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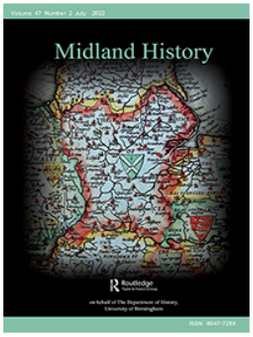

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Edward Bindon Marten: Sanitation Engineering and Industrial Safety in the Black Country

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ABSTRACT

This article explores the career of Edward Bindon Marten, a civil and mechanical engineer based in the Black Country during the nineteenth and early twentieth centuries. It focuses on his role in sanitation engineering and industrial safety. In order to place him within the context of his time, the sanitary state of the nation and the Black Country is examined, as are steam boiler explosions including their consequences and prevention. Marten's work supplying clean water, building an effective sewerage system, inspecting steam boilers and undertaking accident analysis for coroners' inquests is explored. His non-technical abilities are also analysed, including his talent for communicating his knowledge and advice to a wide audience in an engaging manner. The article concludes that Marten made an important contribution to improving Black Country sanitary conditions, and to Black Country and nationwide industrial safety, and was a significant figure in the Black Country and beyond.

KEYWORDS

Edward Bindon Marten; engineering; public health; drinking water; sanitation; sewerage; steam boilers; accidents; industrial safety; Black Country

Introduction

Edward Bindon Marten (1832–1914) was a civil and mechanical engineer. He was born in Vauxhall, London, where his father was the secretary of the Vauxhall Bridge Company.[1] By 1851, Marten was an articled pupil in civil engineering at the Wolverhampton Waterworks Company, and remained in the Black Country for the rest of his life.[2] He worked on the inspection of steam boilers for the prevention of accidents, and on sanitation projects to supply both clean water and sewage disposal schemes, he was an engineer to the South Staffordshire Mines Drainage Commissioners, a local director of the National Telephone Company, a vice-president of the Stourbridge Mechanics' Institute, and a vice-president of the Institution of Mechanical Engineers. This article explores the extent to which Marten made an important contribution to improving the sanitary conditions and industrial safety within the Black Country. Provision of clean water and proper sewage disposal contributed to the reduction in the number of deaths from diseases, such as cholera. Furthermore, regular inspection of steam boilers and the increased scientific knowledge

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[1]Public Record Office (PRO), RG5/138, birth record of Edward Bindon Marten, April 4, 1832, available through online database [accessed: 5 October 2019].

[2]PRO HO107/2017, Census of England and Wales, Staffordshire, Tettenhall, 1851, Edward Bindon Martin (sic), accessed via online database [accessed: 27 September 2019].

of the causes of explosion reduced the number of such incidents, thereby resulting in fewer fatalities and injuries of those working with or near boilers.

This is not a biographical study, but puts his work into a wider historical framework of public health and industrial safety at both a national and regional level. It illuminates sanitary conditions, sanitation engineering, public health, steam boiler explosions, industrial safety, working and living conditions, Victorian engineering and the Black Country, as well as Marten himself.

The Victorian engineers who are most remembered are those who built large visible structures such as bridges, canals and railways, George Stephenson and Isambard Kingdom Brunel being perfect examples. Even Joseph Bazalgette, the engineer behind the extensive London sewerage system which relieved that city of the 'great stink' of 1858, has only recently been re-remembered. Stephen Halliday uncovers Joseph Bazalgette and his development of the London sewerage works, and Richard Byrom recounts the life of William Fairbairn (later Sir William), a leading early figure in the investigation and prevention of steam boiler explosions.[3] Neither of these engineers are one of the well-known historical 'heroic' engineers, but their biographies shed light on their significance and the importance of the work that they undertook. Halliday theorises that Bazalgette's work on sanitation had been forgotten because its infrastructure is mostly underground, a case of out of sight out of mind. However, Victorian railway infrastructure is visible in the form of railway lines, bridges and stations, so railway engineers are remembered and celebrated. This helps to explain why Marten has been neglected, as he worked with covered reservoirs, underground pipes and out of the way pumping stations and sewage treatment plants. Engineers such as Marten, who contributed to the welfare of communities, are not well known or celebrated. This focus on one Black Country engineer aims to rectify that injustice and also reveals the importance of engineering developments away from those in London.

As there is no Marten archive, evidence has been secured from a range of alternative sources. The primary sources include published material such as government reports and institution proceedings, newspapers, and archival material such as the engineers' book of a waterworks company. They reveal views of contemporary individuals or groups of individuals, and the extent of scientific knowledge at the time. Governmental reports on sanitary conditions within the Black Country are used to create a picture of the poor state of sanitation in that region in the nineteenth century.[4] Knowledge of the local sanitary conditions reveal why the work of water and sewerage engineers was important. Reports from Select Committees appointed to inquire into the causes and prevention of steam boiler explosions provide background to the subject through engineering facts and statistical data, but also reveal the opinions of experienced engineers, including Marten.[5] Descriptions of steam boiler explosions highlight their significant impacts on individuals, families and companies. Consequently, this shows how important the work of prevention was. Additionally, investigating legislative

[3]S. Halliday, *The Great Stink of London. Sir Joseph Bazalgette and the Cleansing of the Victorian Metropolis* (Stroud: Sutton, 1999); R. Byrom, *William Fairbairn: the Experimental Engineer. A Study in Mid-19th-Century Engineering* (Market Drayton: Railway and Canal Historical Society, 2017).

[4]Many of these reports are available via the Wellcome Collection or Internet Archive.

[5]These reports are available at UK Parliamentary Papers <https://parlipapers.proquest.com/parlipapers> For example, Report from the Select Committee on Steam Boiler Explosions; together with the Proceedings of the Committee, Minutes of Evidence, and Appendix (House of Commons, 1870).

developments reveals how the responsibility of prevention was in the hands of engineers, thus giving them an essential role in industrial safety. Newspaper articles are used to trace Marten's career through the engineering reports he wrote for the companies he worked for, and through the various career-related activities he was involved in, such as his role in coroners' inquests. Newspapers are also used to provide background information on the impact of steam boiler explosions, highlighting their significance. Despite the absence of a Marten archive, primary sources create a picture of Marten's work and its importance at both local and national levels.

Firstly, in order to show the importance of Marten's work, this article analyses the sanitary conditions of the Victorian Black Country, and considers the public health consequences of poor sanitation, including outbreaks of cholera and high death rates. It subsequently investigates Marten's work with the Stourbridge Waterworks Company and the Upper Stour Valley Main Sewerage Board, detailing his roles, responsibilities and achievements. Then steam boiler explosions are explored, including their personal and financial impact, the formation of steam boiler inspection and insurance companies, and the development of legislation. It examines Marten's work with the Midland Steam Boiler Inspection and Assurance Company, and his other work in the prevention of steam boiler explosions. The conclusion advocates Marten's importance as an engineer contributing to the improvement of sanitary conditions within the Black Country, and the improvement in industrial safety in the Black Country and the nation as a whole.

