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Architectural and Scientific Principles in the Design of the Palace of Westminster

Henrik Schoenefeldt

The right adjustments of the relative claims of the fine and useful arts, where they meet or interfere, forms the very root and basis of all that is most important, more especially in public buildings. Nothing can attain the highest order of beauty that attempts to do so at the expense of an admitted want.¹

In *The True Principles of Pointed or Christian Architecture*, A.W.N. Pugin criticised the original competition entry for the Palace of Westminster for its classical character, but he also rejected the superficial or purely formalist approach to the use of irregularity in Gothic Revival architecture, stressing that irregularly should always be a truthful outward of expression of internal arrangements or a building's evolution.² After 1840, however, the architectural form of the Palace was gradually modified to accommodate a stack ventilation system that had not been part of the early architectural scheme Pugin had criticised. The relationship between architectural form, composition and the functional requirements of the stack ventilation strategy became subject on extensive investigations, and the design development illuminates how this relationship manifested itself in the exterior of the Palace. Following the plans of the Scottish physician David Boswell Reid the existing architectural towers, such as the Clock and Victoria Towers, were converted into air supply shafts, while a third tower of equal architectural prominence was added for the extraction of air. Reid saw the Palace as an opportunity to resolve questions of ventilation using a rational scientific design approach, which he had previously deployed in the design of mock debating chambers³

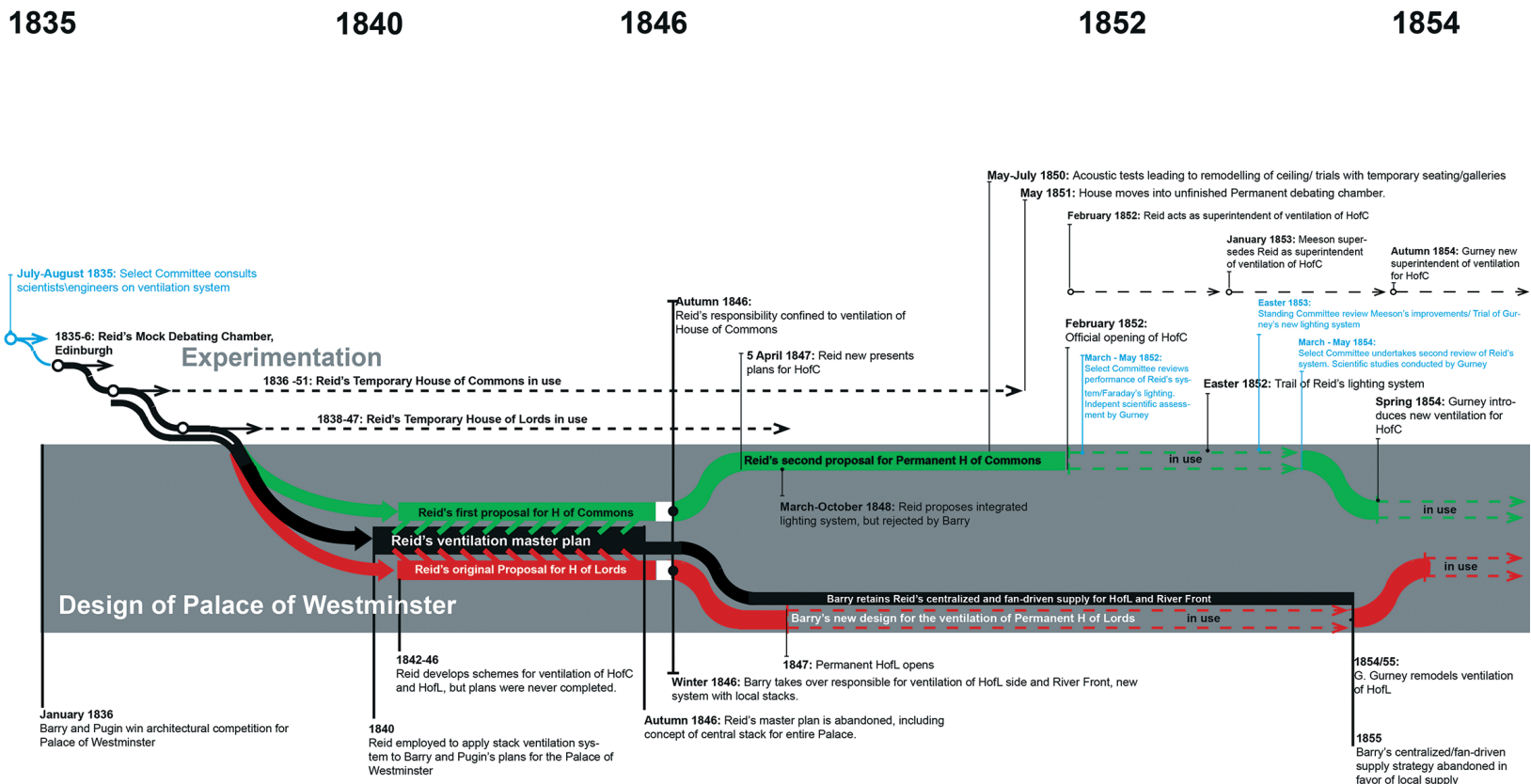
but in the actual Palace, architectural and scientific questions had to be addressed in an integrated way, involving collaborations between engineers, scientists and the architect. Difficulties with achieving this level of collaboration and increasing doubts about the system's technical viability⁴ provided the impetus for adopting a fundamentally different ventilation strategy under Barry's direction. This not only significantly reduced the complexity of the design process, but for the second time, led to a transformation of the building's architectural form. Remnants of the abandoned scheme, such as the Central Tower, were retained without fulfilling its original purpose, but a system of local ventilation turrets was gradually introduced between 1846 and 1854 to compensate for the loss of the Tower as a discharge. The Palace underwent a gradual architectural transformation in response to an evolving system of ventilation. Previous studies have focused on the ventilation as a technical issue, without investigating the relationship between architectural and technical inquiries during the design development.⁵ Based on a detailed study of the original project correspondence, sketches, architectural drawings, this chapter investigates how the architecture of the Palace was transformed in response to the evolving ventilation system. The archival evidence covered the involvement of Barry's architectural practice in great detail, but unfortunately did not provide any insight into Pugin's specific contribution to the development of the ventilation system.

This chapter starts with the original competition scheme and how it was modified between 1840 and 1846 to accommodate Reid's original plans. This is followed by an explo-

13.1 Perspective of New Palace of Westminster, showing the third tower proposed by Reid in 1841 as a central discharge shaft.

[Westminster, Parliamentary Archives: Arc/var/279: "View of the Houses of Parliament from South-East. A water-colour by Thomas Allom", 1844]

- 1 Reid, "The Revision of Architecture", 208ff.
- 2 Pugin, *True Principles*.
- 3 Author's article, looking at the idea of scientific approach to design, iterative.
- 4 The problems were discussed extensively in the original correspondence between Charles Barry, David Boswell Reid and the Department of Woods and Forests over the period between 1845 and 1855. These letters are kept in the National and Parliamentary Archives. Further details in various government papers, including: Reports from the Select Committee of the House of Lords appointed to inquire into the progress of the building of the Houses of Parliament (HL 1846, 719); Third report from the Select Committee on Westminster Bridge and new palace (HC 1846, 574).
- 5 Sturrock and Lawson-Smith, "The Grandfather of Air-Conditioning"; Brucemann and Prowler, "19th Century Mechanical System Designs"; Bruegmann, "Central Heating and Forced Ventilation".



13.2 Timeline of the design development, 1834-1865.
[Author's own drawing]

- 6 These sources are held in the National, Parliamentary and London Metropolitan Archives, British Library and Cambridge University Library.
- 7 Report of the Select Committee on the Ventilation of the Houses of Parliament (HC 1835, 583); Report of commissioners appointed to consider the plans for building the new Houses of Parliament (HC 1836, 66); Report from Select Committee on Houses of Parliament (HC 1836, 245).
- 8 Report of the Select Committee on the Ventilation of the Houses of Parliament (HC 1835, 583), iii-iv.
- 9 *Ibid.*, iii-iv; Letter from Robert Smirke to the Commissioners of Woods and Forests, 11 Nov. 1835 (National Archives, Work 11/12, no. 6).

ration of the development of a new strategy adopted after 1846 under Barry's direction.⁶ Major modifications implemented in 1854 by the engineer Goldsworthy Gurney represented the end of this intense negotiation process as the design remained largely unchanged until the 1880s [13.2]. This chapter also demonstrates that the study of technological aspects and its impact on the overall design process can yield a fundamentally new understanding of the making of architectural form in the Gothic Revival.

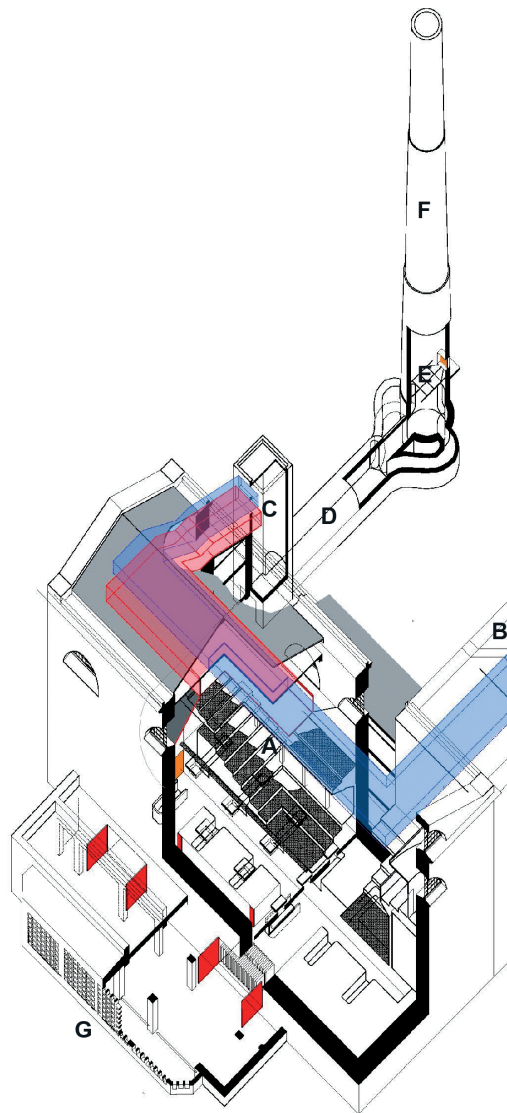
Science and architecture on separate paths, 1835-1840

Over the first five years environmental design inquiries were conducted independently from the development of the architectural scheme for the New Palace of Westminster by Charles Barry and Pugin. Between 1835 and 1840 the government hired Reid to conduct several experimental studies on the

ventilation of debating chambers, utilising scientific methods previously deployed in his chemistry Laboratory in Edinburgh. These studies commenced well before the selection of the architectural scheme in January 1836 and the application of the findings to the scheme did not commence until 1840, when Reid was formally employed to collaborate with Barry's architectural practice. Between 1834 and 1836 the government had appointed various Select Committees and Commissioners to develop a comprehensive brief for a new and purpose-built Houses of Parliament.⁷ The Select Committee on the Ventilation was charged with inquiring into potential technical solutions that could be later adopted in the New Palace once an architectural design had been selected. It consulted various scientists and engineers between August and November 1835 and recommended Reid's proposal for a debating chamber with a stack ventilation system.⁸ Reid was tasked with experimentally verifying its feasibility.⁹ He started testing and

refining different technical arrangements inside a mock debating chamber in Edinburgh.¹⁰ This was followed by the application of the stack ventilation system to the existing Temporary Houses of Parliament, which had been designed by Robert Smirke in 1834 as provisional accommodation for the government until the New Palace was completed.¹¹ As it was used as a debating chamber from 1837 to 1851 the altered Temporary House of Commons enabled Reid to study the performance of the ventilation system at full scale and under real life conditions.¹² In 1839 the ventilation was extended by connecting the Temporary House of Lords, libraries and committee rooms to the ventilation of the House of Commons.¹³ This transformation facilitated Reid to test the feasibility of extracting air from several rooms simultaneously using one tall chimney, an idea he later proposed to exploit at a much larger scale in the New Palace [13.3].

Although these experimental studies provided important technical insights, they did not have any bearing on the architectural scheme during the first five years. Barry's scheme had been recommended by Commissioners for the Selection of Plans,¹⁴ yet a review conducted by another Select Committee in spring 1836 revealed that the technical inquiries of the Ventilation Committee, let alone the specific requirements for Reid's ventilation system, had been widely ignored during the selection process.¹⁵ The original competition brief had specified ventilation as a design requirement¹⁶ but the selection panel had focused on the internal spatial organisation and the architectural character of the exterior.¹⁷ Two of the Commissioners, Lord Sudeley and Edward Crust, reported that they did not have the expertise to evaluate the submitted design from a more technical perspective.¹⁸ They admitted that the Commissioners had neither involved Reid nor consulted the Ventilation Committee's report to guide the selection of the scheme.¹⁹ In their final report it was stated that the Commissioners only evaluated the adequacy of the general massing and spatial organisa-



13.3 Axonometric projection Reid's ventilation system inside the Temporary Houses of Commons, 1836-1850. [Author's own drawing]

12 An in-depth study of the design and technical evaluation of the Temporary Houses of Parliament is provided in Schoenefeldt, "The Temporary Houses of Parliament and David Boswell Reid's architecture of experimentation". Detailed historic accounts of the technical experiments, can be found, among others, in Reid, *Illustrations of the Theory and Practice of Ventilation*; Ventilation of the House: Letter from Reid to Viscount Duncannon, in reply to observations addressed to His Lordship by Sir Frederick Trench (HC 1837-1838, 277); Report from the Select Committee on Lighting the House (HC 1842, 251); Report from the Select Committee on Ventilation of the New Houses of Parliament (HC 1841, 51-52); Report from the Select Committee on Lighting the House (HC 1839, 501).

13 Brayley and Britton, *History of the Ancient Palace*, 420; Reid, *Illustrations of the Theory and Practice of Ventilation*, 285-293.

14 Report of commissioners appointed to consider the plans for building the new Houses of Parliament (HC 1836, 66).

15 Report from Select Committee on Houses of Parliament (HC 1836, 245), Q15-17.

16 Report of commissioners appointed to consider the plans for building the new Houses of Parliament (HC 1836, 66).

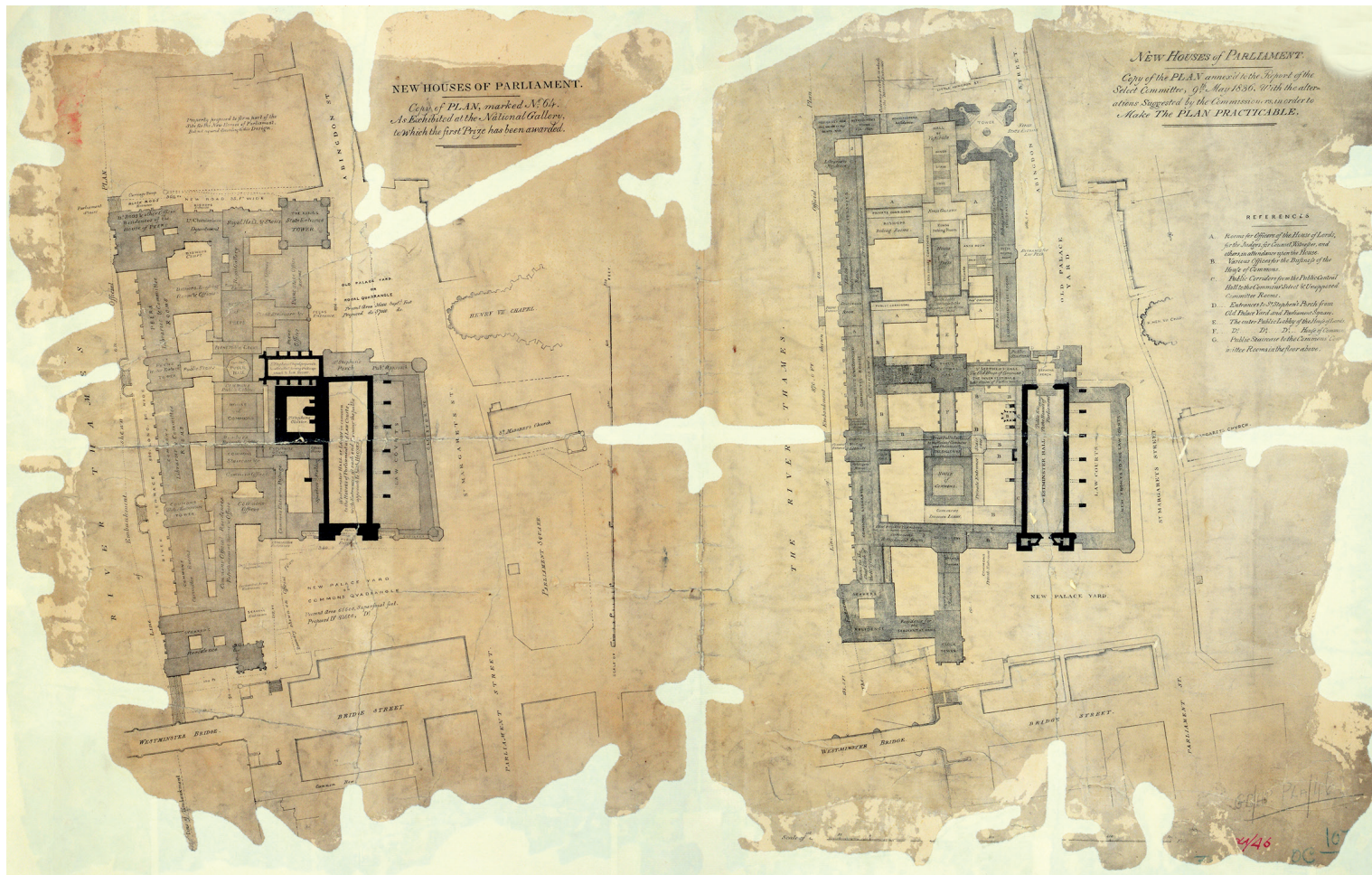
17 Report from the Select Committee on Rebuilding Houses of Parliament (HC 1835, 262), 3.

