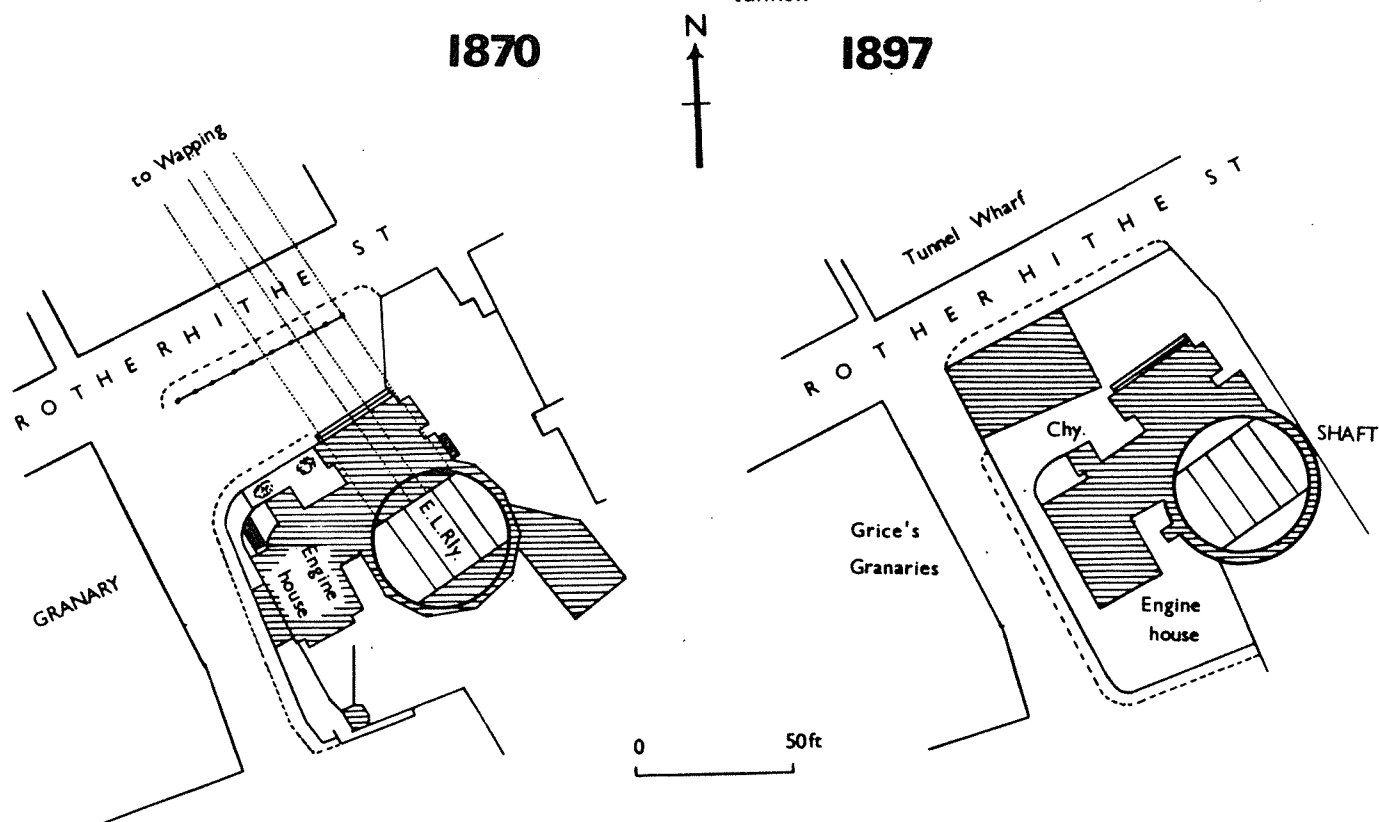


Fig. 4. Sketch maps of the Rotherhithe site based on 1870 and 1897 Ordnance Survey maps.