National and Black Country Sanitary Conditions

Throughout the nineteenth century England became more industrialised, which led to its population becoming increasingly urbanised. In 1801, towns in England and Wales with a population of more than 5,000 were inhabited by 20% of the people, whereas in 1851 this had increased to 54%.[6] Urbanisation created public health issues. The increased density of people resulted in an accumulation of sewage which, in turn, found its way into drinking water, thus contaminating it. The most common way of dealing with sewage in the early nineteenth century was through cesspools, which saturated the surrounding subsoil and leaked into the water table, contaminating wells. Night-soil men cleaned the cesspools, but their financial charge was prohibitive for tenants and slum landlords, so many cesspools were left to overflow. Alternatively, the filth could be piled on a dung heap or thrown into the street. Sewers, such as they were, were broken or inadequate. Consequently, the air stank and the water could be dangerously polluted in Victorian towns.[7] Furthermore, urbanisation led to greater use of the water sources thereby reducing the quantity of water available and leading people to use the most polluted sources to a greater degree.[8] Sanitary conditions in Victorian towns were very poor.

One public health consequence was the cholera epidemics of the Victorian era. A cholera victim's excreta entered the drinking water supply either through leaking

[6]D. McLean, *Public Health and Politics in the Age of Reform. Cholera, the State and the Royal Navy in Victorian Britain* (London: I. B. Tauris, 2006).
[7]A. S. Wohl, *Endangered Lives: Public Health in Victorian Britain* (London: Dent, 1983).
[8]M. Durey, *The Return of the Plague. British Society and the Cholera 1831–2* (Dublin: Gill and Macmillan Ltd., 1979).

cesspools or through sewage being dumped in a water course upstream from where drinking water was obtained. The contaminated drinking water transmitted the bacteria and, therefore, the disease. In Britain, cholera epidemics occurred in 1831–1832, 1848–1849, 1853–1854 and 1866. Cholera has a high level of mortality, with 60% of untended cases resulting in death. The number of deaths in mainland Britain due to cholera in these epidemics was about 31,000, 62,000, 23,000 and 14,000, respectively.[9] Poor sanitary conditions had serious health implications for the population, and effective sewage disposal and access to clean water were both required to prevent cholera.

A ground-breaking investigation into sanitary conditions was undertaken by Edwin Chadwick, resulting in his report on the Sanitary Condition of the Labouring Population of Great Britain which was published in 1842.[10] Chadwick used evidence from about 1,000 Poor Law Medical Officers of Health, death rates, life expectancy statistics and descriptions of examples of poor sanitation. He demonstrated the inadequacy of clean water provisions, including that only 12% of towns investigated had a good supply.[11] He also showed the heavy toll this took on life, and made the case for public health reform, including improved drainage and water supply. Chadwick's findings were confirmed by the Royal Commission on the Sanitary State of Large Towns and Populous Districts reports of 1844 and 1845.[12] Such reports increased public awareness of these important issues and Chadwick's report sold over 100,000 copies, pushing public health onto the political agenda.[13]

Up to this point, there had been no legislation covering water supply and sewage. However, legislation came with the Nuisances Removal and Diseases Prevention Act of 1846 which allowed prosecutions of those responsible for filth and foul drains.[14] Two years later came the Public Health Act (1848) which established a General Board of Health and allowed local authorities to create local boards of health to manage water supplies and sewage systems.[15] These would be created if one in ten ratepayers petitioned for them, whereupon there would be an enquiry into the sanitary conditions of the town. If the district's death rate was greater than 23 in 1,000 then the General Board of Health made it compulsory for a local board to be established. By December 1848, twenty-five towns had applied for the establishment of a local board of health.[16] Further legislation appeared in the form of the Sewage Utilisation Acts of 1865 and 1867 which were concerned with sewage disposal.[17] The need for improvements to sanitation was recognised by Parliament and legislation was enacted to improve sanitary conditions.

Black Country towns experienced rapid population growth during the nineteenth century. For example, the population of the parish of Wolverhampton increased by

[9]McLean, *Public Health and Politics*.
[10]Edwin Chadwick, Report to Her Majesty's Principal Secretary of State for the Home Department from the Poor Law Commissioners, on an Inquiry into the Sanitary Condition of the Labouring Population of Great Britain (London: W. Clowes & Sons for HMSO, 1842).
[11]Wohl, *Endangered Lives*.
[12]*First Report of the Commissioners for Inquiring into the State of Large Towns of Populous Districts* (London: W. Clowes & Sons for HMSO, 1844); *Second Report of the Commissioners for Inquiring into the State of Large Towns of Populous Districts* (London: W. Clowes & Sons for HMSO, 1845).
[13]Wohl, *Endangered Lives*.
[14]Nuisances Removal and Diseases Prevention Act, 1846 (9 and 10 Vict. c.96).
[15]Public Health Act, 1848 (11 and 12 Vict. c.63).
[16]McLean, *Public Health and Politics*.
[17]Sewage Utilisation Act, 1865 (28 and 29 Vict. c.75); Sewage Utilisation Act, 1867 (30 and 31 Vict. c.113).

more than threefold between 1811 and 1848, to 48,000.[18] Between 1831 and 1861, the population of Dudley nearly doubled to 44,975.[19] This rapid urbanisation resulted in additional human waste and the contamination of drinking water which, in turn, led to health problems and disease.[20] Cholera came to the Black Country in 1832 and struck Bilston particularly hard, with 742 cholera deaths out of a population of 14,492.[21] It returned to the region in 1849, hitting nearly as hard as previously. Once again it particularly struck Bilston, leading to nearly 700 deaths, and increasing Bilston's death rate (per 1,000 population) to 55 for that year from an average of 31.1 during the 1840s overall. Cholera visited the region again in 1857, this time affecting Darlaston the worst, increasing that town's death rate (per 1,000 population) to 46.4 from an average of 30.3 over the 1850s.[22] The Black Country suffered the tragic consequences of poor sanitary conditions initiating attempts to provide effective sewage disposal and access to clean water to prevent cholera.