18 Report from Select Committee on Houses of Parliament (HC 1836, 245), Q59-60.

19 *Ibid.*, Q67-70; 1836 (17-18, 59).

10 Reid, "Eight lectures by David Boswell Reid"; 1835 Ventilation Select Committee, 34-40; Reid, *Illustrations of the Theory and Practice of Ventilation*; *Id.*, *Brief outlines illustrative of the alterations in the House of Commons*; *Id.*, *Ventilation in American Dwellings*.

11 Brayley and Britton, *The history of the Ancient Palace and Late Houses of Parliament at Westminster*, 420, 464; "Alterations in the House of Commons", *Champion*, 13 Nov. 1836, 19; "Latest News", *Berrow's Worcester Journal*, 29 Dec. 1836, 4; "Miscellanea", *The Champion*, 3 Oct. 1836, 1.



13.4 The floor plan submitted as part of the original competition entry, November 1835, and the modified floor plan adopted in May 1836, showing the enlarged courtyards. [Kew, National Archives: Work 29/85: Two plans on one sheet. That on the right headed "New Houses of Parliament - copy of the plan annexed to the Report of the Select Committee, 9th May, 1836, with the alterations suggested by the Commissioners in order to make the plan practicable"]

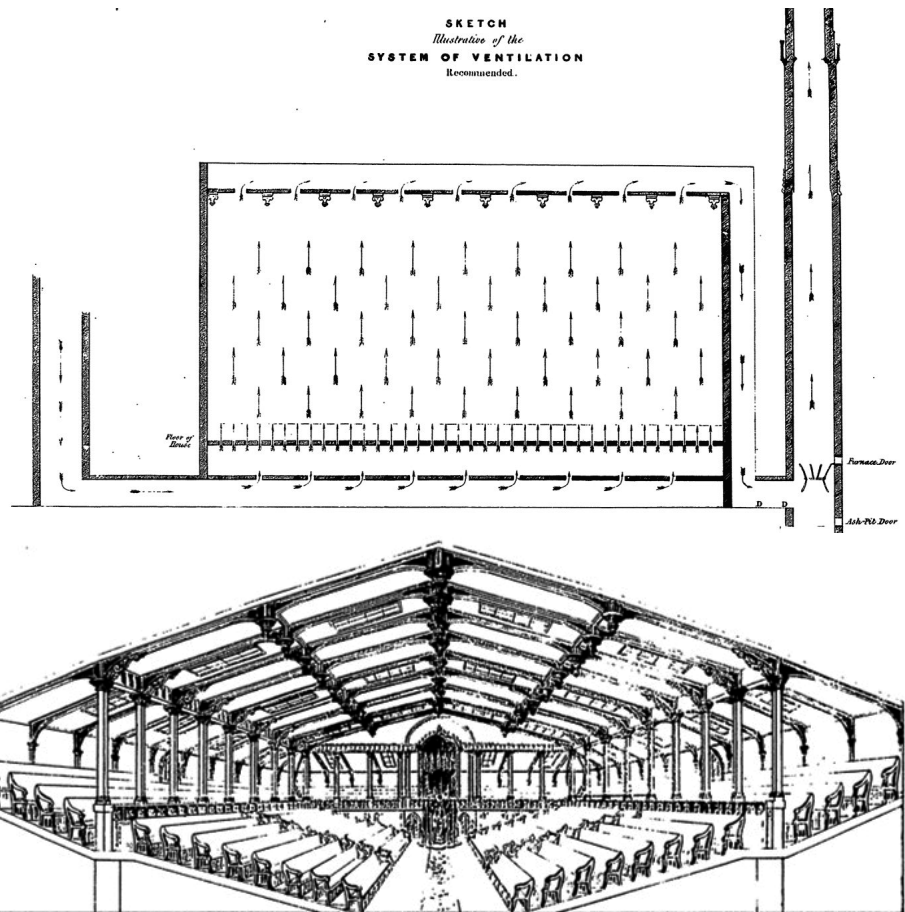
technical provisions were fire places with chimney flues, which acted as joint air and smoke discharge shafts in each individual room.²¹ In early 1836 Barry had also several meetings with the Commissioners to refine the original design. To further optimise it for cross-ventilation, the courts were enlarged, parts of the building were spaced further apart and the depth of spaces was reduced [13.4].²²

In 1840, when Reid's stack system was finally to be incorporated into the Palace, the relationship between architectural form and ventilation was re-appraised as Reid had envisaged a fundamentally different ventilation strategy to Barry, which did not rely on operable windows or the use of local chimneys. Since August 1835 [13.5 -13.6] he proposed a sealed building in which air was admitted and exhausted exclusively via two tall shafts.²³

The challenge of integration

The retrospective introduction of the system had serious implications for the subsequent development of Barry's architectural scheme, in particular as the plans had been developed to a high level of detail over the past five years. After a preliminary examination of Barry's plans in November 1839 Reid alerted Lord Duncannon, Chief Commissioner of the Department of Woods and Forests, that the original plans had to be significantly modified and the construction paused until the new working drawings were completed. He highlighted that the ventilation will "necessarily modify, and are modified by, architectural arrangements."²⁴ In July 1840 he submitted a preliminary report, discussing the positioning of fresh air inlets based on the finding of his analysis of the wind condi-

tions and atmospheric pollution in Westminster.²⁵ Reid wrote that fresh air should be admitted from the highest existing towers or that a new tower should be introduced specifically to retrieve air from the highest possible altitude. According to Reid the atmosphere in central London was considerably purer at an altitude of a few hundred feet than at street level. His objective was to gain access to “an atmosphere at least equal to that of Hyde Park, and often one as pure as it is possible to obtain within some miles of London for the dull, lifeless, languid and heavy air which I have so often experienced around the present house”.²⁶ The reference to the greater air purity around Hyde Park, which in the 1840s was still on the fringes of London, is not insignificant. It was only due to the relative remoteness of Hyde Park that Joseph Paxton was able to deploy direct natural ventilation in the 1851 Great Exhibition Building without excessive pollution damaging exhibits or causing discomfort to staff and visitors.²⁷ The proposal for a sealed building was a direct response to the specific atmospheric conditions in mid-nineteenth-century Westminster. Reid had not included any concrete plans but the Department of Woods and Forests asked Barry to assess the feasibility of these initial recommendations.²⁸ He suggested that the Victoria Tower could be used to obtain air from an altitude of 240 feet through three shafts with a combined area of 200 square feet.²⁹ Barry asked Reid to produce plans and diagrams outlining a clear proposal for the whole system. In August Reid proposed the addition of a third tower above the Central Hall to function as a central discharge for the entire Palace. The tower fulfilled a similar function to the ventilating chimney in the Temporary Houses, but its height and cross-section was significantly increased to achieve the greater power required to ventilate a building of this scale. Reid specified a cross-sectional area of 400 square feet and a height of 150 feet.³⁰ Observations in the Temporary Houses had demonstrated that the small chimney was not sufficient to extract air from both cham-



- 20 Report of commissioners appointed to consider the plans for building the new Houses of Parliament (HC 1836, 66).
- 21 Ibid., Q184.
- 22 Ibid., Q131, Q84, 98.
- 23 Report of the Select Committee on the Ventilation of the Houses of Parliament (HC 1835, 583).
- 24 Letter from Reid to Duncannon, 1839, undated (National Archives, Work 11/12, no. 17).
- 25 Letter from Reid to Viscount Duncannon, 7 July 1840 (National Archives, Work 11/12, no. 34).
- 26 Ibid.
- 27 Schoenefeldt, “Adapting Glass-houses for Human Use”.
- 28 Letter from Milne to Barry, 20 July 1840 (National Archives, Work 11/12, no. 35).
- 29 Letter from Barry to Milne, 14 Aug. 1840 (National Archives, Work 11/12, no. 37).

13.5 Sketch of Reid’s debating chamber presented to the ventilation committee in 1835, showing towers for the admission and discharge of air. [Westminster, Parliamentary Archives: HC 1835, 583: Report from Select Committee on the Ventilation of the Houses of Parliament, plan no 4 in Appendix]

13.6 Sketch of the interior of Reid’s proposed model debating chamber. [Westminster, Parliamentary Archives: HC 1835, 583: Report from Select Committee on the Ventilation of the Houses of Parliament, plan no 2 in Appendix]

30 Letter from Reid to Barry, 24 Aug. 1840, in Report from the Select Committee on Ventilation of the New Houses of Parliament (HC 1841, 51), Q17.

13.7 Perspective of original competition scheme, shows the Clock and Victoria Towers that were adapted to function as inlet shaft.

[Westminster, Parliamentary Archives: HC 1836, 245: Report from Select Committee on Houses of Parliament; with the minutes of evidence, image on final page of report, colours added by author]

- 31 Report from the Select Committee on Ventilation of the New Houses of Parliament (HC 1841, 51), Q2.
- 32 Fourth Report of the Select Committee of the House of Lords appointed to inquire into the progress of the building of the Houses of Parliament (HL 1846, 719), Q24.
- 33 These are explained in letter from the Reid to Office Woods, 28 April 1841 (National Archives, Work 11/12, no. 45).
- 34 Report from the Select Committee on Ventilation of the New Houses of Parliament (HC 1841, 51), Q17.
- 35 Transcript of interview with Reid, 14 Aug, 1846, Fourth Report of the Select Committee of the House of Lords appointed to inquire into the progress of the building of the Houses of Parliament (HL 1846, 719), Q23.
- 36 Letter from the Barry to Reid, 27 April 1841 (National Archives, Work 11/12, no. 151), in response to Reid's letter and plans of 2 Aug. 1841.
- 37 Letter from the Reid to Commissioners of Woods and Forests, 28 April 1841 (National Archives, Work 11/12, no. 45).
- 38 Letter from Milne to Barry, 10 May 1841 (National Archives, Work 11/12, no. 48).
- 39 Letter from Milne to Barry, 17 May 1841 (National Archives, Work 11/12, no. 50); letter from Barry to Milne, 20 May 1841 (Work 11/12, no. 51).



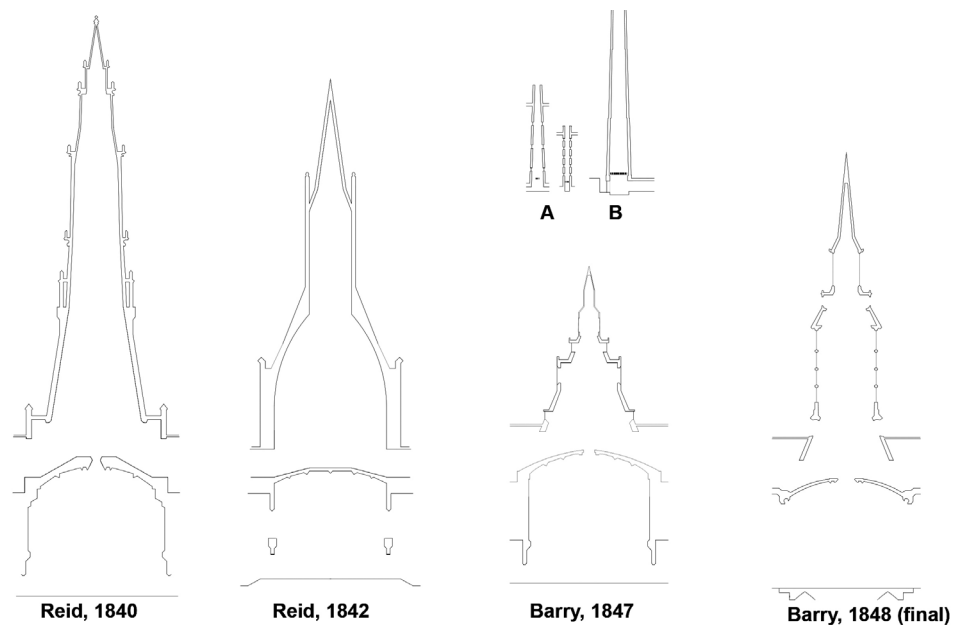
bers simultaneously under crowded conditions.³¹ Figure 8 shows the enormous scale of the proposed ventilating chimney compared to those deployed in the Temporary Houses or the Roxburgh Laboratory [13.9]. Nine months later Reid presented Barry with more detailed drawings,³² in which the Victoria and Clock Towers were adopted as the air supply shafts [13.7; see also 13.1].³³ All of the air ducts and smoke flues were to converge into one central exit point at the summit of the Central Tower, where the fumes would be carried away without re-entering the building at low level.³⁴ Reid and Barry subsequently had a meeting to discuss the proposal, during which Reid increased the cross-sectional area of the shaft to 600 feet, while the height remained at 150 feet above the roof.³⁵