Until 1913 the pumps were driven by steam engines. During the construction of the tunnel the pumps were directly underneath the Maudslay steam engine mounted over the shaft. In 1842 the Maudslay engine was disposed of (to Brunel's annoyance) and the Rennie engine which had been used in building the Wapping shaft was set up in a new engine house at the side of the Rotherhithe shaft. This engine seems to have been a rotative beam engine driving a 12' flywheel and there was evidently a system of connecting rods to transmit a reciprocating motion to the pumps. The unreliability of the first engine meant that a second engine had to be installed which would probably have driven the same flywheel. The installation and maintenance of the pumping machinery was carried out by Donkin & Co of Bermondsey.

The pumps were moved from their position in the centre of the shaft in 1842 but it is not entirely clear where they were moved to. Brunel and the directors were naturally keen that there should be no sound of running water or

The 1827 sketch of the Rotherhithe works (Fig.1) shows a windlass mounted over this well with some empty cement casks that have just been raised from the tunnel below. If this small shaft had indeed been used for the pump rods then we would expect the pumps to be 12' inside the tunnel. That this was so is suggested by a drawing made by the ELR in 1912 which shows two 'rams' between the shaft and the first transverse archway. A simplified version of this drawing is shown in Fig. 5. It is difficult to know quite how significant this drawing is; for example, there is no sign of the suction pipe in the east archway which was often described by Thomas Page. If the rams shown on the 1912 drawing were indeed the force pumps installed by Brunel 70 years earlier the question is posed of how the pumps – directly underneath the pedestrian entrance – were driven by engines at the side of the shaft.

The 1912 drawing suggests that there were two self-contained steam pumps at the side of the tracks in the

Rotherhithe shaft. These were a Tangye pump — a simplified steam pumping unit which was produced from around 1870 — and a grasshopper pump. It would seem reasonable to assume that these would have been installed at about the time the railway took over the tunnel. Brunel had never been particularly happy about the pumping arrangements in 1843 but as the brickwork became less porous over time the influx of water diminished and the pumps would have been adequate until the railway was built. The tunnel itself is still reasonably dry but there was, and still is, a very significant flow of water into the tunnel from the cuttings on either side. It seems very likely that new pumps were required between 1865 and 1869.

of the shaft building. The chimney was not shown in later editions which is perhaps not surprising as it would have been in front of the section depicted. Another diagrammatic view of the scene shows a single Cornish boiler where the engine house now stands.⁷ Evidently the chimney and boiler house were already in existence when the new engine house was built in 1842. Page wrote in May 25th that

the walls adjoining the chimney and entrance lodge ... and those of the new engine house may be built of the old bricks now on the premises at 35/- per rod for labour but besides these the ends and sides of the present boiler house would be required to be finished off in a better manner than at present.

— E. L. RY. THAMES TUNNEL —

DIAGRAM OF BRUNEL PUMP, NEW SUCTION & VALVES, AS LAID IN.