Under the Public Health Act of 1848, an inquiry into the sanitary conditions of Wolverhampton, Bilston, Willenhall and Wednesfield was undertaken by Robert Rawlinson leading to his 1849 report, which was followed up by a report on the conditions of Bilston in 1850.[23] Rawlinson's investigations showed that there were no main sewers in Wolverhampton. The sewers and drains that existed were of little value or even detrimental, as some drains opened out close to houses. The Wolverhampton Waterworks Company's water supply was not constant and only reached a third of the town's population. People had to drink water from wells and pumps, even though many were contaminated by human sewage and effluvia from graveyards. The area known as Caribee Island had no piped water supply, sewers or drains, and was referred to as a 'fever nest'.[24] Rawlinson found that Bilston had no sewers, and that the few drains of the town flowed into the Bilston Brook which was in a terrible state and surrounded by houses. In 1832 and 1849, cholera first appeared in the area around the brook. The Dudley Waterworks Company supplied piped water to Bilston, but it was supplied intermittently; in fact, during the 1849 cholera outbreak, there was no water supply for several days so people took water from a canal, spring or pit. Rawlinson concluded that the preventable sickness and consequent poverty of the labouring class could be reduced, and the health of all classes improved if pure water was supplied to all inhabitants, and if sewers and drains serviced the whole area.[25] Rawlinson's reports highlighted the dreadful sanitary conditions, and the poor health and poverty, endured

[18]R. Rawlinson, *Report to the General Board of Health on a Preliminary Inquiry into the Sewerage, Drainage, and Supply of Water, and the Sanitary Conditions of the Inhabitants of the Borough of Wolverhampton, and the Townships of Bilston, Willenhall, and Wednesfield* (London: W. Clowes & Sons for HMSO, 1849).
[19]R. T. Thorne, *Report on a Prevalence of Typhus at Dudley, and on the Sanitary Condition of the Borough* (London: T. Harrison at the Foreign Office, 1871).
[20]C. J. L. Elwell, *Aspects of the Black Country: Black Country Social and Economic History* (Kingswinford: Black Country Society, 2006).
[21]E. A. Underwood, 'The History of Cholera in Great Britain,' *Proceedings of the Royal Society of Medicine*, 41, 3 (1948), 165–173.
[22]G. J. Barnsby, *Social Conditions in the Black Country 1800–1900* (Wolverhampton: Integrated Publishing Services, 1980).
[23]Rawlinson, *Report to the General Board of Health* (1849); R. Rawlinson, *Report to the General Board of Health, on a Supplementary Inquiry into the Sewage, Drainage, and the Supply of Water, and the Sanitary Condition of the Inhabitants of the Township of Bilston, Situated within the Municipal Borough and Union of Wolverhampton, in the County of Stafford* (London: W. Clowes & Sons for HMSO, 1850).
[24]Rawlinson, *Report to the General Board of Health* (1849), p. 21.
[25]*Ibid*.

by the people of Wolverhampton, Bilston, Willenhall and Wednesfield, and, accordingly, an urgent need to rectify the situation.

An inquiry was later undertaken by William Lee on Dudley leading to a report in 1852.[26] As with Wolverhampton, Dudley proved to be inadequately provided with pure water and poorly drained. Evidence included privies located under people's windows, liquid refuse thrown onto backyards, open drains, frozen filth on the streets in winter, water having to be carried long distances, inability to keep clean due to the lack of water, and supply difficulties of the Dudley Waterworks Company. In 1856, William Ranger continued the investigation into Black Country towns, and his report on Oldbury showed dismal sanitation, with water only available from wells or springs. There were not enough privies for the number of inhabitants of the town, and these were not being emptied so were full and unusable. The canal and brook were recipients of liquid sewage, which also pooled around houses and flooded cellars. Those areas of Oldbury with the most accumulated filth suffered the worst from fevers.[27] The recommendations in the reports emphasised the need for an effective sewerage system and a piped water supply for all inhabitants to improve the health, cleanliness, comfort and economic welfare of the population. Such work was a matter of life and death.

Progress in providing sewerage and piped water systems was made in Britain during the second half of the nineteenth century by waterworks and sewerage companies.[28] These companies employed engineers to design, build, maintain, extend and upgrade the infrastructure and service. Such sanitary measures improved the health of the population. The national death rate steadily decreased from 22.5 in 1,000 during the 1860s, to 21.5 in the 1870s, to 18.9 in 1881.[29] Death rates in the Black Country also decreased. Bilston's death rate per 1,000 fell from 31.1 during the 1840s to 22.5 in the 1890s, and Wednesbury's death rate fell from 26.3 to 19.0 during the same period.[30] Although the decrease in the death rate is likely to have been affected by other things, such as better health care provision, it is reasonable to assume that an effective sewerage system and access to water free of faecal matter contributed to a reduction in waterborne diseases and, thus, reduced mortality rates. Between 1860 and 1880, there was a reduction by almost a half in the national death rate from principal contagious diseases, including typhoid fever, which is contracted by consuming water contaminated with faecal matter.[31] The preventative intervention of better sanitation had made its mark.

[26]W. Lee, *Report to the General Board of Health on a Preliminary Inquiry into the Sewerage, Drainage, and Supply of Water, and the Sanitary Conditions of the Inhabitants of the Parish of Dudley, in the County of Worcester* (London: G. E. Eyre and W. Spottiswoode for HMSO, 1852) in Barnsby, *Social Conditions in the Black Country*.
[27]W. Ranger, *Report to the General Board of Health on a Preliminary Inquiry into the Sewerage, Drainage, and Supply of Water, and the Sanitary Condition of the Inhabitants of the Township of Oldbury, in the Parish of Hales-Owen, in the County of Worcester* (London: G. E. Eyre and W. Spottiswoode for HMSO, 1856) in J. Sullivan, 'Paying the Price of Industrialisation: the Experience of a Black Country Town, Oldbury, in the Eighteenth and Nineteenth Centuries' (PhD thesis, University of Birmingham, 2014).
[28]Wohl, *Endangered Lives*.
[29]*Ibid*.
[30]Barnsby, *Social Conditions in the Black Country*.
[31]Wohl, *Endangered Lives*.

Edward Bindon Marten's Sanitation Work

This section explores the extent to which Marten made an important contribution to the improvement of Black Country sanitary conditions by examining his extensive work at the Stourbridge Waterworks Company (SWC) and the Upper Stour Valley Main Sewerage Board (USVMSB), including his engineering duties, personal skills and achievements.

SWC was formed through an Act of Parliament in 1854.[32] Its aim was to supply piped water to Stourbridge and the surrounding area. To achieve this, a well was bored to the springs under Mill Meadow near Amblecote, and the water was pumped to a covered reservoir on the high ground of Amblecote Bank.[33] The water came from a deep bored well, was away from human habitation and, consequently, human contamination, and spent time in the reservoir so that impurities could settle out. The reservoir was covered thereby further protecting the water from contamination.[34] By March 1857, SWC was supplying constant water to Stourbridge town centre and parts of Amblecote, and by the end of June 1858 it supplied ninety one houses.[35] However, it struggled financially as it was unable to raise enough capital for extensions and improvements, and could not provide a dividend to its shareholders, so it leased the works to Marten from 1 August 1858.[36] The agreement between Marten and the company gave Marten exclusive control and management of the works: he was to keep the works in good repair, appoint staff and be responsible for them, including fixing and paying their wages.[37] Marten's lease was terminated in 1866, but he was retained as engineer and manager of the waterworks, and stayed with the company until 1910.[38]

Whilst at the company, Marten undertook numerous works. He laid new mains water pipes, such as 3,000 yards in Lye and Old Swinford district starting in November 1859, and extensions at Oldswinford and Stamber Mill in 1862. He dealt with leakage from the Amblecote reservoir in August 1859, repaired pipes damaged by frost, and enlarged the well room at Amblecote pumping station in 1862, and he made various improvements to the pumping station at his own cost.[39] He also experimented with a new water and salt mixture to spray on the streets of Stourbridge to keep the dust down in the summer of 1870.[40] These examples show him extending the water pipe network, maintaining the supply and making improvements successfully. His use of the new dust control system also shows that he was innovative and willing to experiment. These achievements required Marten to have exceptional engineering and managerial skills.