The rise and fall of the three-tower scheme, 1840-1847

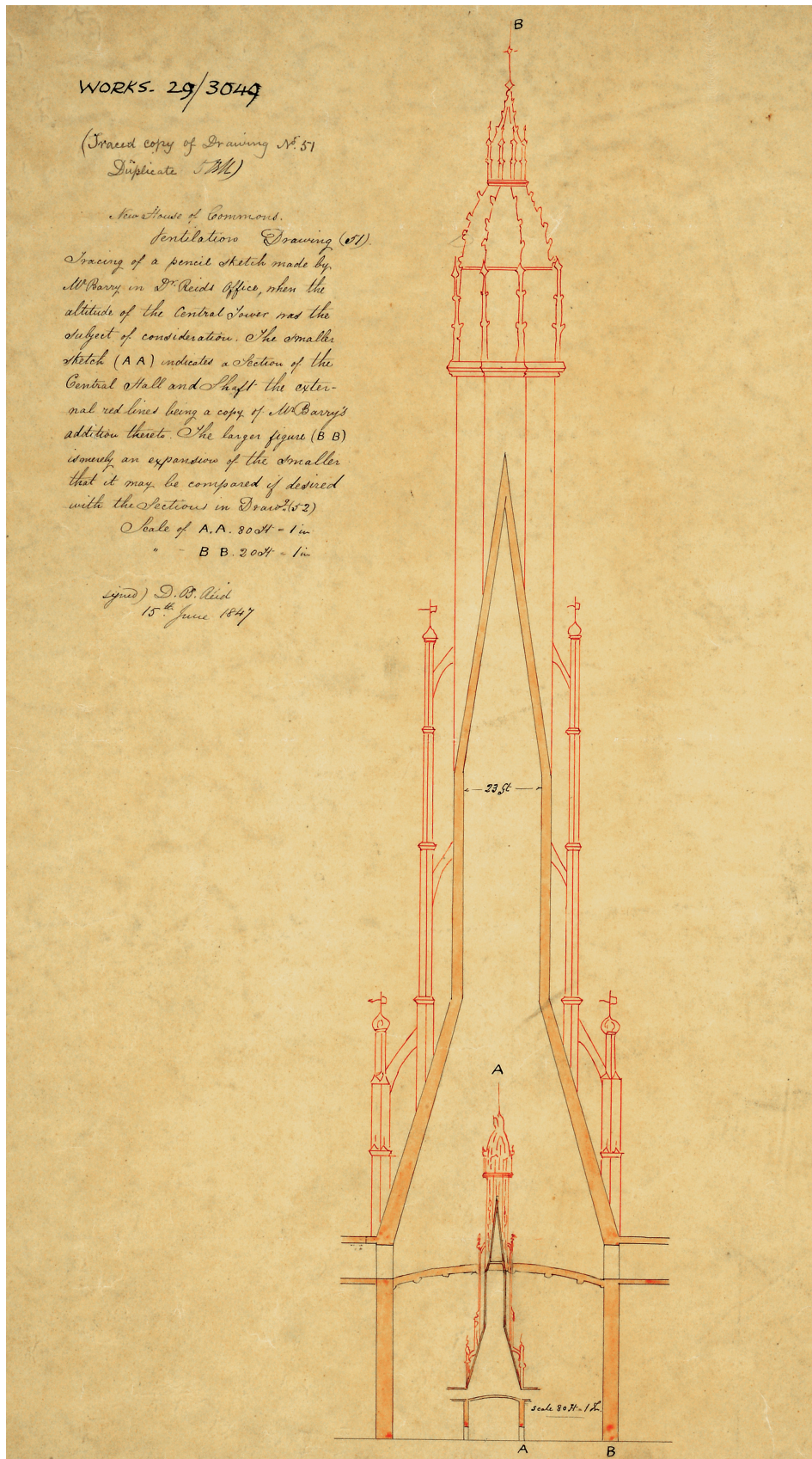
Barry approved the plans from an architectural perspective,³⁶ but due to its impact on the design and cost of the original scheme it required government approval. On 28 April 1841 Reid presented his plans to the Department of Woods and Forests,³⁷ which approved the proposal but was anxious about the potentially high costs which were not accounted for in the budget.³⁸ On 20 May

Barry provided the Department with an estimate, which was £62,000, excluding £21,000 for making the system fireproof.³⁹ A more detailed estimate was submitted to the Treasury for approval,⁴⁰ but the Department defended the additional investment, writing “the works necessary for effecting such scientific and comprehensive system of warming and ventilating as has not henceforth been adopted in any building of the same magnitude”.⁴¹ Due to the high sum the Treasury was unable to make a decision without Parliamentary approval until the next Session in September 1841,⁴² but the intermitting period was used to identify ways of lowering the costs. As the costs for the Central Tower alone were estimated at £20,000, the Department urged Reid and Barry to explore the possibility of using only the two existing towers. It suggested appropriating the Victoria Tower as a principal discharge to overcome the requirement for a third tower.⁴³ On 15 July Reid confirmed that it was technically feasible to abandon the Central Tower if the discharge shaft was moved inside the Victoria Tower, which already contained the air supply shafts.⁴⁴ The architectural character of the Victoria Tower was also preserved as all of the alterations would be confined to a reorganisation of ducts within the interior.⁴⁵ Another proposal was to adopt simplified, more utilitarian shafts but this was rejected by Barry. He wrote that “as from the

proposed height of the tower in question, it will be necessarily become an important feature of the building and should therefore in my opinion accord in architectural character with the exterior generally".⁴⁶ Reid and Barry were asked to produce a joint review of the proposals from the point of ventilation and architectural effect respectively.⁴⁷ On 31 July the Department received two separate reports. Barry did not object to Reid's scheme, but to lower costs he contemplated adopting a shorter Central Tower, which was to function as an inlet rather than discharge, but the plan was abandoned as Reid had shown that the inlet was not sufficiently protected from the emissions of the surroundings chimneys under certain wind conditions.⁴⁸ Both agreed that the Victoria Tower could be adopted for the purpose of a central discharge for only £10,000, but expressed a strong preference for the three-tower scheme on functional and architectural grounds.⁴⁹ In early August, Barry and Reid finally submitted a joint report, in which they stated that "as concerns the services respectively confided to us, that the architectural effect, the convenience and the comfort of the building would be promoted by incurring the larger outlay, and resorting to the plan of the central tower".⁵⁰ Lord Duncannon, First Commissioner of the Department, also advocated the proposal and asked the Treasury for their support.⁵¹ On 27 August he wrote that this additional investment was necessary if the principles used in the Temporary House of Commons, which had received wide approval from MPs, was to be successfully implemented in the New Palace. Barry promoted the tower as an architectural feature.⁵² On 21 August he submitted a drawing of the river elevation, showing the effect of the "tower of the height and diameter required by Dr. Reid for the purpose of ventilation according to the first suggestion" and emphasised that the tower "would considerably improve the general effect and importance of the intended building".⁵³ The project correspondence illustrates that the joint inquiries into the form of the Tower were concerned with



- 40 Abstract of estimate for warming and ventilating, 26 May 1841, signed Charles Barry (National Archives, Work 11/12, no. 54 & 55).
- 41 Letter from the Commissioners of Woods and Forests to the Treasury, 7 June 1841 (National Archives, Work 11/12, no. 57).
- 42 Letter from the Treasury to Commissioners of Woods and Forests, 24 June 1841 (National Archives, Work 11/12, no. 59).
- 43 Letter from Commissioners of Woods and Forests to Reid, 8 July 1841 (National Archives, Work 11/12, no. 64).
- 44 Letter from Reid to Milne, 15 July 1841 (National Archives, Work 11/12, no. 65).
- 45 Letter from Charles Gore (Woods) to Barry, 17 July 1841 (National Archives, Work 11/12, no number).
- 46 Letter from Gore to Barry, 27 July 1841 (National Archives, Work 11/12, no. 68).
- 47 Letter from Gore to Barry, 20 July 1841 (National Archives, Work 11/12, no. 69); letter from Milne to Reid, 17 July 1841 (Work 11/12, no. 67); letter from Gore to Reid, 20 July 1841 (Work 11/12, no. 70).
- 48 Letter from Barry to Gore, 31 July 1841 (National Archives, Work 11/12, unnumbered).
- 49 Letter from Gore to Barry, 27 July 1841 (National Archives, Work 11/12, no. 68).
- 50 Joint report by Barry and Reid to Commissioners of Woods and Forests, 9 Aug. 1841 (National Archives, Work 11/12, no. 75).
- 51 Letter from Treasury to Commissioners of Woods and Forests, 13 Aug. 1841 (National Archives, Work 11/12, no. 77).
- 52 Copy of letter from the First Commissioner of Woods and Forests to the Chancellor of the Exchequer on the subject of warming, ventilating, and securing from fire of the new Houses of Parliament, 27 Aug. 1841 (HC 1841, 23).
- 53 Letter from Barry to Duncannon, 21 Aug. 1841 (National Archives, Work 11/12, no. 79 & 80).
- 13.8 Cross-sections of alternative proposals for the Central Tower made by Reid and Barry between 1840 and 1848.
[Author's own drawings]



functional as well as formal architectural requirements. Sketches produced during a meeting between Reid and Barry in 1841, for instance, show that Reid provided the basic outline and dimensions for the tower, while Barry investigated the architectural form it might take, using Gothic spires as precedents [13.9]. They had several conversations regarding the form and dimensions the Tower could take to meet the ventilation requirements and several alternative tower designs were considered [13.8].⁵⁴ In 1846 Reid reported that there was some flexibility regards to the proportions and dimensions of the tower, noting that the height and cross-sections of the shaft were variables the architect could work with.⁵⁵ These inquiries were part of on-going efforts to reconcile functional requirements with more formal architectural concerns.

In autumn 1841 the decision was further delayed as the Parliament appointed the Select Committee on Ventilation of the New Houses to make an independent review of the feasibility and costs of the three-tower scheme.⁵⁶ Between the 24 September and 1 October 1841, Reid and Barry were interviewed and alternative ventilation strategies were discussed in detail, from point of cost, performance and architectural effect. Three other arrangements were explored in addition to the original scheme. The first involved two towers, with the existing Clock and Victoria Towers functioning as inlet and outlet shafts. The second scheme comprised three towers, but to reduce costs a more utilitarian discharge shaft was to be adopted, moved to a more remote position where it did not interfere with the architecture. The third scheme comprised a series of small local discharge stacks assisted by mechanical fans. Although this was cheaper to construct, it was rejected by Reid for being less reliable and incurring higher running cost due the fuel and manual labour required operating and maintaining the steam engines. Reid argued in favour of a discharge with minimal mechanical aids, but which could only be achieved through a tall tower. Referring

to his earlier experiments in Edinburgh he wrote to the Treasury that “with a lofty shaft, such as has been proposed, the natural impulse of the wind, aided by the action of the shaft, will provide sufficient power on all ordinary occasions”.⁵⁷ He claimed that the thermal buoyancy produced by the waste heat from people, central heating, gas lighting and fire places was sufficient to drive air and smoke out of the building. Ventilation fires were only required periodically during hot weather or when the Houses were exceptionally crowded. In October the government authorised the construction of the stronger foundations required for the Central Tower to keep the options open without further delaying the construction. The final decision concerning the third tower was postponed until July 1842, when Reid’s on-going experiments were expected to have yielded further empirical evidence of the system performance.⁵⁸ The development of the ventilation system was paused for an entire 11 months as the final direction of the design was depended on the government’s decision. The Committee proceeded with its inquiry in July 1842,⁵⁹ during which Reid and Barry gave more detailed explanations of the scheme.⁶⁰ Fresh air was admitted through inlets at the summit of Clock and Victoria Towers and was forced down air shafts into the basement by a steam driven fan.⁶¹ The fan also propelled fresh air into the debating chambers and operated independent from the Central Tower, which was used exclusively for the extraction of air and smoke. The Tower had been increased to a height of 250 feet, which according to Barry was most effective if it had a similar height to the two inlet towers.⁶² Unlike in the ventilating chimney of the Temporary Houses, the Central Tower was designed to minimise the use of fuel.⁶³ Apart from exploiting waste heat to achieve the required buoyancy, the cross-section of the Palace and the position of the Tower were to ensure that air could ascend naturally from the rooms towards the discharge shaft above.⁶⁴ Due to fears that

the large column of smoke issuing from the Tower could disfigure the building, the Select Committee opposed plans for a central smoke outlet. It suggested using it exclusively for vitiated air while the smoke was to be conveyed through separate chimneys. Reid, however, warned that smoke from local chimneys would pollute the courtyards and that conducting the smoke flues into the Tower was critical to achieve strong draughts without the aid of ventilating fires.⁶⁵ In their report the Committee finally approved the Central Tower, but demanded that the local chimneys in Barry’s original plans were retained as a back-up system in case the Tower failed.⁶⁶ The ultimate arrangement, it wrote, was to be left “open for future consideration after an experiment shall have been made of the real merits of the plan”. On 30 August these recommendations were also approved by the Treasury,⁶⁷ allowing Reid and Barry to progress with the development of the plan. After two years the development of the design was severely delayed again, but this time due to issues with achieving an effective collaboration between Reid and Barry’s offices.

13.9 Tracing (dated 15 June 1847) of original sketches produced by Barry and Reid during a meeting in 1841. [Kew, National Archives: Work 29/3049: “Houses of Parliament: Ventilation. Dr Reid’s scheme: tracing of a sketch plan made by Mr Barry in Dr Reid’s Office showing ventilation shaft in central tower, but before design had been settled”, 15 June 1847]

- 54 Transcript of interview with Reid, 14 Aug. 1846, Fourth Report of the Select Committee of the House of Lords appointed to inquire into the progress of the building of the Houses of Parliament (HL 1846, 719), Q26.
- 55 *Ibid.*, Q22.
- 56 Report from the Select Committee on Ventilation of the New Houses of Parliament (HC 1841, 51).
- 57 Letter from Reid to the Treasury, 30 Sept. 1841, in Report from the Select Committee on Ventilation of the New Houses of Parliament (HC 1841, 51), 36-37.
- 58 Report from the Select Committee on Ventilation of the New Houses of Parliament (HC 1841, 51).
- 59 Letter from Barry to Milne, 17 June 1842 (National Archives, Work 11/12, no. 87).

- 60 Second report from the Select Committee on Ventilation and Lighting of the House (HC 1852, 402).
- 61 Report from the Select Committee on Ventilation of the New Houses of Parliament (HC 1842, 536), Q29.
- 62 *Ibid.*, Q90, 94.
- 63 *Ibid.*, Q56.
- 64 *Ibid.*
- 65 *Ibid.*, Q4.
- 66 *Ibid.*, 3-4.
- 67 In a reply to the Board, Reid stresses that he will need specialist draughtsmen, familiar with machinery, to produce these drawings. On 5 Oct. 1842, the Commissioners of Woods and Forests authorised Reid to employ his own specialist draughtsman, and on 9 Jan. 1844 authorised the appointment of a clerk specifically to assist Reid in producing the drawings of the ventilation apparatus.

13.10 Diagrammatic sections illustrating evolution of ventilation system in the House of Commons.
[Author's own drawings]

68 Transcript of interview with Reid, 14 Aug. 1846, Fourth Report of the Select Committee of the House of Lords appointed to inquire into the progress of the building of the Houses of Parliament (HL 1846, 719), Q22.

69 Letter from Reid to Commissioners of Woods and Forests, 10 Feb. 1845 (National Archives, Work 11/12, no. 147); letter from Reid to Barry, 9 May 1845 (Work 11/12, no. 139-140); letter from Barry to Reid, 10 May 1845 (Work 11/12, no. 140-141).

70 E.g., letter from Barry to Reid, 15 April 1845 (National Archives, Work 11/12, no. 124); letter from Barry to Reid, 7 May 1845 (Work 11/12, no. 138); letter from Reid to Barry, 7 May 1845 (Work 11/12, no. 138); letter from Reid to Barry, 12 May 1845 (Work 11/12, no. 141); letter from Reid to Commissioners of Woods and Forests, 12 May 1845 (Work 11/12, no. 141); letter from Reid to Commissioners of Woods and Forests, 20 May 1845 (Work 11/12, no. 152).

71 Transcript of interview with Barry, 23 Feb. 1846, First Report of the Select Committee of the House of Lords appointed to inquire into the progress of the building of the Houses of Parliament (HL 1846, 719), Q21.

72 Report of the Select Committee of the House of Lords appointed to inquire into the progress of the building of the Houses of Parliament (HL 1846, 719).

73 *Ibid.*, Third Report from the Select Committee on Westminster Bridge and new palace (HC 1846, 574).

74 Third Report, in the Report of the Select Committee of the House of Lords appointed to inquire into the progress of the

Reid's centralised scheme is challenged

Between 1844 and 1845 Reid and Barry had several disputes, including quarrels about the cross-section of the Central Tower,⁶⁸ the use of roof spaces for the communication of air and smoke to the Central Tower⁶⁹ and the potential fire risks posed by the duct arrangements.⁷⁰ As this severely delayed the design process several inquiries were made between June 1845 and August 1846. Following Barry's advice, the Department in summer 1845 appointed the architect Joseph Gwilt to make an independent inquiry into the working methods Reid had deployed.⁷¹ Based on examinations of the correspondence, drawings and interviews with Reid and Barry, he came to the conclusion that the main cause of delays was that Reid as a scientist had an insufficient understanding of the architectural design process.⁷² In the following year two Select Committees were appointed and an independent technical inquiry was conducted to further review the situation.⁷³ The transcripts from the House of Lords Select Com-

building of the Houses of Parliament (HL 1846, 719).

75 First Report of the Select Committee of the House of Lords appointed to inquire into the progress of the building of the Houses of Parliament (HL 1846, 719), Q5-15.

76 "House Of Commons, Monday, May 25", *Times*, 26 May 1846, 5.

