St George’s Dock-Mersey Tunnel ventilating station

MERSEY TUNNEL
VENTILATION

CIBSE Heritage Group
6. THE DAWN OF TUNNEL VENTILATION

One of the Great Western Railway of England’s pioneering achievements in the field of civil engineering was the building of the 4½ mile long tunnel beneath the River Severn estuary. At the time of its construction it was the world’s longest underwater and the first to connect two countries - England and Wales. Work commenced in 1873 and the inaugural goods train ran through on the 9th January 1886, carrying South Wales coal bound for the metropolis. Passenger traffic did not commence until the December, awaiting the construction of some connecting lines, thus proving that the Channel Tunnel is unique in nothing. During construction, following the death from inflammation of the lungs of two men who had been working in one of the headings, a Guibal fan having an impeller diameter of 5.5m and a width of 2.1m was installed. This was fitted to the top of the New Pit shaft at Sudbrook (Fig 26). When the tunnel was completed a larger Guibal fan having an impeller diameter of 12.2m and a width of 3.7m was installed for permanent ventilation. This was steam engine driven, the supply being from three Lancashire boilers each 2.1m diameter by 7.9m long. The maximum rotational speed of the fan was 60 rev/min, but less than half this was stated to be sufficient for normal operation.

Whilst the contractor, Thomas A Walker, claimed that the appliances for ventilating the tunnel had proved to be thoroughly efficient, the Inspecting Officer, Colonel F H Rich noted that “the means of ventilation are ample, but did not act well when I made my inspection”. Whatever the rights or wrongs the Guibal fan did not last and was subsequently replaced by a Walker Indestructible fan with a capacity of 27.3 m³/s against 210 Pa fan static pressure. The attached characteristic curve (Fig. 27) shows that this was not well-matched to the system and an operating efficiency of less than 40% was achieved. Nevertheless, apart from conversion of the original steam engine drive to electric motor, the unit continued to operate in its original form until very recently. Perhaps the name was well earned after all.

With the steam locomotive as the only proven and practical form of motive power, the idea of a long sub-aqueous railway tunnel raised acute problems of ventilation. Hence the first Mersey rail proposal envisaged pneumatic propulsion, a single carriage, fitting the bore like a piston, being alternatively sucked and blown through the tunnel between terminal air-locks. This Mersey Pneumatic Railway was authorised by Act of June 1866 but it failed to win support so a more orthodox scheme was substituted using condensing locomotives. The name was changed to the Mersey Railway Company and in 1871 it was authorised to make connections with main line railways on both banks and formally opened on the 20th January 1886 by the Prince of Wales. Despite the use of giant steam-driven ventilating fans up to 12.2m in diameter, also believed to be of Guibal design, the tunnel had the
dubious distinction of possessing the foulest atmosphere of any underground railway. With a ruling
gradient of 1 in 27, this is scarcely surprising and as early as 1903 the line was electrified and steam
locomotives banished from the tunnel forever.

**Fig 26**

**Fig 27**
Ventilation of road tunnels became of importance with the development of the internal combustion engine and the consequent carbon monoxide pollution. The Mersey Road Tunnel was conceived in the 1920’s as an infrastructure improvement which, in a time of high unemployment, would give work to many. It was designed with a state of the art ventilation system to reduce the carbon monoxide concentration and to maintain visibility. The fan stations dominated the Liverpool skyline, along with the Liver building, and the Anglican and Catholic cathedrals. Many claimed that the fan buildings, were, however, of the greatest architectural merit (Figs. 28 & 29).

The nearest fan manufacturers to the tunnel, capable of constructing units of an appropriate size were Walker’s of Wigan and Sturtevant with a head office in London, but, importantly, a main works at Denton near Manchester. Each made bids and were so unlike each other as to cause the tunnel authorities much anguish. Walkers offered their Indestructible design (Figs 30 & 31) - what else?

Fig 28
Walkers “indestructible design” ventilation fans
Sturtevant GVM (Grand Vitesse-Mersey) ventilation fans
Sturtevant at that time had a French Chief Engineer named Lebrasseur. He designed a new backward curved bladed centrifugal fan which by appearance was the progenitor of today's modern fans and which for performance was far in advance of those currently available (Figs 32 & 33). The design, known in Sturtevant parlance as the GV/M was in reality the Grande Vitesse-Mersey thus showing an early French predilection for the use of these words. Unable to make up their minds, the authorities split the contract between the two companies, but not before the GV/M had proved its efficiency of greater than 80% on a test tunnel 46 metres long and with a cross-section 3.7m x 3.7m. The blowing fan tested had a capacity of 82 m$^3$/s.

Thirty fans in total were installed, duplicated to give running and standby capacity. The total operating supply flowrate was about 1917 m$^3$/s and that for extract 1211 m$^3$/s. It is of interest to note that the Walker Indestructible fans had impellers about twice the diameter of the Sturtevant GV/M type, but operated at a maximum speed of only 62 rev/min.
The Mersey Tunnel under construction
The Tunnel under construction
Tunnel shaft under construction
Lining the Mersey Tunnel
LIVERPOOL
DAILY POST
SUPPLEMENT

OPENING OF THE
MERSEY TUNNEL

by

H.M. King George V

JULY
18TH
1934
The opening of the tunnel in 1934
All about the new Mersey Tunnel

With Plan—Price 2
The opening of the tunnel in 1934

Commemorative postcard
Ventilation station
Kingsway ventilating station
Birkenhead vent shaft

Mersey tunnel ventilation system
The ventilation fans
Detail fan drive arrangements
REFERENCES AND SOURCES OF ILLUSTRATIONS


------asenseofplace/wonders-of-the-world-the-mersey-tunnel (website)

See also the CIBSE Heritage Group website under Electronic Books:

*Fan Engineering*

*Buildings & Transport/Tunnel Ventilation*

*Organisations/Merseyside & North Wales Regions of CIBSE, 75th Anniversary*, Dr Neil S Sturrock, Chapter 10, *Mersey Tunnel-Queensway* (with additional references)