[32] J. S. Brown, *A Century of Water Supply in the Stourbridge District. A History of the Waterworks Undertaking* (Stourbridge: Stourbridge and District Water Board, 1957).
[33] N. Perry, *A History of Stourbridge* (Chichester: Phillimore, 2001).
[34] This was in contrast to waterworks that used surface sources, such as at Hull, which supplied water from the river Hull which was polluted with sewage, see J. Snow, *On the Mode of Communication of Cholera* (London: Churchill, 1855).
[35] Brown, *A Century of Water Supply; Birmingham Daily Post*, September 5, 1866.
[36] Brown, *A Century of Water Supply*.
[37] Worcestershire Archive and Archaeology Service, 899:1427, BA 14107, Stourbridge Waterworks Company, Agreement, August 31, 1858.
[38] Brown, *A Century of Water Supply*.
[39] Worcestershire Archive and Archaeology Service, 260.43:1, 2074, Parcel 3, Stourbridge Waterworks Company (SWC) Engineers' Report Book, 1855–1865, Volume I.
[40] *Birmingham Daily Gazette*, June 2, 1870.

The demand from customers increased thus precipitating the need for an additional engine, with its accompanying boiler and pump, at the Amblecote pumping station. A second engine allowed water to be supplied constantly when the original engine had to be shut down for maintenance or repair. Marten asked the directors of SWC for such an engine, boiler and pump in August 1859, starting a battle with the directors to get the equipment, which lasted over four years. He pressed for a second engine in his reports to the directors, the tone of which grew more desperate as time went on. For instance, in January 1863, he informed the directors that he was certain there would be a great demand for water in the summer and urged the necessity of an additional engine, and in August he complained that the engine had to work every day with no time for repairs. Finally, in early 1864, tenders were agreed, and in August, Marten was given permission to proceed with the installation. The well was complete by February 1865, and the new engine was working by August 1865.[41] Marten's battle for the new engine, boiler and pump had paid off, and Stourbridge and its neighbouring area did not have to rely on only one engine for its water supply, thus reducing the risk of cut-offs. Indeed, after the installation of the new engine, Marten commented on the abundance of the water supply in his reports to the directors, for example, in September 1866, that the 'supply of water continues abundant of the usual brilliant and pleasant quality'.[42] Marten foresaw that the demand for piped water would increase, and he did not want there to be any disruption to the water supply, which would have inconvenienced his customers, as well as having negative health and hygiene consequences. His persistence and persuasive abilities eventually led to that risk being mitigated.

By the end of 1 December 1866, 1,478 houses had been supplied with piped water by SWC, and in February 1867, the waterworks was supplying 100 gallons of piped water per house per day.[43] This was a huge increase from the initial ninety-one houses that were supplied when Marten took up his post, allowing a greater number of people to benefit from clean piped water and improving the area's health and hygiene.

Marten also had an impact on sanitary conditions elsewhere in the Black Country. By the early 1890s, both Rowley Regis Local Board (RRLB) and Dudley Corporation had received complaints from local residents and traders about sewage polluting the rivers Tame and Stour. In fact, Birmingham Corporation had taken proceedings against RRLB under the Rivers Pollution Act. RRLB and Dudley Corporation united in an application for a provisional order under the Lands Clauses Consolidation Acts to acquire land for a sewage disposal scheme.[44] This resulted in the creation of USVMSB in 1892, which served areas of both Staffordshire and Worcestershire, incorporating a population of 81,000. Marten and a fellow engineer, William Fiddian, wrote a joint report for the new sewerage board on a suitable scheme which comprised 26.5 miles of sewers, and disposed of the sewage through irrigating land at Whittington.[45] Their scheme was approved by the board, and Marten and Fiddian were retained as joint

[41]SWC Engineers' Report Book.
[42]*Birmingham Daily Post*, September 5, 1866, p. 4.
[43]SWC Engineers' Report Book.
[44]*Birmingham Daily Post*, February 18, 1891.
[45]E. B. Marten and W. Fiddian, *Upper Stour Valley Main Sewerage Board. A Scheme of Main Sewerage and Sewage Disposal* (Stourbridge: Mark and Moody, 1894).

engineers to the board from 1892 to 1909.[46] Although he was joint engineer with Fiddian at USVMSB, Marten appears to have had sole responsibility for the design of the sewage disposal schemes of RRLB. During his employment with USVMSB, Marten prepared monthly engineering reports for the board's meetings, and attended meetings of RRLB to report on progress. His achievements can be followed through these extensive reports which were included in the local press.

Marten worked on preparing plans for sewage disposal schemes for RRLB, including for the Tividale district and for the southern part of the board's district which included Cradley Heath, Toy's Green, Old Hill, Blackheath, Whiteheath and Rowley Regis itself. After inspecting and surveying the various regions, he presented his plans and cost estimates to RRLB in March 1894.[47] The board gave their general approval, and Marten requested a loan of £25,000 from the Local Government Board to cover the schemes for a sewerage scheme which would serve a wide area and benefit a large number of people.

In October 1894, an invitation to tender was advertised in the local press for the construction of an engine house, stores, tanks, filters, carriers, drains, roads, ejector stations, and cast-iron mains for the sewage disposal works and outfall at Tividale, showing that progress on the schemes was being made.[48] Details were to be obtained from Marten or Fiddian. A flurry of invitations to tender were then issued for other aspects of the schemes, including for sewers to the outfall works at Tividale and a sewer at Blackheath, both in June 1895.[49] Away from the Tividale district, Marten negotiated for the purchase of land at Cradley Pool for a storm reservoir in 1894, and he oversaw the invitation to tender for this reservoir and the Titford sewage pumping station in June 1898.[50] The improved quality of the effluent after treatment, showed that the sewerage systems were operating successfully. In November 1897, Marten reported to the Rowley Regis Urban District Council that the outfall water from the Tividale sewerage works was 'bright and free from anything deleterious' after filtration.[51] Additionally, when the effluent from the Whittington site was tested in 1904 it was found to be of 'an unusually high character'.[52] Marten and Fiddian were managing the construction and operation of the sewerage schemes successfully.