77 Select Committee of the House of Lords appointed to inquire into the Progress of architecture of the building of the Houses of Parliament (HL 1846, 719), Q4-51.

78 *Ibid.*, Q54.

79 "Report upon the system proposed by Dr. D. B. Reid, for warming and ventilating the new Houses of Parliament" (HC 1846, 447).

80 Jones, *Design methods*, 50-54.

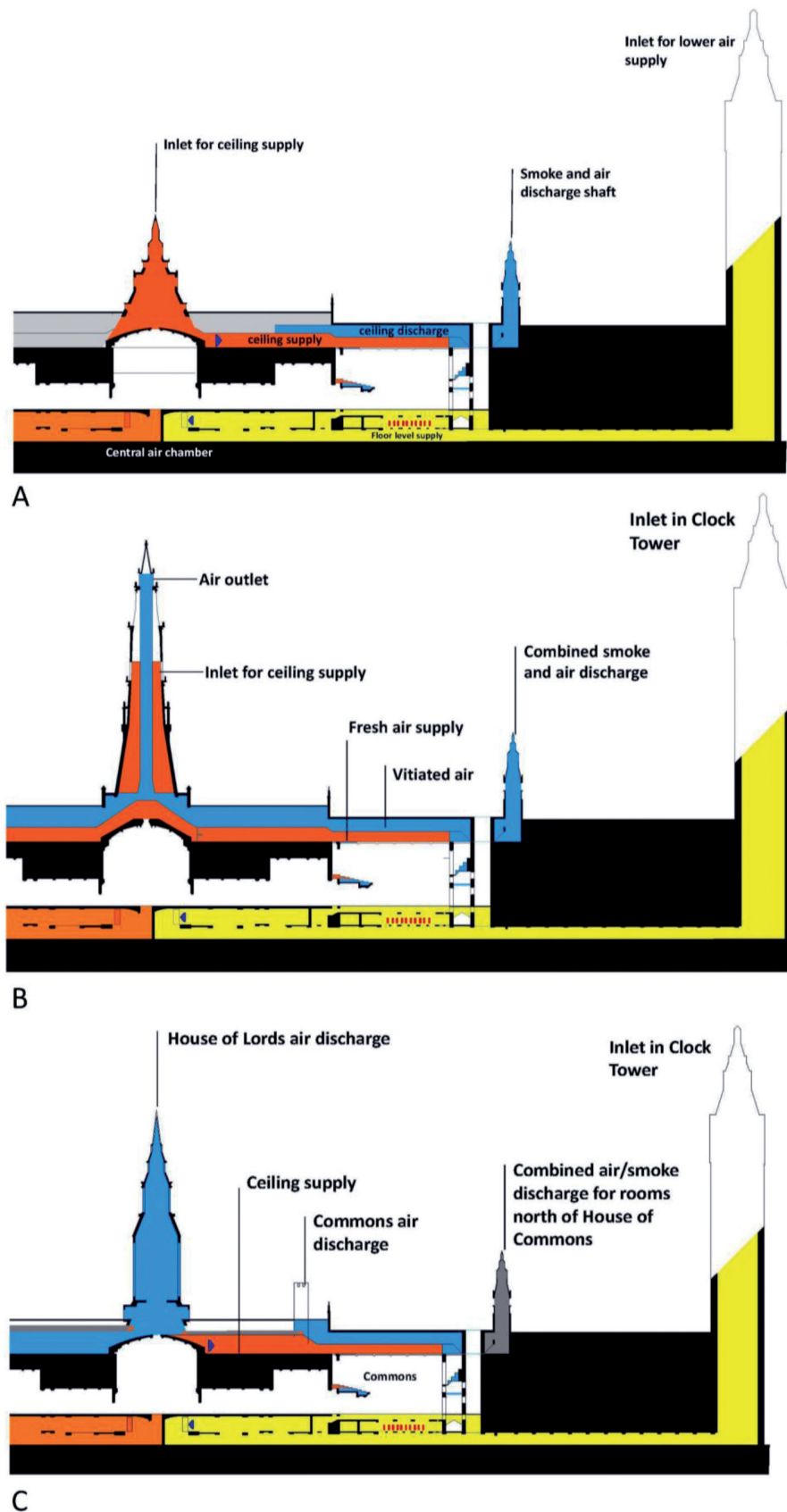
81 "Diary of E. M. Barry" (Parliamentary Archives), Select Committee reports 1850s.

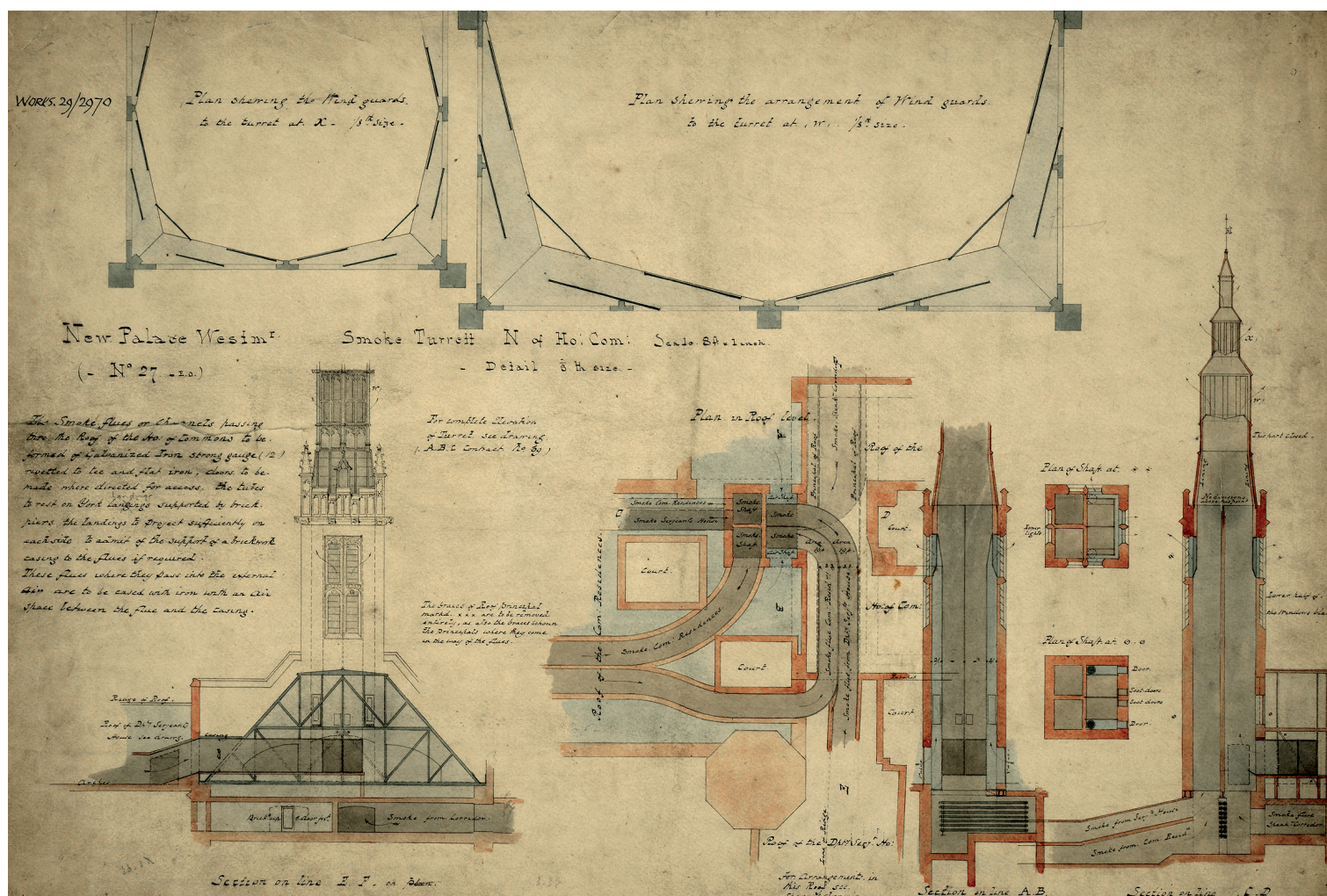
mittee show that Gwilt, Gurney and Barry agreed that Reid had an in-depth knowledge of the scientific principles but was unacquainted with the architectural design process.⁷⁴ His ability to effectively collaborating with the architects and engineers was seriously compromised by his insufficient drawings skills, which he required to communicate his ideas, and his limited understanding of technical design, which was required to translate his concepts into concrete technical solutions. According to Barry he tended to submit several alternative proposals without specifying a specific solution, which complicated the decision making process.⁷⁵ The engineer Goldsworthy Gurney, who was invited as an independent advisor after petitioning in the Commons for a review of the proposed system, also questioned the technical feasibility of Reid's scheme.⁷⁶ During an interview with the Lords Committee in May 1846 he claimed that the building was too large to be ventilated by one tall chimney. He questioned that the hot smoke and waste heat would produce a sufficiently strongly draughts, and argued that even if the height of the Tower was increased to 200 feet and strong ventilating fires were introduced, it would still remain too weak to overcome the friction produced by complex network of air channels.⁷⁷ His advice was to divide the Palace into different sections, each with its own discharge shaft.⁷⁸ Acknowledging the seriousness of Gurney's criticism the Department appointed three referees, the engineer George Stephenson, the architect Phillip Hardwick and the chemist Thomas Graham, to conduct another technical review of Reid's system.⁷⁹ The referees seconded Gurney. It concluded that the centralised scheme, if applied to the entire building, was too complex and that it should be simplified by breaking it up into a four local ventilation systems, operating independently from each other: (1) Houses of Lords, (2) Houses of Commons, (3) committee rooms and (4) residences. These recommendations became the blueprint for the development of a radically new ventilation strategy after 1846.

The decentralisation of the ventilation

Barry had also offered the Lords Committee to take over the responsibility of ventilating the House of Lords and guaranteed that it could be completed in 1847 if it was done without Reid's interference. The Committee accepted the proposal in August 1846, arguing that further delays in the completion of the House could only be prevented if Barry's office was given full control over all aspects of the design. This shows that the fear of further delays, resulting from difficulties with managing the complex collaborative design process, was the primary impetus for abandoning Reid's original scheme, and subdividing the ventilation into a series of local systems. The project correspondence illuminates that the two teams were struggling with establishing the collaborative working methods required to implement in integrated design approach. They encountered what Chris Jones described as complex or unsplitable design problems, which involve resolving highly interrelated design issues through tight cross-disciplinary collaborations.⁸⁰ The reorganisation of the ventilation into local systems facilitated a significant simplification of the design process. Reid's responsibilities as Barry's ventilating consultant was now limited to the ventilation of House of Commons district. The rest of the building was under Barry's authority, who collaborated with his in-house engineer Alfred Meeson, his son Edward Middleton Barry, and the scientist Michael Faraday in developing a fundamentally new scheme, underpinned by their own technical experiments.⁸¹

Despite these efforts the required level of collaboration remained high and the earlier problems did not cease. In the new scheme, numerous highly complex issues need to be resolved, including the new design and function of the Central Tower, the position and height of the discharge shafts and fresh air inlets. Moreover, questions of architectural form and ventilation requirements had to be reconciled. The Central Tower was retained





13.11 Cross-section and elevation of the smoke and vitiated air turret at the North end of the House of Commons, dated November 1853.

[Kew, National Archives: Work 29/2970: "Houses of Parliament: Ventilation. Details of smoke turret north of House of Commons", November 1853]

82 Tracing of Central Tower, dated 15 June 1847 (National Archives, Work 29/3050).

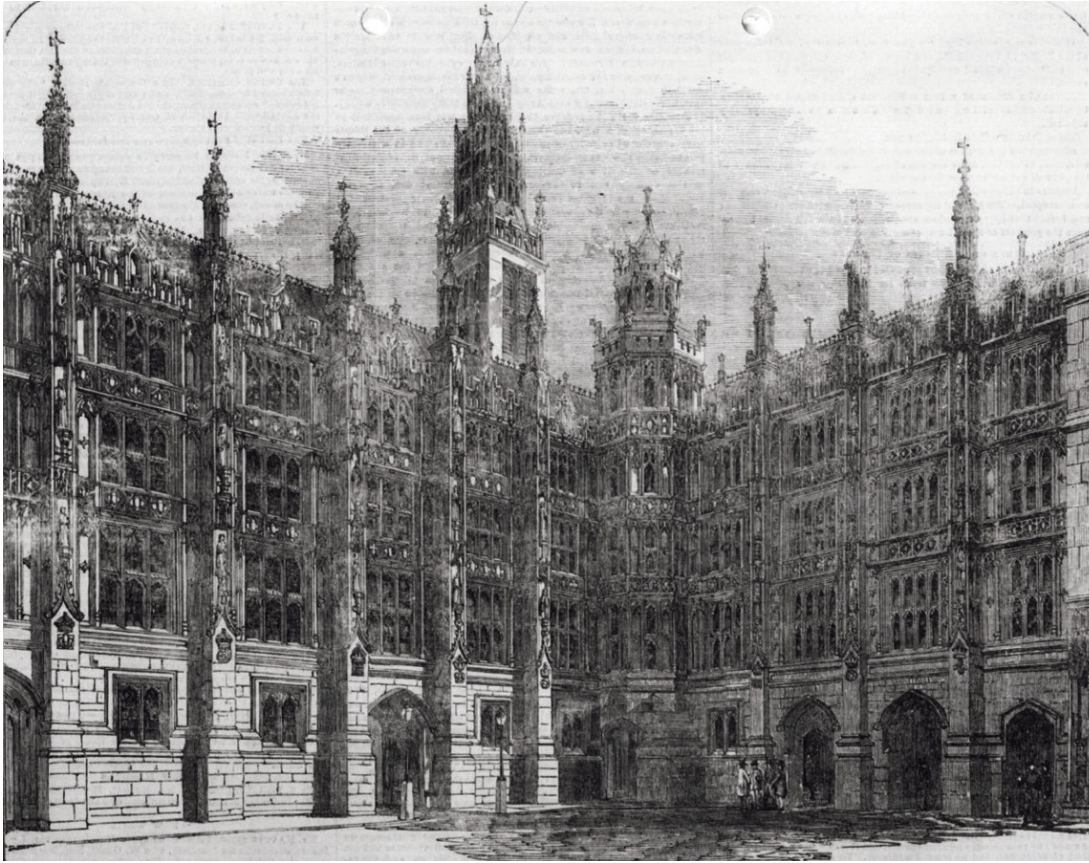
83 Transcript of interview with Barry, 23 June 1846, in Third Report from the Select Committee of the House of Lords appointed to inquire into the progress of the building of the Houses of Parliament (HL 1846, 719), Q38-41.

84 Ibid., Q41-42.

as a local shaft, but its height had been significantly reduced by Barry⁸² and its actual purpose within the new system became subject of extensive discussions. In June 1846 Barry stated that the tall Central Tower was no longer required in his new scheme for the House of Lords and thereby functionally obsolete, unless Reid was intending to realise his original strategy in his part of the Palace.⁸³ Barry advocated its retention as an architectural ornament even if it was no longer required for ventilation purposes.⁸⁴ By April 1847 Reid had also abandoned the original strategy for the House of Commons. In his new scheme, which he outlined in a set of architectural drawings and technical details, the Central Tower was no longer used as a discharge but was to permit the admission of fresh air through the ceiling of the

House.⁸⁵ Air was propelled from the Central Tower to the ceiling by steam driven fans,⁸⁶ while the inlets in the floor of the House continued to be supplied with fresh air from the Clock Tower [13.13].⁸⁷ The hot air was extracted through holes in the sloping sides of the ceiling, which was connected to a local discharge tower introduced at the north end of the House [13.10A].⁸⁸

Based on Reid's set of drawings, Barry produced first details for the northern discharge,⁸⁹ but on 14 May 1847 Reid informed Barry that the shaft was not tall enough to be an effective discharge without the assistance of a powerful ratification system.⁹⁰ The working drawings produced under Meeson's direction five years later show that the height of the square base shaft and the Gothic turret had been significantly increased and



13.12 Smoke and vitiated air turret at the north end of the House of Commons, as executed in 1854. View from Star Chamber Court, published in *Illustrated London News*, 16 December 1854.