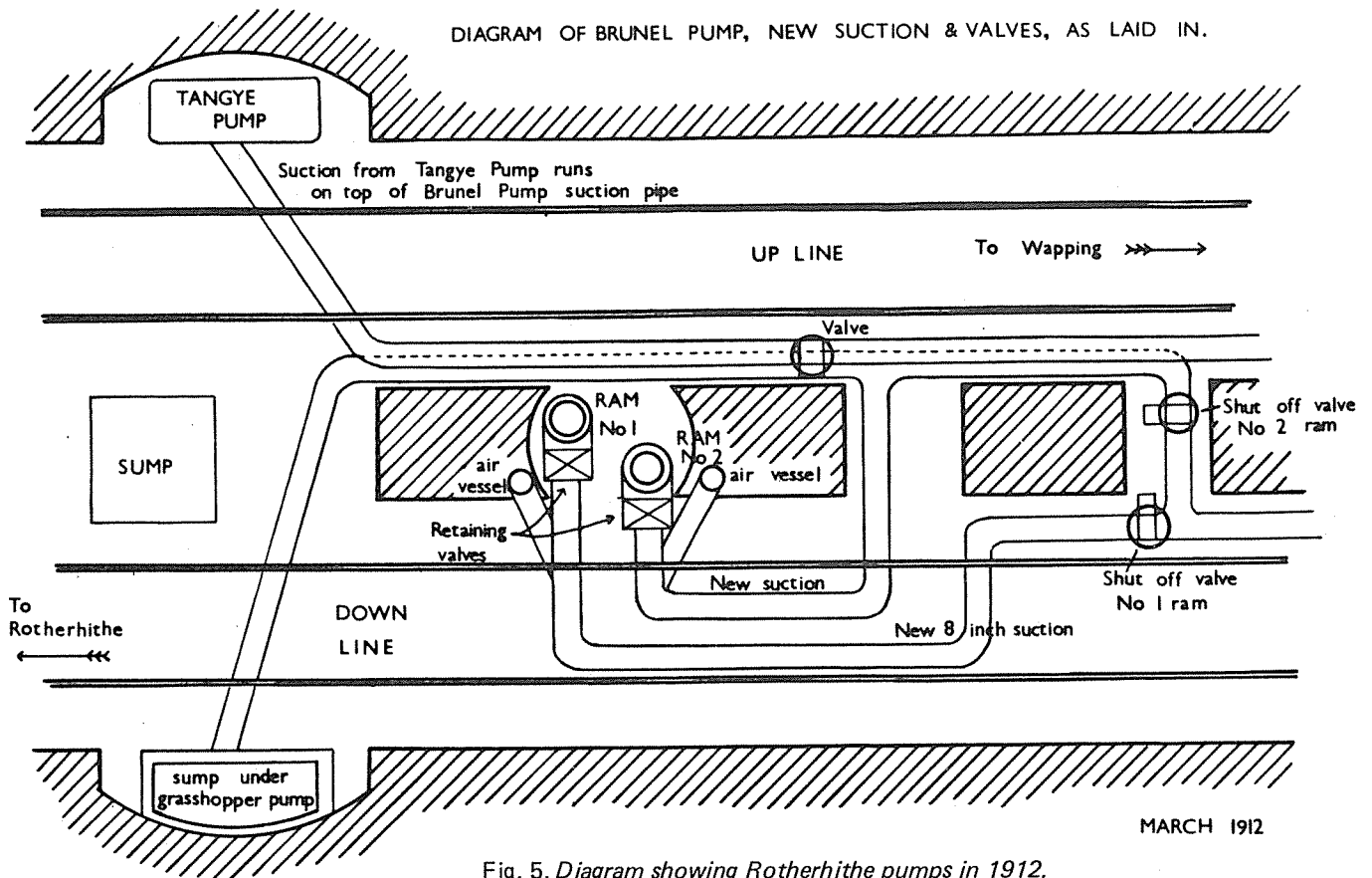


Fig. 5. Diagram showing Rotherhithe pumps in 1912.

The 1912 drawing does not show the source of steam for the pumps in the shaft, but it appears reasonable to assume that the building on the surface was used as a boiler house until the steam pumps were replaced. The existing structure is consistent with its use as a boiler house but it is quite clear that the building has undergone many structural alterations and that parts of it may well date from Marc Brunel's time.

The surviving structure

We must now try and interpret the surviving structure in the light of what we know about its history. The square chimney may well date from the very early days of the Thames Tunnel project. There would have been a boiler house near the shaft and such evidence as we have is consistent with this having been where the present building stands. *Sketches of the Works of the Thames Tunnel*⁶ published in 1828 has an illustration of the tunnel in which a square chimney is drawn to the north

On June 1st a tender from W.E. Wyatt was accepted for the building of engine house at Rotherhithe for tunnel works.

The estimated price was £15; if a rod of brickwork is assumed to be 306 cubic feet then the maximum amount of brickwork involved could have been 2700 cubic feet (15 x 306/1.75 = 2700 cu. ft.). This is not inconsistent with a brick building about 40' x 20' x 20' — about the size of the present building.

The *Mirror* illustration of 1843 shows parts of what we must assume to be a combined boiler and engine house. This is evidently somewhat different from what we have today: although the chimney base is very similar to the present structure the end of the building appears to be an elaborate portico in contrast to the rather bare gable of the present building. The details (or to be more accurate the lack of detail) on the present roof, gutter and north window are similar to those on other functional structures on the ELR such as the pump house at Surrey Docks and

various outbuildings at New Cross. If indeed the railway company installed new boilers in 1869 to provide steam for pumps in the shaft it is not surprising that parts of the engine house have been rebuilt; they may have needed to demolish part of the building to get the machinery out.