Marten could not have made an important contribution to the improvement of sanitary conditions if he had not been successful at what he did. He achieved this success through his excellent technical skills, such as engineering design, but also because of non-technical abilities and characteristics. As the lessee, manager and engineer of SWC, and the joint engineer of USVMSB, Marten managed the workforce, land, budgets, contracts and capital. He had organisational, planning and communication skills, and kept accurate records, reporting progress to the directors of the companies. He had the ability to work with others, whether his employees, superiors, contractors or land sellers, and he worked collaboratively with Fiddian on sewerage systems. Marten made improvements at SWC's waterworks at his own cost, showing his

[46] *Ibid*.; Dudley Archives and Local History Centre, DHAR/20/8, Draft Agreement, Marten and Fiddian regarding Upper Stour Valley Main Drainage, November 28, 1892.
[47] *County Advertiser and Herald for Staffordshire and Worcestershire (CAHSW)*, 24 March 1894.
[48] *CAHSW*, October 27, 1894.
[49] *CAHSW*, June 8, 1895.
[50] *CAHSW*, July 7, 1894 and June 10, 1898.
[51] *CAHSW*, November 20, 1897, p. 6.
[52] *CAHSW*, May 12, 1900 and December 10, 1904, p. 7.

dedication and ability to take calculated risks. He was forward-looking, foreseeing the increased demand for piped water in the Stourbridge region, and his determination and persuasive skills led to the installation of a second engine at the waterworks. His experimentation with a new dust control system for Stourbridge streets shows him to be innovative and modern. Marten was leased the waterworks when it was failing, and he ran the waterworks admirably for several decades, achieving what SWC was unable to do without him. He was appointed the lessee when he was in his early twenties, showing that SWC recognised him as a talented engineer and manager from a young age. USVMSB also trusted his abilities, as they gave him sole responsibility for the Rowley Regis sewerage scheme. Marten stayed with both SWC and USVMSB until his retirement which demonstrates that he was successful in his roles for providing piped water and an effective sewerage system.

Marten greatly improved the piped water system of the Stourbridge area. He provided an abundant supply of good quality water to its population, and significantly increased the numbers of households supplied. Those connected to the system no longer had to take their water from contaminated sources. Furthermore, Marten and Fiddian designed, constructed and managed new sewerage systems for the upper Stour valley region, which removed sewage from the locality. Under their care, the effluent was treated to a high standard before being returned to the water courses thus preventing contamination. Additionally, Marten had sole responsibility for the Rowley Regis sewerage systems. Marten, with his excellent engineering, managerial and personal skills, greatly improved the water supply and sewerage systems within parts of the Black Country. This contributed to the health, cleanliness, comfort and economic welfare of its inhabitants. It also contributed to the falling death rates and reduction in water-borne diseases as described above. His work was of vital importance and, consequently, Marten made an important contribution to the improvement of sanitary conditions of the Black Country.

Prevention of Steam Boiler Explosions

The steam boilers powering the engines of the eighteenth century were worked at a low pressure, only rarely above twelve pounds per square inch and, consequently, had a low risk of explosion.[53] From the early nineteenth century, however, higher pressures were used and boilers had to withstand more than thirty pounds per square inch. Boilers of higher pressures were more powerful and efficient, and although boiler design improved, the higher pressure along with poor construction, the user's lack of technical knowledge, disrepair and misuse resulted in an increased risk of explosions.[54] As the use of steam boilers proliferated, explosions became frequent.[55]

In 1881, Cornelius Walford, a barrister concerned about the high number of all types of explosions, listed the more serious steam boiler explosions, four of which had occurred in the Black Country. Walford quoted Marten's figures on boiler explosions,

[53]*Select Committee on Steam Boiler Explosions* (1870); E. B. Marten, 'Boiler Explosions', *Mining Magazine and Review*, January to June (1872), 12–22.
[54]P. W. J. Bartrip, 'The State and the Steam Boiler in Nineteenth Century Britain,' *International Review of Social History*, 25, 1 (1980), 77–105.
[55]Marten, 'Boiler Explosions.'

which estimated that between 1800 and 1880 there were 1,536 explosions, which resulted in 2,293 deaths and 2,026 people injured within the UK.[56] The number of explosions markedly increased from the mid-1850s and peaked in 1873 with eighty eight explosions, and fatalities peaked in 1876 at ninety three.[57] Fatalities caused by steam boiler explosions were relatively low compared to those from mining accidents; however, for deaths due to a single accident, only major mining, marine and railway accidents were worse.[58]

Explosions were accompanied by a loud noise, the shaking of buildings, escaping steam and scalding water, and flying objects such as large fragments of the exploded boiler, timber, red-hot bricks and burning coal and missiles specific to the works such as molten iron. The flying debris would land throughout the neighbourhood. Entire works could be completely destroyed, and neighbouring buildings damaged. Boiler explosions caused horrific injuries including bruising, fractures, scalds, burns, peeling off of skin, severed limbs and crushed skulls. People were thrown through walls. People injured and killed were not just in the works of the exploded boiler, but could be in neighbouring works and houses, or pedestrians in the street or children playing nearby. With a workplace being left in ruins, workers could be unemployed for several weeks until repairs were completed, and the injured and bereaved may have been reliant upon charity, but sometimes subscriptions helped those in need. The effects of steam boiler explosions could be short-lived or, as with the case of debilitating injuries, life-long. Steam boiler explosions were very serious events and, consequently, their prevention was of the utmost importance.

To help prevent steam boiler explosions, the Manchester Association for the Prevention of Steam Boiler Explosions was founded in 1855 on the recommendation of William Fairbairn to provide steam boiler inspections in order to identify and, consequently, reduce the risk of explosion. However, this association did not offer insurance and, therefore, was not financially responsible for an explosion of a boiler under its care. To rectify this situation, several companies were set up offering inspection of steam boilers with or without insurance, including the Midland Steam Boiler Inspection and Assurance Company (MSBIAC).[59] Engineers were employed by the companies to examine steam boilers at regular intervals, report the state of the boilers to the owners and make recommendations as to repairs and improvements.

The steam boiler explosion at Millfields ironworks at Priestfield, Staffordshire, in 1862 was particularly devastating, with twenty-eight fatalities and extensive destruction to property which was estimated at between £2,000 and £3,000 for the works alone.[60] This explosion precipitated the promoters of a midlands-based steam boiler inspection company to hold a meeting immediately in its wake on 28 April 1862.[61] *Aris's Birmingham Gazette* commented on 3 May

[56]*Ibid*. The author has not been able to find corresponding full statistics beyond 1880.
[57]C. Walford, 'The Increasing Number of Deaths from Explosions, with an Examination of Causes,' *The Journal of the Society of Arts*, 29, 1479 (1881), 399–418.
[58]Bartrip, 'The State and the Steam Boiler.'
[59]*Select Committee on Steam Boiler Explosions* (1870).
[60]*Birmingham Journal*, April 19, 1862.
[61]*Aris's Birmingham Gazette*, May 3, 1862.

> … it is plain that a simple system of boiler inspection would have prevented that catastrophe [at Millfields], and would prevent many others, and is consequently most essential. Similar associations have had a remarkable effect in diminishing the number of boiler explosions in other parts of the country.[62]

The result was the formation of MSBIAC by June that year which had the aims of mitigating and preventing future explosions. Boilers were insured by MSBIAC, although an inspection-only option was also available.