[Cambridge, Cambridge University Library]

equipped with intricate systems of wind guards and ratification [13.1-13.12].⁹¹ The result was a tall and slender tower which formed a prominent vertical feature rising above the horizontal main body of the Palace. The exterior resembled a square church tower crowned by a Gothic spire but to meet the ventilation requirements it had become more slender in proportion than its ecclesiastical precedent. The windows and the stepped turret provided openings at different altitudes. Smoke fumes were taken to the highest point and escaped through the open tracery of the turret, while the air was exhausted via the rectangular windows in the masonry tower [13.11].⁹²

The new purpose of the Central Tower and the question of a second air supply

Back in May 1847 Barry proposed introducing a second discharge to complement the northern shaft and requested Reid to provide details about the height and design requirements,⁹³ but instead he submitted a proposal for accommodating the second air discharge within the Central Tower. Its height was significantly increased to allow vitiated air to be discharged at a high altitude. The lower part the shaft continued to be used for the House of Commons' second air supply ([13.10B]).⁹⁴

Reid was banned from using the Central Tower as an air supply, and Barry insisted

85 Set of Drawings, dated 5 April 1847 (National Archives, Work 29/2905-2959).

86 Drawings, dated 5 April 1847 and signed Reid (National Archives, Work 29/3009, 3046).

87 List of drawings with brief explanatory remarks, 5 April 1847, submitted by Reid to Milne (National Archives, Work 11/12, no. 271).

88 Drawing no. 29, dated 5 April 1847 and signed Reid (National Archives, Work 29/3046).

89 Ventilating tower at north end of the House of Commons, dated 1 May 1847 and signed Barry (National Archives, Work 11/12, no. 298).

90 Letter from Reid to Commissioners of Woods and Forests, 14 May 1847, including answers to Barry's questionnaire of 10 May 1847 (National Archives, Work 11/12, no. 297).

91 Drawing, dated 27 November 1853 and signed Alfred Meeson (National Archives, Work 29/2970).

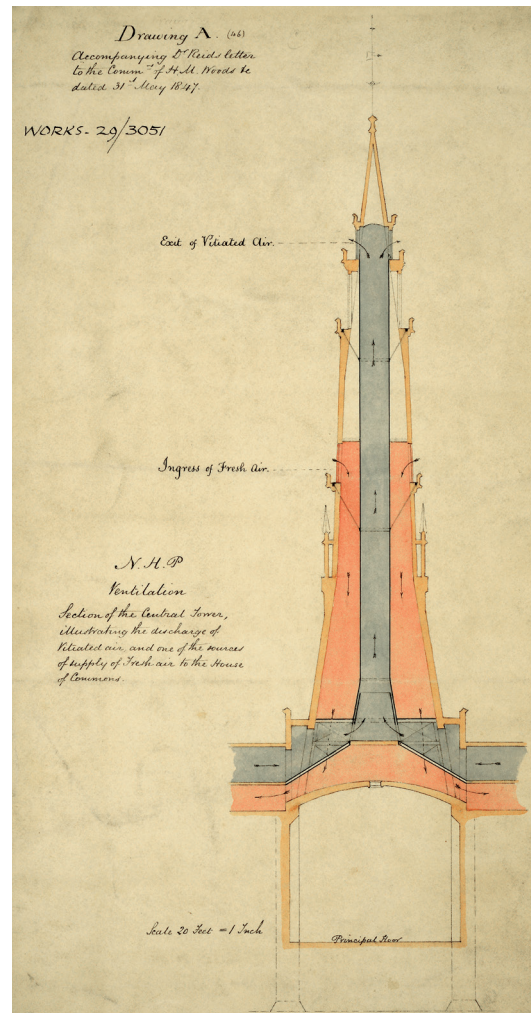
92 The problem of managing smoke emissions was a major problem. In the report of the 1852 Select Committee it was reported that minor discharge shafts occasionally polluted the air inside the courtyards, preventing the use of the low level inlets and it was recommended raising the smoke outlets to a high altitude: Second report from the Select Committee on Ventilation and Lighting of the House (HC 1852, 402), Q3541-3542.

93 Queries relating to Dr Reid's drawing for the ventilation, 45 in number, dated 5 April 1847 (National Archives, Work 11/12, no. 276-286).

94 Two drawings dated 31 May 1847 (National Archives, Work 29/3051 & 3047).

13.13 Cross section, showing tall Central Tower incorporating air inlets and outlets, Reid, 31 May 1847. [Kew, National Archives, Work 29/3051: “Houses of Parliament: Ventilation. House of Commons: Dr Reid’s scheme. Section of central tower illustrating discharge of vitiated air and one of the sources of supply of fresh air”]

- 95 Letter from Barry to Milne, 4 June 1847, reproduced in “Copies of correspondence relative to the new Houses of Parliament” (HC 1847-48, 205), 1f.
- 96 Ibid.
- 97 Report from the Select Committee on House of Commons (ventilation) (HC 1890-91, 371), Q949.
- 98 Drawing no. 48, discussed in Reid’s letter of 15 June 1847 (National Archives, Works 29/3050).
- 99 Letter from Barry to Milne, 10 June 1847, reproduced in “Copies of correspondence relative to the new Houses of Parliament” (HC 1847-48, 205), 2.
- 100 “Copies of correspondence relative to the new Houses of Parliament” (HC 1847-48, 205), 2ff.
- 101 Drawing no. 49 with Reid’s commentary, dated 15 June 1847 (National Archives, Work 29/3048).
- 102 Letter from Reid to Barry, 9 May 1845 (National Archives, Work 11/12, no. 139-140); letter from Barry to Reid, 10 May 1845 (Work 11/12, no. 140-41).
- 103 Letter from Barry to Commissioners of Woods and Forests, 6 July 1847 (National Archives, Work 11/12, no. 308).
- 104 Letter from Reid to Commissioners of Woods and Forests, 19 July 1847 (National Archives, Work 11/12, no. 302-305).
- 105 Drawing 53, dated 19 July 1847 and signed Reid (National Archives, Work 29/3053).
- 106 Drawings from Reid’s office, dated 19 July 1847 (National Archives, Work 29/3054 & 3055).

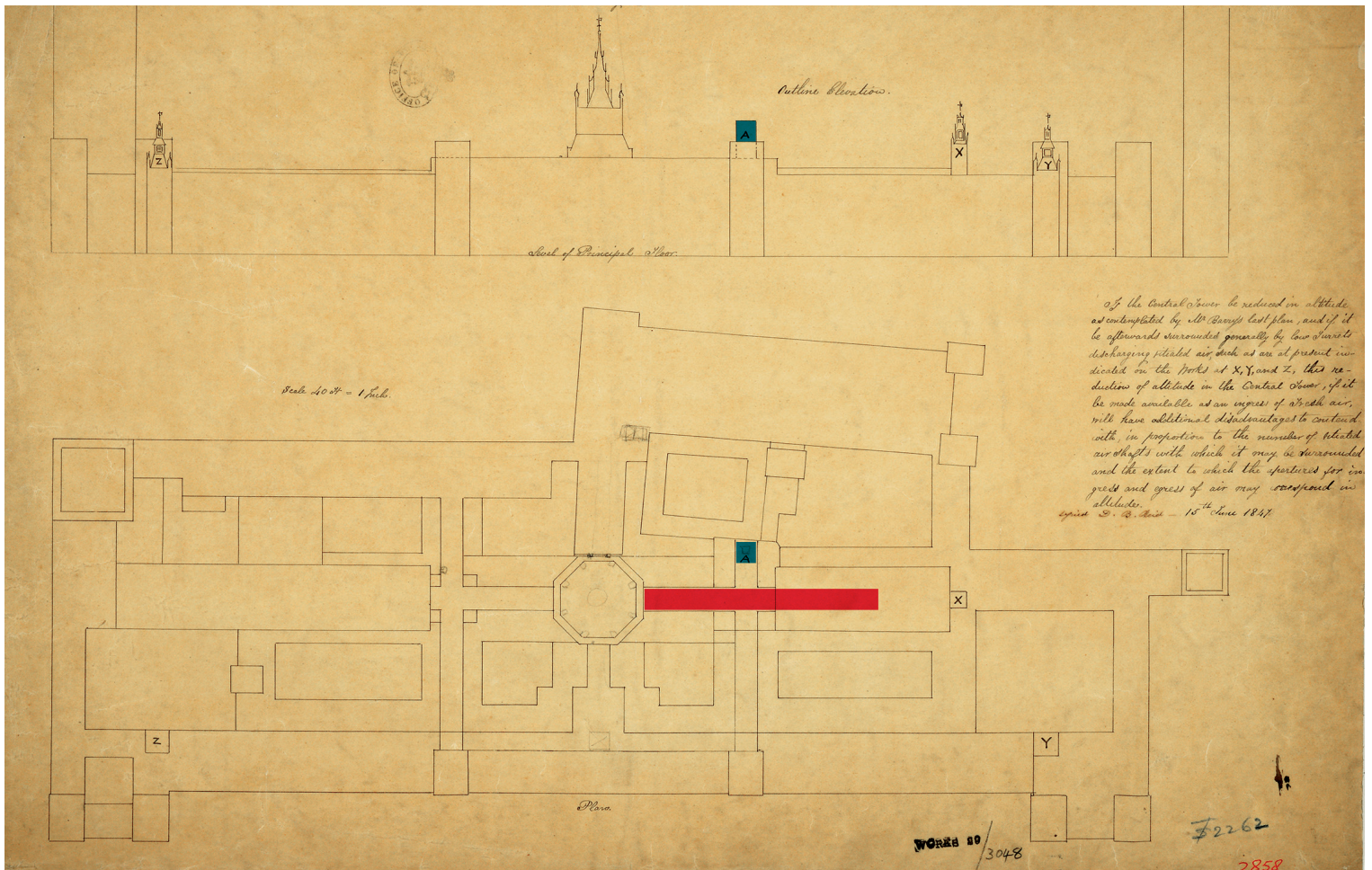


that his original plans for a second local shaft were followed.⁹⁵ Barry opposed the tower for its extreme height and claimed that he never considered carrying out a tower of this height as it appeared to him “very extravagant notions on his part, as to altitude, which at one time he wished to exceed that of St. Paul’s.”⁹⁶ According to another Select Committee report, published in 1890, Barry felt that the tall tower made the Palace “look like an enormous steamer”, and previously had adopted it as he was forced by the Department to adhere to Reid’s plans.⁹⁷ After the fall of Reid’s scheme in 1846, however, Barry introduced a new tower that was less than half the height Reid had specified. He argued that a tall tower was not required for architectural effect or ventilation purposes.⁹⁸

Reid disagreed with Barry.⁹⁹ In drawings returned to Barry on 15 June 1847 he commented that the Central Tower had to be taller than the surrounding discharge turrets first to avoid the fresh air inlets to be exposed to exhausted air and second to gain access to “atmosphere free from fog and suspended dew, as well as from the smoke from numerous manufactory chimneys”.¹⁰⁰ He urged Barry to specify the greatest height he is willing to accept. In his plans Reid also indicated the position of the local discharge towers relative to the Central Tower [13.14]. The discharges for the House of Commons were at the north end of the House (x) and west of the Commons Lobby (A).¹⁰¹ The north turret was subsequently converted into a combined smoke and vitiated air shaft for the rooms north of the House of Commons. Barry had introduced two turrets on the river front (y, z), which were connected with the chimney and air flues of the libraries and Committee Rooms, which in Reid’s previous plans were to be joined to the Central Tower.¹⁰²

The number of discharge towers was gradually increased and their position relative to air inlets was subject of lengthy inquiries. In early July 1847 Barry wrote that six local discharges, “110 feet above Trinity Standard High water” were introduced at the Speaker’s court, Judges’ Court, Star Chamber Court, north end of House of Commons, the north angle of Public Lobby (House of Lords) and Royal Court. Two smoke shafts were planned on the west side of the Central Tower, but Barry stressed the ultimate number of turrets could only be determined “upon the success or failure of the shafts already enumerated”.¹⁰³ Although he continued to argue that the Central Tower would be more effective as a second discharge,¹⁰⁴ Reid on 19 July submitted five drawings for the air discharge shaft west of the House of Commons Lobby.¹⁰⁵

These drawings show that the shaft, unlike the north tower, was designed exclusively for the discharge of vitiated air and did not have a turret [13.15-13.16].¹⁰⁶ The top of



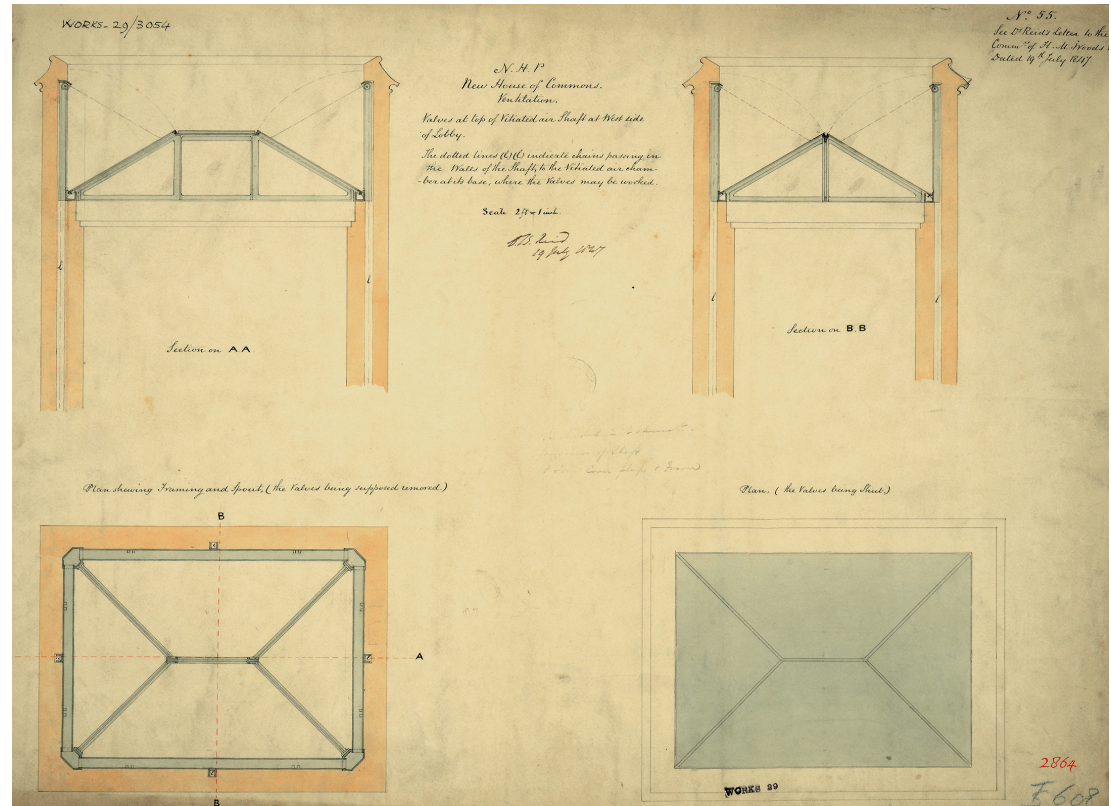
the shaft was open, but had a damper in the shape of a hipped roof, operated from the base of the tower by pulleys. At the bottom of the shaft was a fire, “to be used more especially in sultry weather or when the movement of machinery is not in operation”.¹⁰⁷ The historic drawings reveals that this shaft was one of three discharge tower typologies developed for the Palace: (1) vitiated air shafts, (2) smoke chimneys and (3) combined air and smoke turrets [13.19]. Their difference in function was also articulated by giving each type a distinctive architectural form. The pure air shafts, of which the tower west of the lobby is an example, were rectangular masonry towers with crenelated parapets. The same typology was adopted for the local shaft serving the House of Lords [13.17]. The combined air and smoke towers were tall shafts crowned by stepped turrets,

which allowed accommodating openings for the discharge of air and smoke fume at different altitudes. The form of church spires or medieval front covers thereby provided a suitable Gothic precedent for the design of modern ventilating towers. An example of this typology is the central turret above the Central Waiting Hall [13.18]. The original drawings show that the turret, although it had the appearance of an ornate Gothic spire, was a technical feature of the ventilation system. It was designed to protect the vitiated air and smoke outlets from the winds. This was achieved through a system of iron louvres, which was responsive to wind pressure. The louvre blades were kept open by counterweights, but closed if exposed to higher wind pressures. The *Illustrated London News* wrote:

13.14 Block plan and elevation, showing positions and altitude of the new Central Tower and local discharge shafts proposed by Barry, 15 June 1847. [Kew, National Archives: Work29/3048: “Houses of Parliament: Ventilation. Dr Reid’s scheme. Diagrammatic plan and elevation of river front”, 15 June 1847]

107 Notes on drawing from Reid’s office, dated 19 July 1847 (National Archives, Work 29/3055).

13.15 Cross-section and plans of the vitiated air shaft west of the Commons Lobby, proposed in 1847. [Kew, National Archives: Work29/3054: "Houses of Parliament: Ventilation. Dr Reid's scheme: plans and sections showing valves at top of vitiated air shaft at west side of lobby", 19 July 1847]



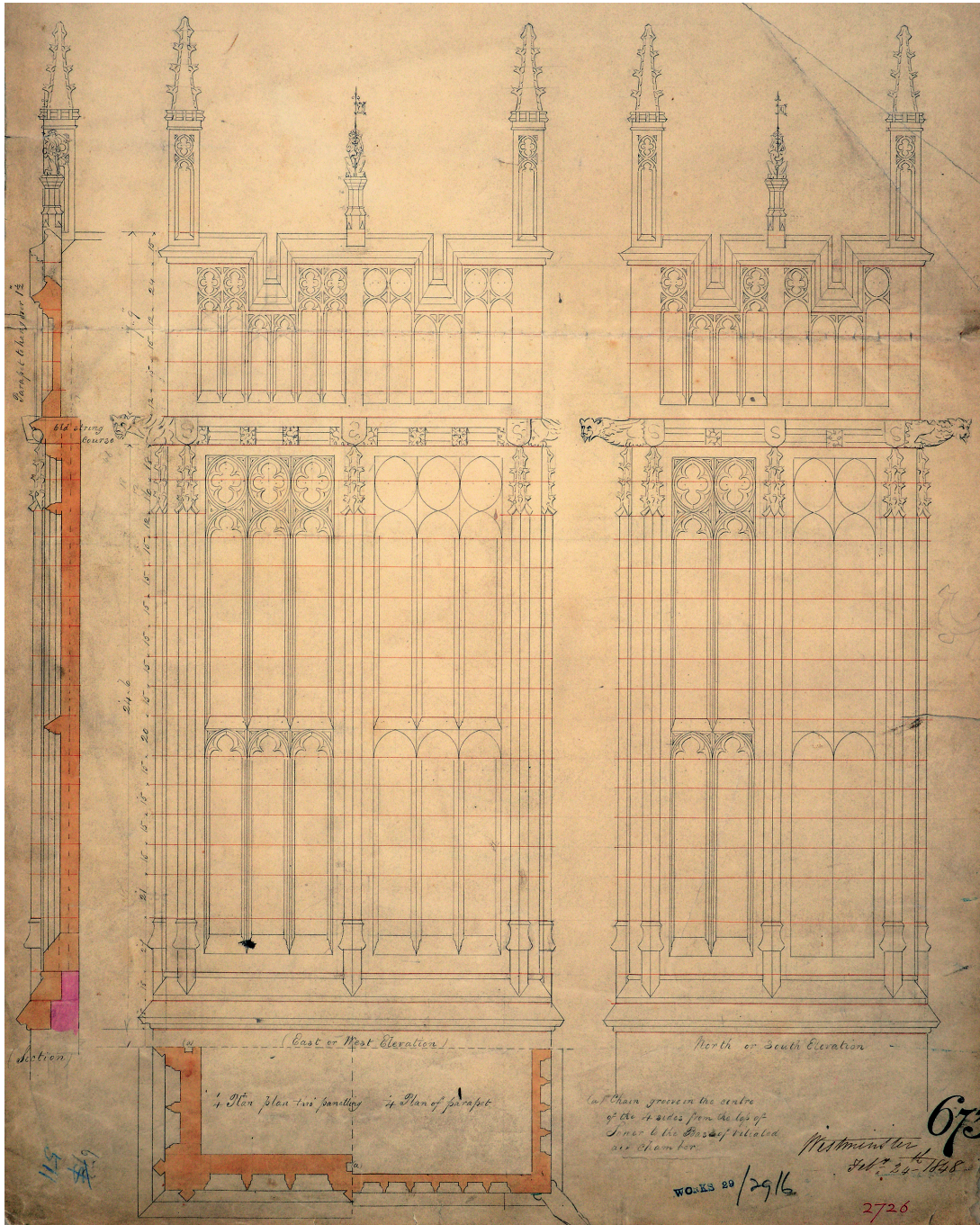
- 108 "The Ventilating Shaft".
- 109 Letter from Commissioners of Woods and Forests to Reid, 9 Dec. 1847 (National Archives, Work 11/13, no. 356).
- 110 Letter from Reid to Commissioners of Woods and Forests, 29 Dec. 1847 (National Archives, Work 11/13, no. 360); letter from Reid to Commissioners of Woods and Forests, 7 Jan. 1848 (Work 11/13, no. 363).
- 111 Letter from Barry to Commissioners of Woods and Forests, 17 Jan. 1848 (National Archives, Work 11/13, no. 365).
- 112 Letter from Barry to Milne, 3 Feb. 1848 (National Archives, Work 11/13, no. 370).
- 113 Letter from Commissioners of Woods and Forests to Reid, 9 Feb. 1848 (National Archives, Work 11/13, no. 374).
- 114 Letter from Barry to Commissioners of Woods and Forests, 16 Feb. 1848 (National Archives, Work 11/13, no. 376); letter from Reid to Commissioners of Woods and Forests, 22 Feb. 1848 (Work 11/13, no. 378).
- 115 Letter from Milne to Reid, 26 Feb. 1848 (National Archives, Work 11/13, no. 383).

The louvres are ingeniously contrived to open or shut, as the wind may play against – that is, when the wind is beating against one side, or at the angle-for though quadrangular at the base, it assumes the form of an octagon, just at the commencement of the louvres, thus be fanning any one side, or angle, the opposite apertures remain open; thus the foul air readily finds egress.¹⁰⁸

Reid's plans of 5 April 1847 were only approved by the Treasury on 9 December 1847¹⁰⁹ and two weeks later Reid commented that the works executed under Barry had not followed his new scheme and submitted details about executed work deviating from his plans.¹¹⁰ Barry, however, highlighted that these works were executed before the Treasury's formal approval,¹¹¹ and that he never had received a full set of drawings. In February 1848, after receiving the missing drawings,¹¹² Barry finally agreed that the current design for the Central Tower was unsuitable as an upper air supply, but still refused to in-

crease its height to protect the inlets from the emissions from surrounding turrets. Instead he proposed moving the second inlet inside the courtyards whilst the Central Tower was to be appropriated as discharge for the House of Lords. Reid got very angry and complained to the Department that Barry has been interfering with his currents plans by depriving him of the Central Tower as a potential air supply.¹¹³ Reid favoured using it as a second inlet, even if parts functioned as an air discharge for the Lords. Barry accepted Reid's proposal for using the Tower as a combined supply and discharge shaft and in February asked him to furnish detailed drawings of the arrangements inside the Central Tower, but Reid refused, claiming that he had already sufficiently explained his plans.¹¹⁴

On 26 February 1848 Barry complained that Reid's reply did not contain details of "arrangements required by him to be made in the Central Tower".¹¹⁵ He wrote that he had already sufficiently explained his intention, which was to use the Central Tower as



13.16 Elevation and plan of vitiated air shaft at the west end of the Commons Lobby, dated 24 February 1848. [Kew, National Archives: Work 29/2916: "Houses of Parliament: Ventilation. House of Commons: plan, elevations and sections of vitiated air shaft, west end of lobby", 1848]

a discharge for vitiated air only, and required details to ascertain how far Reid's plans can be reconciled with his own plans.¹¹⁶ Becoming increasingly impatient with Reid and Barry's lack of collaboration, the Department urged them to cooperate,¹¹⁷ but both remained stubborn.¹¹⁸ The design process again became obstructed by severe communication problems, in particular as Barry and

Reid were highly dependent on each other in the decision making process. The correspondence strongly suggests that these quarrels arose from serious misunderstandings about each other's intentions. Barry explained that he had only referred to the purposes for which he required the Central Tower in relation to the House of Lords, and that he intended to accommodate the vitiated and

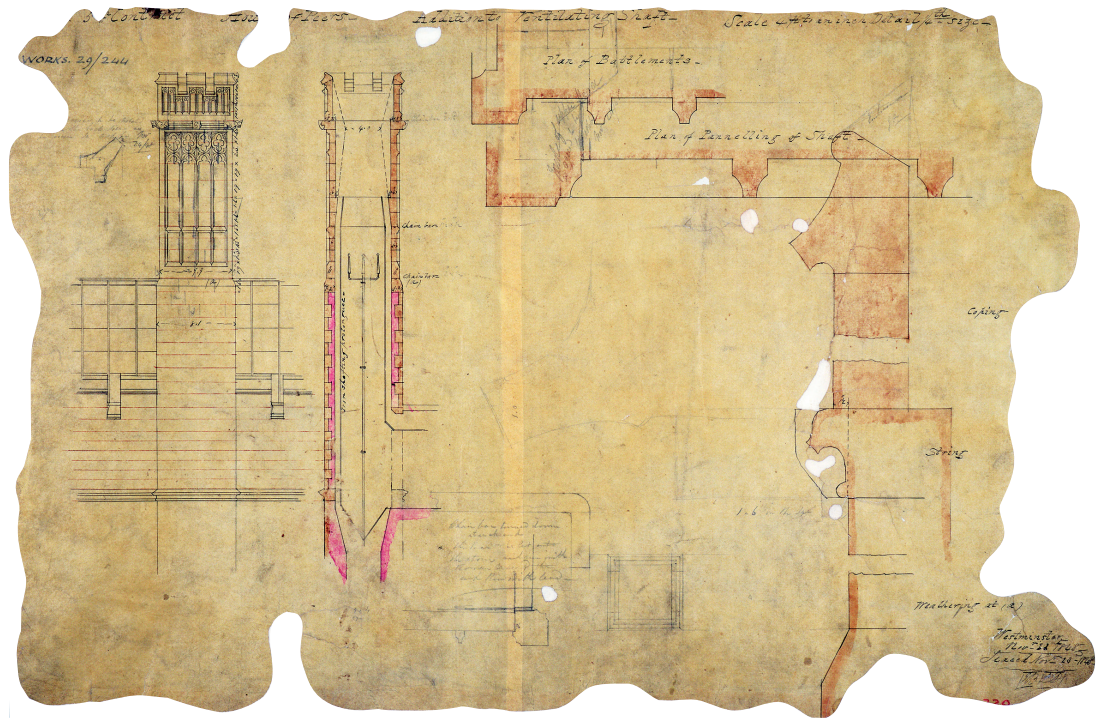
116 Ibid.

117 Letter from Reid to Milne, 2 March 1848 (National Archives, Work 11/13, no. 384); letter from Commissioners of Woods and Forests to Reid, 24 Feb. 1848 (Work 11/13, no. 379); letter from Reid to Commissioners of Woods and Forests, 25 Feb. 1848 (Work 11/13, no. 381).

118 Letter from Milne to Reid, 26 Feb. 1848 (Parliamentary Archives, Work 11/13, no. 383); letter from Barry to Milne, 7 March 1848 (Work 11/13, no. 386); letter from Reid to Milne, 2 March 1848 (Work 11/13, no. 384).

13.17 Section and elevations air shafts of the House of Lords, dated 1851. [Kew, National Archives: Work 29/244: "Houses of Parliament: House of Peers. Detail of stone ventilation shaft", 22 November 1848]

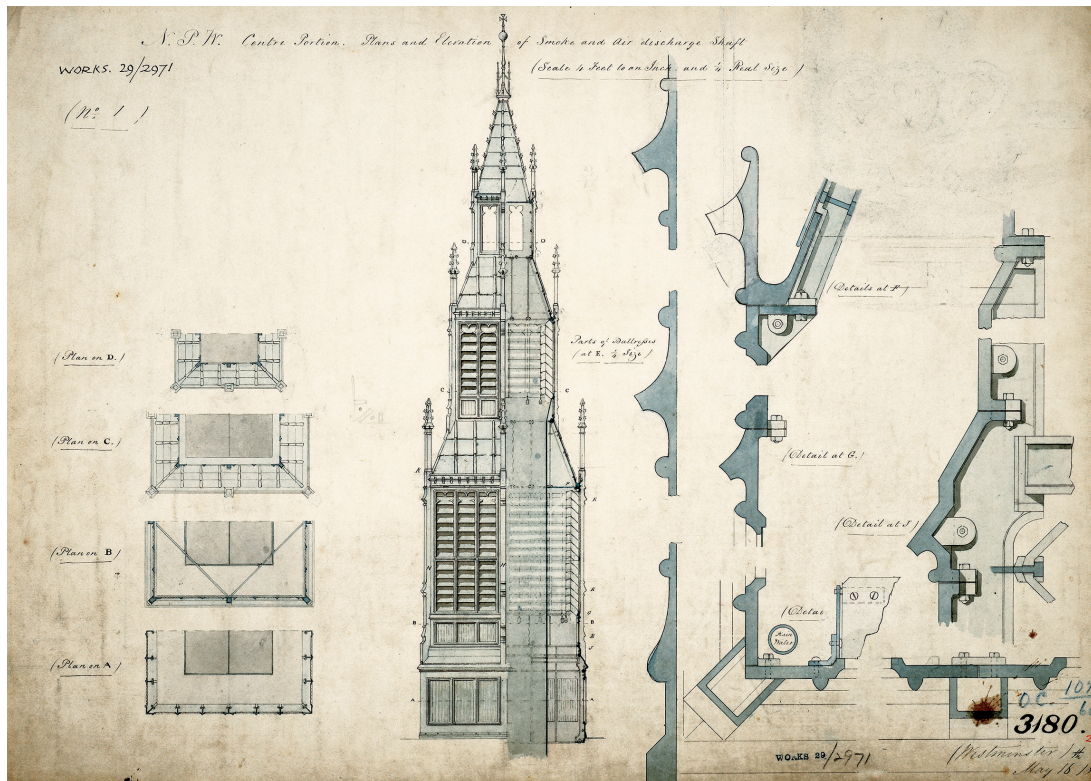
- 119 Letter from Barry to Milne, 7 March 1848 (Parliamentary Archives, Work 11/13, no. 386)
- 120 Barry's replies accompanying his letter to Commissioners of Woods and Forests, 16 March 1848 (National Archives, Work 11/13, no. 395); queries to Mr. Barry as the appropriation of the upper portion of the Central Tower, accompanying Dr Reid's letter to the Commissioners of Woods and Forests, 13 March 1848 (Work 11/13, no. 395).
- 121 Barry's replies accompanying his letter to Commissioners of Woods and Forests, 16 March 1848 (National Archives, Work 11/13, no. 395).
- 122 Letter from Reid to the Commissioners of Woods and Forests, 13 March 1848 (National Archives, Work 11/13, no. 394).
- 123 Letter from Barry to Commissioners of Woods and Forests, 16 March 1848 (National Archives, Work 11/13, no. 400).
- 124 Letter from Barry to Department of Woods and Forests, 18 March 1848 (National Archives, Work 11/13, no. 402).
- 125 Letter from Reid to the Commissioners of Woods and Forests to Barry, 20 March 1848 (National Archives, Work 11/13, no. 404); "Queries to Mr. Barry, accompanying Dr. Reid's letter addressed to the Commissioners of H. M. Woods", dated 21 March 1848 (Work 11/13, no. 406).
- 126 Letter from Reid to Woods, 24 March 1848, 2 PM (National Archives, Work 11/13, no. 414).
- 127 Diagram accompanying Dr. Reid's letter to the Commissioners of H. M. Woods, dated 5 April 1848 (National Archives, Work 29/3061).



fresh air shafts required by him and Reid respectively.¹¹⁹

Continuing to struggle with understanding how the Central Tower was to be used, Reid in March 1848 submitted a questionnaire to Barry.¹²⁰ In his reply it was explained that if the tower was solely deployed for the supply of fresh air to the House of Commons, it would only be necessary to apply “valves or shutters to all apertures communicating with the open air, so that fresh air could be conveyed to the House of Commons by the channels indicated from any of the apertures, according to the state of the external atmosphere”. Knowing that Barry “desired to use a portion of the tower for the discharge of vitiated air”, he asked him to supply with detailed sections and plans of the arrangements inside the tower.¹²¹ To ensure that the fresh air supply was protected from air pollution¹²² Reid asked for drawing indicating the “precise position and altitude of every intended discharge of vitiated air from the roofs”. In his reply to Reid’s questionnaire Barry confirmed that he still intends to use the whole of the Central Tower as an air discharge, but that the smoke flues from

fireplaces were to be connected to separate smoke shafts on the west side of the Central Hall. In other letters¹²³ Barry wrote to the Department that Reid through his continued refusal to “explain the mode by which he wishes to make use of it as a means of supply for fresh air” has been responsible for delays in resolving these design questions.¹²⁴ On 21 March Reid posted a second questionnaire to Barry asking for specifications of the position of the smoke shafts and the height at which vitiated air will be emitted by the various discharge turrets.¹²⁵ Reid’s requests were refused again.¹²⁶ To gain an overview of the arrangement of ventilating towers,¹²⁷ Reid on 5 April 1848 consolidated the information concerning the position and height of the various discharge towers introduced since 1846 in a drawing and urged Barry to finalise the number and position of towers [13.14].¹²⁸ The red rectangle shows the fresh air channel connecting Central Tower with the House of Commons. The blue tower is the discharge adopted as a substitute for the Central Tower after Barry prohibited its use as a discharge for the House of Commons.¹²⁹ It shows a total of seven vitiated air shafts



13.18 Part elevation and section of vitiated and smoke turret above the Central Waiting Hall. (Kew, National Archives: Work 29/2971: "Houses of Parliament: Ventilation. Plans and elevation of smoke and air discharge shaft in centre portion with details"]

and two smoke flues, including shafts whose exact position Barry had not specified. Barry stressed he was unable to determine the ultimate number of discharges until the performance of the existing shafts had been tested.¹³⁰ The design was not completely resolved, but was allowed to evolve gradually.