The engine house has a tiled roof. The ELR buildings have slate roofs as did Grissel & Peto's shaft superstructure. The contract for building the engine house mentions 'tiling' the roof and a rather improbable illustration in the *Illustrated London News* of 18th March 1843 apparently shows a tiled roof (but no chimney) behind the tunnel entrance. Figure 1 shows a tiled building — perhaps the 1825 boiler house — adjacent to the Rotherhithe shaft. In view of the desire of the Thames Tunnel Company to re-use old materials wherever possible it does not seem impossible that the engine house originally had a tiled roof.

Conclusions

Nineteenth century engineers were often loth to waste anything and neither the Thames Tunnel Company nor the ELR were particularly affluent. Parts of the old buildings have been re-used where one might have expected the old to have been demolished to make way for the new. We do not know everything about the history of Brunel's engine house but can construct a reasonable working hypothesis about the changes of use of the present building. The main phases can be summarised as follows.

1825–1842. There was a temporary boiler house on the site of the present building which was used for raising steam for the engine over the Rotherhithe shaft. The present chimney, and maybe the foundations of the engine house, date from this time.

1842–1869. In 1842 a new engine house, making use of the existing chimney and boiler house, was built to house the machinery for driving the pumps which drained the tunnel during its use as a footway. This building, which adjoined the shaft superstructure, is incorporated in the present structure.

1869–1913. Around 1869 the internal machinery was removed and the building used as a boiler house for the engines in the shaft. Much rebuilding may have taken place when the machinery was removed. The roof structure and the horizontal flues that were excavated in 1976 presumably date from this time.

1913–1973. The building was no longer required by the authorities after electric pumps were installed. The empty boiler house was let to various tenants as a shed. One of these tenants was a stonemason who had premises nearby.

1973 onwards. At the instigation of the Brunel Exhibition Project (Rotherhithe) the building has been scheduled as an

Ancient Monument. The building is currently (June 1978) derelict but plans to restore the structure are going ahead. The area around the building has been paved and 'landscaped' with trees: the structure will be made safe and a new roof erected. It is intended that the engine house should be used to house a permanent exhibition about the tunnel and the London works of both Brunels.

Acknowledgements

Figures 1 and 2 are reproduced, with permission, from the London Borough of Southwark Local Studies Library.

Figure 5 is reproduced by permission of London Transport.

It is very easy to find out a great deal about the Thames Tunnel because of the ready availability and high quality of the published literature about it: for this we must be grateful to Paul Clements, Charles E Lee and others. The professional staff at the libraries mentioned in the references have been very useful. Thanks are also due to London Transport Civil Engineering Department, to Goldsmiths IA group for surveying the engine house and to everyone else with whom I have corresponded about this small facet of a heroic engineering achievement.

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2. Lee, C.E. *The East London Line and the Thames Tunnel*. London Transport, 1976.
3. *Southwark Library Local History Department*, Newington District Library, 155-157 Walworth Road, London, SE17. A comprehensive collection of prints, booklets, press cuttings and other material is maintained here. Similar collections are at the Guildhall Library and Tower Hamlets Local History Dept.
4. *The Mirror of Literature, Amusement and Instruction*, Saturday November 4th, 1843. There is a copy of the relevant cutting at Southwark.
5. *Thomas Page*, Site Engineer's Reports and *Marc Brunel*, Chief Engineer's Reports, to the Thames Tunnel Company. These are in the Library of the Institution of Civil Engineers.
6. *Sketches of the works for the Tunnel under the Thames from Rotherhithe to Wapping*. Published by Harvey & Dalton, 55 Gracechurch St and C. Tilt, St Brides Avenue, 56 Fleet St; 1828. There are many versions of this and other souvenir booklets published between 1826 and 1869. Copies are in the local collections described above and the Science Museum Library.
7. Reproduced in *Brunel's Tunnel and where it led*. Brunel Exhibition Project (Rotherhithe), Hope (Sufferance) Wharf, 61 St Marychurch St, London SE16; 1976.