Marten was appointed MSBIAC's sole engineer to inspect boilers and give advice on repairs, alterations and construction of the boilers, and on the engines and machinery they powered. He was also empowered to withhold insuring a boiler if he thought it was unsafe, thus giving a financial incentive to the owner to keep the boiler in good working order.[63] By the end of June 1863, there were 1,119 boilers under MSBIAC's care.[64] Marten later became the company's chief engineer, managing and being responsible for a number of inspectors. As the sole or chief engineer, he attended the half-yearly meetings of the company's shareholders, at which he provided the number of boilers under the company's care and inspections undertaken, the recommendations made to the boiler owners, and information on boiler explosions. There were no major explosions of boilers under MSBIAC's care during Marten's time there, which was an excellent achievement. He was employed by the company until it was bought by the Scottish Boiler Insurance and Engine Inspection Company in 1888, thereafter acting as a consultant to the company.[65] That he became the chief engineer with inspectors under him, and was retained by the company for twenty six years, shows that he was successful in his engineering and managerial work. Marten's work entailed a great deal of responsibility as people's lives and livelihoods were at stake, and he could only have succeeded with dedication and skill.

The only public investigation into steam boiler explosions until the 1880s was through the coroner's inquest when there had been a fatality. As part of the inquest, an engineer was engaged by the coroner to undertake a scientific examination of the exploded boiler and the site of the explosion, reporting their findings at the inquest, and giving their opinion of the cause of the explosion. Although scientific evidence of the cause was presented by the engineer, newspaper reports on coroners' inquests shows that the jury's verdict was 'accidental death' in the overwhelming majority of cases. Fairbairn criticised these inquests at a Select Committee in 1870 (see below), highlighting that the jury and most witnesses were not technically knowledgeable enough to understand and interpret the scientific facts of the explosions.[66] The verdict of 'accidental death' resulted in no one being held to account for any neglect or misuse of the boiler which caused the explosion. Consequently, coroners' inquests did little to acknowledge that explosions were preventable and people should be held responsible for them, and the opportunity to increase the motivation of steam boiler owners and users to prevent explosions was lost.

[62] *Ibid.*, p. 4.
[63] *Berrow's Worcester Journal*, June 21, 1862.
[64] *Staffordshire Advertiser*, August 22, 1863.
[65] *Worcestershire Chronicle*, July 28, 1888.
[66] *Select Committee on Steam Boiler Explosions* (1870).

Marten gave evidence to at least thirty-six coroner's inquests relating to boiler explosions, mostly within the Black Country.[67] One of these was the explosion at Britannia ironworks, Bradley, in December 1869, which resulted in the deaths of eight men. The works had six boilers, some of which were inspected and insured by MSBIAC, but the boiler that exploded was not. At the coroner's inquest, Marten gave his evidence after inspecting the boiler and site. He stated that the plate of the central tube of the boiler and many of the rivet heads were corroded, and deduced that the cause of the explosion was the collapse of the central tube. His opinion was that the central tube was unable to bear even the working pressure of thirty pounds per square inch, and he thought that it had exploded at this pressure, though it would have been dangerous at any pressure. When questioned by the coroner, he said that he would have condemned the boiler if he had examined it, and would not have insured it.[68] His testimony was damning: 'this fatal corrosion being inside was not hidden by brickwork, but would have easily been seen by anyone walking round the bottom of the boiler inside'.[69] He stated that one of his inspectors would have discovered the problem if they had inspected the tube. The verdict of the jury was that age and the much-worn condition of the boiler caused the explosion, but no one was censured.

Marten's work for coroners' inquests involved the examination of the exploded boiler and site of the explosion, both of which contributed to the scientific accident analysis he undertook. He determined the cause of the explosion by interpreting the facts he had ascertained from the examination, using his technical knowledge and experience in these matters. The above example of an inquest demonstrates the bad state of repair some boilers were in and the importance of regular inspection as a means of prevention. It also shows the valuable work Marten was undertaking by bringing this to light through his investigations.

A Select Committee on Steam Boiler Explosions was appointed in 1870 to inquire into the causes and best means of preventing explosions. Marten stood as a witness in July 1870, making several recommendations to the committee, including periodic boiler inspections, the power to stop a boiler operating if it was deemed to be dangerous, and to have two independent and experienced engineers write a report on every boiler explosion, and for these reports to be printed and sold as was done with railway accidents.[70]

The Select Committee could not complete its inquiry in the session, but issued a report. It reconvened in 1871, and the papers Marten had read before the Institution of Mechanical Engineers (IMechE) on steam boiler explosion prevention in 1866 and 1870 (see below) were produced. The Select Committee published a further report in 1871, detailing several recommendations, including that the boiler user be held responsible for the safe use of the boiler and machinery, and for employing competent people to work them and that the user be held responsible for any explosion unless they could prove that the fault was not theirs or it was beyond their control. Furthermore, it recommended that boilers should be examined frequently, and have

[67]These were reported in the local press but, no doubt, there would have been others that the author's research missed or were not reported by the press.
[68]*The Standard*, December 7, 1869.
[69]'The Explosion at the Britannia Ironworks, Bradley,' *The Engineer*, 28 (1869), 387.
[70]*Select Committee on Steam Boiler Explosions* (1870).

proper safety valves, pressure gauge, water gauge and blow-off tap installed. The committee also recommended that all explosions, fatal or not, be reported by the user to the coroner, who should then inform the Board of Trade. Someone would then be appointed to inspect the exploded boiler and assist the coroner's investigation. The Board of Trade should also write up the case and present such cases to Parliament on a yearly basis.[71] However, these recommendations were not made into law, and it was not until the Boiler Explosions Act of 1882 that legislation came into place.

Marten's national reputation as an authority on steam-boiler explosion prevention was shown by being called as a witness and the reading of his papers at a Select Committee. Unfortunately, no legislation was generated at that time, so it cannot be claimed he contributed directly to a change in the law. This lack of legislation, however, resulted in coroners' inquests remaining the only official means for the investigation into the cause of steam boiler explosions and, as demonstrated above, Marten played a prominent role in these.

Marten gained much scientific knowledge on steam boiler explosions through his work inspecting boilers for MSBIAC and his investigations into explosions for coroners' inquests. He was active in disseminating this knowledge, and the following explores how he achieved this. Marten presented papers at the annual IMechE conference in 1866 at Manchester and in 1870 at Nottingham, which were subsequently published in that Institution's Proceedings.[72] These contained details of the causes of explosions, and his recommendations for keeping accurate records of explosions and the wide dissemination of facts in order to educate boiler users and thereby reduce the risk of explosions. He also advocated regular boiler inspections stating that boiler explosions generally arise 'from some defect which could have been remedied if it had been known to exist', asserting that regular inspections would have prevented most of the explosions he described.[73] The 1866 paper was praised by the *Staffordshire Advertiser* as containing 'an immense amount of really valuable practical information'.[74] Marten shared his knowledge on steam boiler explosions with the engineers who attended the conferences and read the papers, thus increasing their understanding of the subject.