Becoming increasingly concerned about the delays caused by this deadlock in the design development, the Department not only put pressure on Reid to specify the information he required from Barry to complete his plans,¹³¹ but also put forward an alternative proposal for a high level inlet. It proposed converting the architectural towers on the northern end of the River Front's centre portion into an inlet turret that was connected to the House of Commons through ducts inside the roof.¹³² Reid found the northern tower unsuitable, as it was located in the path of the prevailing westerly winds carrying foul air from the discharge turrets.¹³³ He submitted annotated block plans showing various alternative arrangements for the upper air supply contemplated since June 1847,¹³⁴ and

kept insisting that the most adequate position for the second inlet was the Victoria Tower or, if increased in height, the Central Tower.¹³⁵

Following pressure from the newly appointed Commissioners of the New Palace, who had taken over the responsibility for supervising the project from the Department, Barry submitted tracings outlining four alternative schemes for the supply of fresh air to the Commons [13.20].¹³⁶ In schemes 1 and 2 the Clock Tower functioned as the only fresh air supply. In Scheme 3 the smoke from the boiler flues was emitted through apertures on the top of the Central Tower. New turrets were proposed above the Upper Waiting Hall and in the South-East corner of Westminster Hall, functioning as principal smoke shafts for the fireplaces. In scheme 4 the Central Tower was adopted as a combined inlet and air discharge. The drawings show that the apertures in the upper two tiers were designed as outlets for vitiated air, while the lower tiers functioned as inlets for the House of Commons' upper air supply. To protect the inlets,

- 128 Ibid.; letter from Reid to Milne, 5 April 1848 (National Archives, Work 11/13, no. 426).
- 129 Letter from Barry to Milne, 4 June 1847, reproduced in "Copies of correspondence relative to the new Houses of Parliament" (HC 1847-48, 205), 1ff.
- 130 Letter from Barry to Office of Woods, 6 July 1847 (National Archives, Work 11/12, no. 308).
- 131 Letter from Department of Woods and Forests, 12 April 1848 (National Archives, Work 11/13, no. 439).
- 132 Letter from the Department of Woods to Reid, 20 April 1848 (National Archives, Work 11/13, no. 440).
- 133 Letter from Reid to Henry Cole, 26 April 1848 (National Archives, Work 11/13, no. 441-2); Drawing no. 58, dated 26 April 1848 (Work 29/3064).
- 134 Ibid.
- 135 Drawings 47 (National Archives, Work 29/3047) and Drawings 46 (Work 29/3051), accompanying "Dr. Reid Letter to the Commissioners of H. M. Woods", dated 31 May 1847.
- 136 Four tracings enclosed in a letter from Barry to Commissioners of New Palace, 5 May 1848 (National Archives, Work 11/13, no. 441-2).

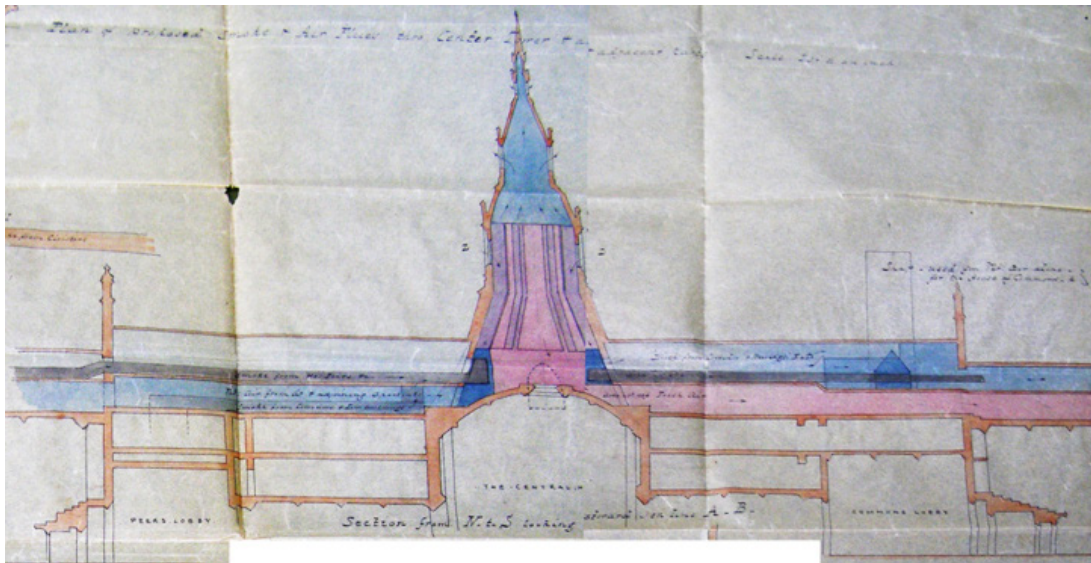
13.19 View from Victoria Tower, showing the Central Tower, rectangular vitiated air shafts of the House of Lords and House of Commons and two octagonal smoke shafts, published in *Illustrated London News*, 28 January 1860. [Cambridge, Cambridge University Library]

- 137 Letter from Reid to the Office of Woods, 15 May 1848 (National Archives, Work 11/13, no. 446).
- 138 Letter from Reid to Commissioners for the completion of the New Palace of Westminster, 29 June 1848 (National Archives, Work 11/13, no. 462); Drawing no. 64, dated 29 June 1848 (Work 29/3068).
- 139 Drawing no. 62, dated 22 May 1848 (National Archives, Work 29/3065).
- 140 Letter from Reid to the commissioners of H.M. New Palace of Westminster, 22 May 1848 (National Archives, Work 11/13, no. 453).
- 141 Letter from Reid to H. M. commissioners for the completion of the New Palace of Westminster, 29 June 1848 (National Archives, Work 11/13, no. 462); Drawing no. 64 (Work 29/3068).
- 142 Letter from Treasury to H. M. commissioners for the completion of the New Palace of Westminster, 28 March 1849 (National Archives, Work 11/13, no. 558).
- 143 Drawing no. 6, dated 22 June 1848 (National Archives, Work 29/2910).
- 144 A detailed study of Reid's ventilation system in the Permanent House of Commons is provided in: Schoenefeldt, "Reid's Short-lived ventilation system for the Permanent House of Commons".
- 145 Pencil sketches and drawings of Central Tower are kept in the RIBA Drawing Collection and Parliamentary Archives, e.g. undated study of central lantern and octagon (Parliamentary

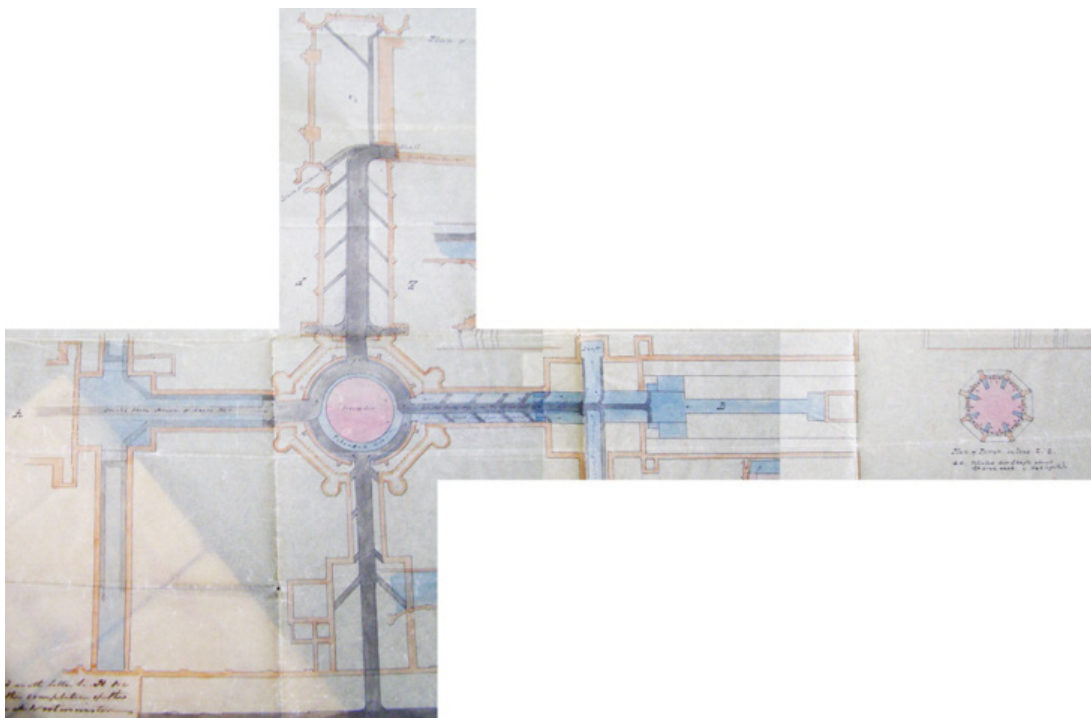


Barry proposed moving all of the smoke discharges located within a 120 feet radius of the Central Tower to a shaft in the South-East corner of Westminster Hall. On 15 May 1848 Reid warned that the fresh air apertures, if positioned at the bottom of the Central Tower, were still exposed to emissions from the adjacent smoke shafts.¹³⁷ He now recommended moving the air supply away from the Central Tower, which was to be retained as a vitiated air shaft, into two new inlets, one on the River Front and a second inside the turret in the South-West corner of Westminster Hall.¹³⁸ The plans illustrate that the air from the river and Westminster Hall converged in the air chamber above the central hall before it was directed towards the ceiling in the House of Commons. Two alternative solutions for the inlet on the River Front were contemplated. The first was based on Department's earlier proposal, but the inlet was moved from the northern to the southern tower of the River Front, where it was less exposed to emissions from the turrets.¹³⁹ In the alternative proposal the inlets were introduced in the roof plane facing the

Thames [13.21].¹⁴⁰ Unlike the architecturally prominent discharge towers, the inlets on the River Front were made conspicuous by integrating the openings, which were covered by horizontal louvre blades, into the existing roof plane and appropriating the dormers as apertures for the admission of air.¹⁴¹ On 22 June 1848 Reid and Barry finally agreed on the arrangements of inlets, which was approved by the Treasury in March 1849 and implemented by 1854.¹⁴² The plans [13.22-13.23] show that the River Front inlet was retained but the second air supply was moved from the shaft on the South-East corner of Westminster Hall, into the North-West turret of St Stephen's Porch.¹⁴³ The Central Tower was adopted as the principal air discharge shaft for the House of Lords. For this purpose Barry introduced a significantly taller spire, replacing the very short tower he had been proposing since spring 1847 [13.10A-13.10B].¹⁴⁴ The later working drawings and sketches produced during the detail designs stage, show that these ventilation drawings were the starting point for the development of the prominent Gothic



13.20 One of four tracings produced by Barry on 5 May 1848 outlining alternative schemas for the supply of fresh air to the Commons, plan and cross-section. (Kew, National Archives: Work 11/13 no 441-2: Tracing in box of letters]



Archives, Arc/RIBA/222); four pencil sketches of Central Tower (Parliamentary Archives, Arc/RIBA/218-21); preliminary studies for Central Tower (RIBA Drawing Collection, SA36/6-9). 146 Drawing of final design was published in: Central Tower, *RIBA Transactions*, 7 (1856-7), plate facing p. 158 and *Building and engineering News*, 31 Dec. 1858.

147 Letter from Barry to Cole, 5 March 1851 (National Archives, Work 11/13, no. 632); letter from H. M. commissioners for the completion of the New Palace of Westminster to Barry, 29 March 1851 (Work 11/14, no. 641). The design of low level supply was extensively discussed in the project correspondence of July 1848, e.g. letter from Reid to H. M. commissioners for the completion of the New Palace of Westminster, 6 July 1848 (Work 11/13, no. 464); letter from H. M. commissioners for the completion of the New Palace of Westminster to Reid, 6 July 1848 (Work 11/13, no. 465); letter from Barry to H. M. commissioners for the completion of the New Palace of Westminster, 6 July 1848 (Work 11/13, no. 467); letter from H. M. commissioners for the completion of the New Palace of Westminster to Barry, 29 March 1851 (Work 11/14, no. 641).