Along with such prestigious national meetings, he also presented papers locally, such as at meetings of the South Staffordshire Mill and Forge Managers' Association (SSMFMA) in 1880, and the South Staffordshire Institute of Iron and Steel Works Managers in 1887.[75] To aid his talks, he displayed diagrams and models of exploded boilers showing the ruptures and the positions they were in after the explosions. Following his talk in 1880, his models were exhibited at Dudley's Public Hall to allow members of the SSMFMA and their friends to have a closer look.[76] This was accompanied by Marten performing a number of table-top experiments which were billed as 'highly instructive and entertaining', and were undertaken to dispel some myths about

[71] *Report from the Select Committee on Steam Boiler Explosions; together with the Proceedings of the Committee, Minutes of Evidence, and Index* (House of Commons, 1871).
[72] *Manchester Courier*, August, 1 1866; *The Times*, August 4, 1870; E. B. Marten, 'On Steam Boiler Explosions and their Records, and on Inspection as a Means of Prevention,' *Proceedings of the Institution of Mechanical Engineers*, 17, 1 (1866), 130–180; E. B. Marten, 'On the Conclusions Derived from the Experience of Recent Steam Boiler Explosions,' *Proceedings of the Institution of Mechanical Engineers*, 21, 1 (1870), 170–218.
[73] Marten, 'On Steam Boiler Explosions,' p. 164.
[74] *Staffordshire Advertiser*, March 23, 1867, p. 3.
[75] *CAHWS*, 2 October 1880 and February 26, 1887.
[76] *Dudley and District News*, November 6, 1880.

the causes of explosions.[77] Marten was disseminating scientific knowledge on boiler explosion prevention to local boiler owners and users, and doing so in a visually engaging manner which facilitated learning.

Marten used a variety of media to better illustrate the facts of steam boiler explosions and his conclusions, and he exhibited his collection of diagrams, models and photographs throughout the country. He displayed models of exploded boilers and a large collection of photographs in the industrial section of the Worcestershire Exhibition which was held in 1882 at Worcester.[78] Also he showed photographs and models at an exhibition of life saving appliances at Alexandra Palace, London.[79] The following year he exhibited his models, sketches and photographs to the Cleveland Iron Trade Foreman's Association in Middlesbrough, for which he also demonstrated his myth-busting experiments.[80] Marten took his steam boiler explosion prevention message to the country.

Marten collected details of local and national steam boiler explosions, and published his findings as books on a yearly basis. The books contain details of explosions from 1866 up to the year of publication, and include the numbers of explosions and fatalities, boiler type, purpose of the boiler and cause of the explosion, along with relevant sketches. They were prefaced by the papers Marten had presented at IMechE conferences of 1866 and 1870.[81] These books were useful to engineers and, as the *Staffordshire Advertiser* commented in 1867, contained 'one of the most interesting accounts of the boiler explosions of the preceding year ever published'.[82] They were for sale to the public, therefore, Marten reached a wide audience with his boiler explosion prevention information. Additionally, Marten's nationwide boiler explosion statistics were incorporated into the Reports of the Inspectors of Factories in 1871 and 1877, and quoted in papers by other authors such as Walford.[83] Marten diligently collected and analysed data on steam boiler explosions, collated this information into books which added to the available scientific knowledge of the subject. His books received praise, and the reproduction of his statistics shows how respected his work was. He was an excellent communicator, and passed on his knowledge and advice through literature, presentations, talks, exhibitions and experiments through a variety of media, including academic papers, books, diagrams, models and photographs to explain his findings and dispel myths. This served to make his message engaging and entertaining, and he reached wide and varied, local and national audiences.

Marten's achievements required engineering ability, but also personal skills and character traits. As a steam boiler inspector, he had to be conscientious in his duties as people's lives and livelihoods were at stake. The newly formed MSBIAC trusted him otherwise they would have not employed him in a hugely responsible role. His pain-

[77] *Dudley Herald*, October 23, 1880, p. 5.
[78] *Worcestershire Chronicle*, July 22, 1882.
[79] 'Exhibition of Life-saving Appliances,' *The Engineer*, 54 (1882), 135.
[80] *Northern Daily Gazette*, February 16, 1883.
[81] For example, E. B. Marten, *Records of Steam Boiler Explosions*, (London and Stourbridge: E. and F. N. Spon, 1872).
[82] *Staffordshire Advertiser*, March 23, 1867, p. 3.
[83] *Reports of the Inspectors of Factories to Her Majesty's Principal Secretary of State for the Home Department for the Half Year Ending 31 October 1870* (London: G. E. Eyre and W. Spottiswoode for HMSO, 1871); *Reports of the Inspectors of Factories to Her Majesty's Principal Secretary of State for the Home Department for the Half Year Ending 30 April 1877* (London: G. E. Eyre and W. Spottiswoode for HMSO, 1877); Walford, 'The Increasing Number of Deaths from Explosions.'

staking collection and analysis of boiler explosion data indicates someone of great patience, diligence and logic. Marten cared about facts and dispelling myths, showing that he had a scientific mind and intellectual curiosity. He was also an excellent communicator: his published works were written in a clear, concise and methodical manner, which makes them easily understood. His use of cutting-edge techniques, such as photography, shows him embracing modernity and using the best tools available to impart his knowledge. He certainly had a talent for educating. He was academically successful, as shown by the papers published by IMechE, but he also reached the people in charge of workplace boilers through their local associations. The dissemination of the message was important to him, not just academic prestige. Without his dedication, personal skills and characteristics he would not have contributed to industrial safety to the extent that he did.

The number of steam boiler explosions reduced from a peak of eighty-eight in 1873 and by 1880 had dropped by more than a half to thirty-one.[84] Fatalities also decreased after peaking at ninety-three in 1876, and by the year ending 30 June 1905 they were down to fourteen in the UK.[85] These reductions occurred even though boiler use was increasing. This is likely to have been due to a number of factors including the use of mild-steel in the manufacture of boilers from 1865, medical advances and the Employers' Liability Act of 1880.[86] However, the contribution of regular inspections and insurance by private companies certainly played its part. This is shown by the figures Marten gave to the 1870 Select Committee. He stated that the number of explosions of boilers not registered with MSBIAC was 1 in 1,333, but for boilers insured by the company the figure was nearly half that at 1 in 2,600.[87] The work of MSBIAC and its chief engineer, Marten, resulted in the reduction of steam boiler explosions.

Steam boiler explosions resulted in a large number of fatalities, injuries, loss of business, unemployment, and poverty. Marten was active in their prevention through his inspection work at MSBIAC and by investigating explosions for coroners' inquests. He also collected and analysed explosion data from across the country and abroad and communicated his vast knowledge locally and nationally and stood as a witness at a Select Committee. Marten played a significant role in reducing the number of explosions and, consequently, his work was of vital importance to industrial safety.

Conclusions

This article has explored the extent to which Marten made an important contribution to the improvement of Black Country sanitary conditions and to industrial safety both locally and nationally, by examining his career through the use of primary and secondary sources. Born in a year of a cholera epidemic, Marten started his career when the nation's sanitary conditions were atrocious, and combated such conditions through supplying piped water and effective sewerage systems within the Black Country. He was the lessee and manager of SWC, where he was busy with repairs,

[84] *Ibid*.
[85] *Ibid*.; W. H. Chaloner, *Vulcan: The History of 100 Years of Engineering and Insurance 1859–1959* (Manchester: Vulcan Boiler and General Insurance Company, 1959).
[86] Bartrip, 'The State and the Steam Boiler.'
[87] *Select Committee on Steam Boiler Explosions* (1870).

maintenance, improvements and extensions to the waterworks and the distribution system, including laying new water mains, repairing frost-damaged pipes and improving the pumping station. He also harried the company directors for a second engine, boiler and pump at the waterworks to reduce the risk of the clean water supply being cut off. During his time at SWC, he supplied an abundant amount of good quality piped water to Stourbridge and its neighbouring district, and increased the number of houses supplied significantly. This meant that less people relied on potentially contaminated water sources, such as wells and the river Stour.

Marten's work with USVMSB started at its inception with his design for a sewerage system for Rowley Regis. When this was combined with other regional schemes, the full sewerage system that Marten worked on for USVMSB served over 80,000 inhabitants. Although he was joint-engineer with Fiddian at USVMSB, he was solely responsible for the Rowley Regis sewerage scheme. He was involved with a variety of tasks, including overseeing contracts and contractors, negotiating the purchase of land, laying and repairing sewers, installing sewage flushing chambers, the construction and extensions of the sewerage treatment works, outfall works, a storm reservoir and pumping station. As the effluent from the sewage treatment works was found to be of good quality when tested, the works were clearly maintained to a high standard by Marten and Fiddian. Such an extensive and well-maintained sewerage system removed the sewage from the areas people lived and worked in, and treated it so that the effluent did not contaminate the water courses it was returned to. Consequently, Marten's work improved regional sanitary conditions.

The effects of increased access to clean water and improved sewerage is shown by the disappearance of cholera and falling death rates in the Black Country and nationally. Although other factors, such as better medical care, are likely to have contributed to this, it is a reasonable assumption that sanitary improvements reduced water-borne diseases and, thus, improved health and reduced mortality rates. It was engineers who designed, built, maintained and improved the new water and sewerage systems, therefore, engineers contributed to the improvement in sanitary conditions and public health in their districts.

Steam boiler explosions had catastrophic effects but, due to the lack of legislation, the only independent means of reducing the risk of explosion was for a boiler to be covered by one of the steam boiler inspection and insurance companies, and by the cause of an explosion to be investigated through coroners' inquests. Marten was involved in both of these, as the chief engineer to MSBIAC and by playing a major role in coroners' inquests in the Black Country. At MSBIAC, he was responsible for undertaking regular boiler inspections, recommending repairs and improvements, and had the power to withhold insurance if a boiler was deemed unsafe, thus incentivising the owner to keep it in good repair. For coroners' inquests, he inspected the exploded boiler and the site then provided his professional accident analysis of the cause and his opinion of what would have prevented the incident. Throughout his work with MSBIAC and coroners' inquests, and by gathering additional data on explosions within the UK and abroad, Marten collected a wealth of material on steam boiler explosions, and gained immense technical knowledge and experience, which resulted in him becoming a recognised expert in the field. He also gave evidence and made recommendations at a Select Committee on Steam Boiler Explosions, which shows that he was respected as an

authority on the subject. Furthermore, he actively disseminated his scientific knowledge and advice on explosion causes and prevention using his communication skills and multi-media resources, showing that explosions were preventable, and inspections contributed to that prevention. Marten became well-known and respected in his field and played an active role in the prevention of steam boiler explosions.

The number of steam boiler explosions reduced after the mid-1870s, and fatalities were down to fourteen in the UK by the year ending 30 June 1905.[88] Factors such as the use of mild-steel in the manufacture of boilers from 1865, better medical care and the Employers' Liability Act of 1880 are likely to have contributed to this reduction. However, having a steam boiler under the care of an inspection and insurance company lowered the risk of a boiler exploding. For example, boilers within the region covered by MSBIAC, but not under their care, had more than twice the rate of explosion than those under the company's care.[89] Marten raised awareness of explosion causes and the importance of inspections, which helped steam boiler owners to understand that explosions were preventable, and thus encouraged them to take better care of their boilers and register with an inspection and insurance company. Marten's work resulted in the reduction in steam boiler explosions and, thus, saved lives, reduced injuries, kept works open and reduced economic privation locally and nationally. Marten made an extremely valuable contribution to industrial safety. Although Marten's work and achievements have been neglected, they deserve recognition.

In addition to rediscovering Marten's work, this essay throws light on a variety of topics. It shows the dire conditions people lived in before sanitary improvements were implemented, how the first steps in the provision of sanitary infrastructure were made and what that infrastructure looked like, for example, by considering early piped water systems. Industrial working conditions and dangers are also revealed through the dreadful effects of steam boiler explosions, thus providing a balance to the almost universal glorification of steam power. Explosion prevention legislation was slow in the making and coroners' inquests were inadequate in holding people to account, but individuals and private enterprise stepped in to address the problem.

Importantly, the article uncovers aspects of the engineering profession during the second half of the nineteenth century, with its extensive networks, professional bodies, academic publications and exhibitions. Engineering reports were important enough to be reported in the local and national press, which shows how the profession was respected and celebrated in the Victorian period. Although Marten's work had national impact and saved innumerable lives, he has passed out of public consciousness, and this itself throws light on how history is written. The engineers who are remembered by history are those such as Stephenson and Brunel who built visually impressive structures. Marten did not build such structures, his work is out of sight and so, unfortunately, out of mind. What has been demonstrated, is that engineering is not just about magnificent structures, but the improvement of the quality of life, health and safety. The engineers who contributed to this deserve recognition. Marten was one of many such engineers working in the Black Country. For example, Fiddian was Marten's co-engineer at USVMSB, and Marten's elder brother, John Henry Marten, was also

[88]Walford, 'The Increasing Number of Deaths from Explosions'; Chaloner, *Vulcan: History*.
[89]*Select Committee on Steam Boiler Explosions* (1870).

a water engineer. Further research should be undertaken on these forgotten Black Country engineers. Additionally, although national public health history has had attention, the history of Black Country public health has yet to be written, and industrial safety is a neglected topic at both national and local levels. This article has contributed to the re-remembering of important engineers and their achievements, and can serve as an entry-point to further research on public health and industrial safety.

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Sarah Jordan has an MA in West Midlands History and a background in engineering including a PhD in the subject. Her research interests include the social history of engineering in the Victorian and Edwardian eras.