148 Letter from Barry to the Commissioners for the completion of the New Palace of Westminster, 20 Feb. 1849 (National Archives, Work 11/13, no. 546).

design of the Central Tower realized in the mid-1950s.¹⁴⁵ The distinctive cross-section of the Tower, adopted in response to Barry's scheme for extracting the vitiated air of the House of Lords, was outlined in the ventilation drawings and was subsequently transformed into an architectural spire.¹⁴⁶

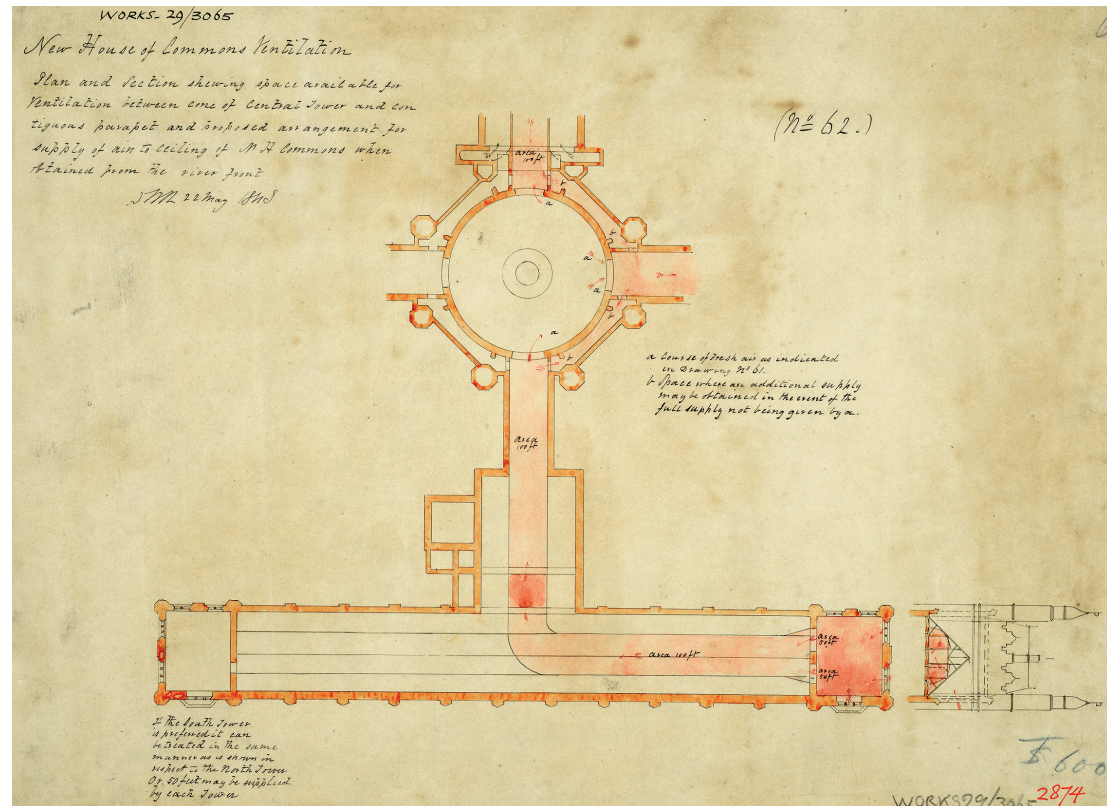
Over the next three years the high level inlets were complemented by inlets inside the courts next to the House of Commons

and House of Lords and around the central hall, designed as back-up supplies when the air around the high level inlets was too polluted.¹⁴⁷ A few alterations and additions to the existing arrangements were made over the same period. In 1849 the smoke shaft in the South-East corner of Westminster Hall was moved inside two turrets next to the Central Tower¹⁴⁸ and in 1850 a new discharge turret for smoke and air from the

13.21 Reid's plan for upper air supplies from Westminster Hall and the River Front, 22 May 1848.

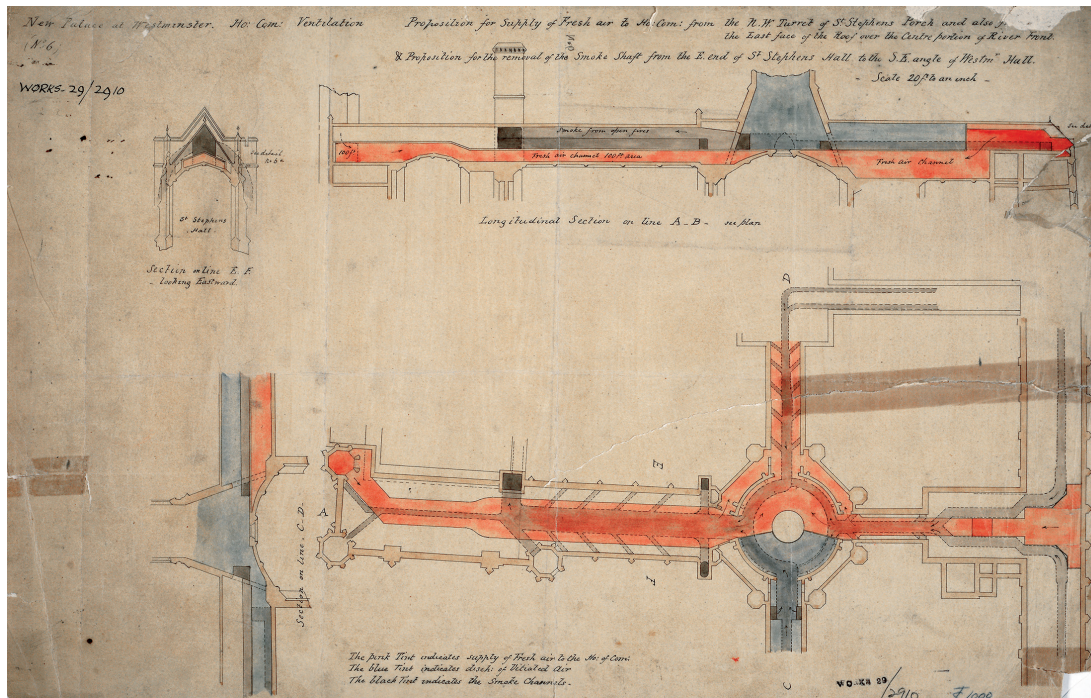
[Kew, National Archives: Work 29/3065: "Houses of Parliament: Ventilation. House of Commons: Dr Reid's scheme. Plan and section showing space available for ventilation between cone of central tower and contiguous parapet and proposed arrangements for supply of air to ceiling when obtained from the river front", 22 May 1848]

- 149 First report from the Select Committee on the Ventilation of the House (HC 1854, 149), Q161-6.
- 150 Letter from Meeson to J. Thornborrow, 13 Aug. 1855 (National Archives, Work 11/14, no. 881-4).
- 151 Alfred Meeson, First Report on the State of the Warming, Ventilating, and Lighting arrangements throughout the building, dated Dec. 1852 (National Archives, Work 11/14, no. 768-81).
- 152 Letter from Barry to H. M. commissioners for the completion of the New Palace of Westminster, 20 Feb. 1849 (National Archives, Work 11/13, no. 546); letter from Meeson to J. Thornborrow, 13 August 1855 (Work 11/14, no. 8814).
- 153 Board Minutes, 30 Oct. 1852 (National Archives, Work 11/14, no. 748).
- 154 Ritchie, *A Treatise on Ventilation*, 140; letter from Meeson to Philipps, 23 Oct. 1852 (Parliamentary Archives, Work 11/14, no. 755); letter from Lord John Manners to Office of Works, 18 Dec. 1852 (Work 11/16, no. 115-116).
- 155 Select Committee of the House of Lords, appointed to inquire into the possibility of improving the ventilation and lighting of the House (HL 1854, 384), 110-118.



committee rooms and libraries was added over the central waiting hall.¹⁴⁹ In 1852 Barry and Meeson reported that the Central Tower was still intended to function as the principal air discharge for the House of Lords, equipped with a steam rarefying system to increase the flow.¹⁵⁰ It was to replace the air turret on the West side of the House of Lords (to be converted into a smoke shaft) once the Tower is gone operational.¹⁵¹ Later reports, however, reveal that the Central Tower was only temporarily used as a discharge in the mid-1850s¹⁵² as the Victoria Tower was later adopted by Gurney as the principal discharge for the House. From autumn 1852 the development of the ventilation came under the direction of Meeson and Gurney. Reid's employment contract as chief ventilating consultant was terminated, largely in response to Reid's on-going quarrels with Barry.¹⁵³ He was succeeded by Meeson and in 1854 Gurney took over the responsibility for the management of the ventilation.¹⁵⁴ Between 1851 and 1854 four Select Committees, with Gurney's assistants, critically

evaluate the performance of the ventilation, which not only revealed various technical issues but also led Gurney to implement major modifications to existing air supply and discharge arrangements.¹⁵⁵ The Clock and Victoria Towers, originally designed as the primary air supply shafts, were converted into discharge shaft for the Houses of Commons and Lords respectively.¹⁵⁶ The mechanical fans used to force fresh air into the building, were decommissioned and the air was propelled entirely by means of the stack effect inside the up-cast shafts, which were equipped with furnaces.¹⁵⁷ The main air supply for the House of Commons was through doors inside Commons and Star Chamber courts, and in the House of Lords from Peers and State Officers courts.¹⁵⁸ These modifications did not lead to any major changes to the exterior form or number of the existing ventilating towers, but they illuminates that the architectural form of the towers could be preserved while the function and the internal technical arrangements was changing.



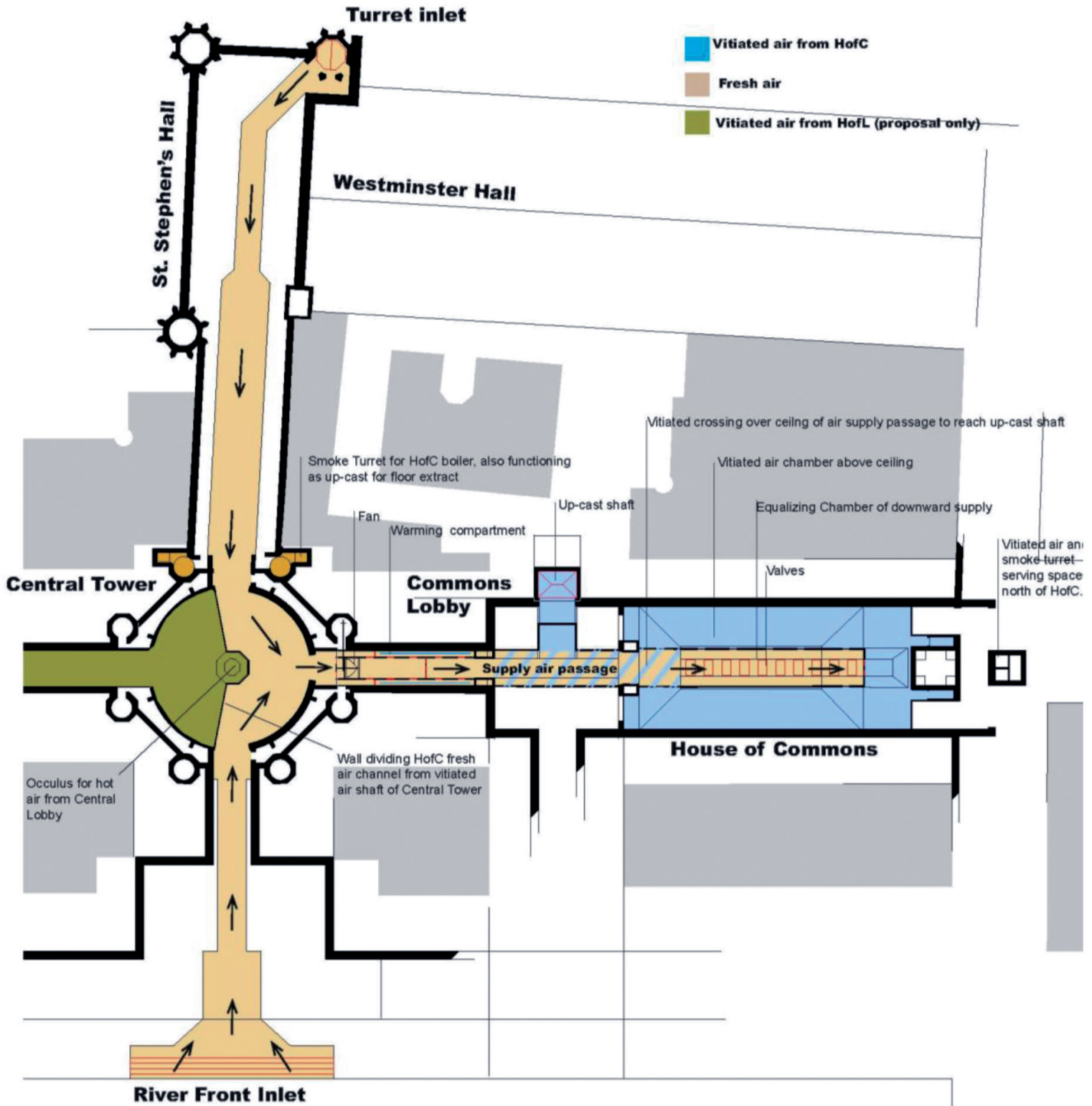
13.22 Outline of arrangement agreed between Reid and Barry on 22 June 1848, plan (top) and cross-section. [Kew, National Archives: Work 29/2910: “Houses of Parliament: Ventilation. Plan and section through central tower and adjacent corridors showing the proposition for supply of fresh air to the House of Commons from the north west turret of St Stephen’s Porch and from the east face of turret over centre portion of river front, 22 June 1848]

Conclusion

In the nineteenth-century critics of contemporary architectural practice and education, including Joseph Hume, James Fergusson, Joseph Paxton and Reid himself,¹⁵⁹ considered science as a potential alternative to historicism in the addressing of new architectural problems. The latter is based on the presumption that the scientific research can be used to address questions of architectural form, but in the design process adopted in the Palace of Westminster, reliance on historicist architectural models did not exclude the use of advanced technologies and scientific experimentation. In this context the Temporary Houses of Parliament and earlier experimental structures in Edinburgh could be understood as the most uncompromised expressions of this utilitarian philosophy. In the actual Palace of Westminster, however, Reid and Barry’s offices were confronted with the challenge of integrating the previously divided architectural and technical strands. Throughout the design process the use of towers and their respective functions within the ventilation system was extensively discussed. The Palace underwent a gradual

architectural transformation in response to the evolving system of ventilation. In Reid’s original scheme the existing architectural towers, such as the Clock and Victoria Towers, were converted into air supply shaft, while a new Central Tower was added specifically for exhausting hot air and smoke. By 1852, however, only few elements of Reid’s original scheme had survived. After 1846 the architectural towers were retained as inlets but a system of local discharge towers and turrets was introduced. This had a significant architectural impact. The form, height and position of the stacks largely followed ventilation requirements, but Barry resorted to Gothic details and tower forms for their architectural treatment. The design illuminates the symbiotic relationship between the functional requirements, mechanical technology and Gothic architectural precedents underlying their design. The stepped cross-section of Gothic spires permitted accommodating openings for the emission of smoke and air at different altitudes, but did not adhere to the proportions of their medieval models. Their extreme height and slenderness reflected the requirement for tall ventilation shafts, which were necessary to achieve sufficiently

- 156 Third report from the Select Committee on Ventilation of the House, 31 March 1854 (HC 1854, 403); Select Committee of the House of Lords, appointed to inquire into the possibility of improving the ventilation and lighting of the House (HL 1854, 384).
- 157 Report on the ventilation, warming and lighting of the Houses of Parliament, by Dr F.R.S. Percy (HC 1866, 98), 4-6.
- 158 Select Committee of the House of Lords, appointed to inquire into the possibility of improving the ventilation and lighting of the House (HL 1854, 384); Cross-section of the House of Lords, 1860s (National Archives, Work 29/2985-7). Detailed drawings and descriptions of the ventilation system in the House of Lords and Commons can be found in Schoenefeldt, *First Report on the Victorian Ventilation system in the House of Lords*.
- 159 Reid, “Eight lectures by David Boswell Reid”, 147-186; Reports from the Select Committees on Foundation Schools and Education in Ireland (HC 1836, 630); Kennedy, “Dr. D. B. Reid and the Teaching of Chemistry”.



strong draughts and to emit smoke and vitiate air at a high altitude. It could be argued that this relationship between function and architectural form exemplified a departure from the purely formalist use of the Gothic style and picturesque principles of composition that Pugin had criticised in *True Principles*. The picturesque composition of the Palace's skyline was not driven by architectural ideas, but was the accidental outcome of an array of turrets that were retrospectively introduced at an ad-hoc basis for ventilation purposes. The architectural impact of these new turrets, however, was immediately recognised by Barry's architectural team, which transformed these utilitarian elements into architectural features harmonising with the overarching Gothic vision behind the Palace. It also illuminated that the picturesque compositional principles associated with the Gothic style provided the flexibility to architecturally assimilate not only the original ventilation scheme with its large Central Tower but also the new system introduced after 1846. In Liverpool's St Georges Hall, on the contrary, the ventilation shafts were partially disguised behind a false façade in order not to disturb the symmetry of the neo-classical design.¹⁶⁰ As a style it was therefore less suitable for giving architectural expression to these functional requirements. In Westminster it was through an unusual collaboration between architects, scientists and engineers that this new relationship between historicism and modern science and technology was established. The Palace can be understood as a demonstration of a potential marriage between the compositional principles of the Gothic Revival and the rational scientific paradigm that Reid and his utilitarian contemporaries were promoting. It was displayed in buildings of various styles, including the neo-baroque Reichstag in Berlin and the Gothic Revival structures of the Royal Courts of Justice and the Hungarian parliamentary building in Budapest.¹⁶¹

13.23 Diagrammatic plan showing arrangements for the supply and discharge of air for the House of Commons, roof level.
[Author's own drawing]

160 Mackenzie, "On the mechanical ventilation and warming of St. George's Hall, Liverpool".

161 First Report of the Select Committee on House of Commons, 25 June 1903 (HC 1903, 227), Q502-558; Cook and Hinchcliffe, "Designing the Well-Tempered Institution of 1873"; Id., "Delivering the well-tempered institution of 1873".