



# Function and Fantasy

## Iron Architecture in the Long Nineteenth Century

Edited by Paul Dobraszczyk and Peter Sealy

ROUTLEDGE



## FUNCTION AND FANTASY

The introduction of iron – and later steel – construction and decoration transformed architecture in the nineteenth century. While the structural employment of iron has been a frequent subject of study, this book re-directs scholarly scrutiny on its place in the aesthetics of architecture in the long nineteenth century. Together, its eleven unique and original chapters chart – for the first time – the global reach of iron’s architectural reception, from the first debates on how iron could be incorporated into architecture’s traditional aesthetics to the modernist cleaving of its structural and ornamental roles.

The book is divided into three sections. *Formations* considers the rising tension between the desire to translate traditional architectural motifs into iron and the nascent feeling that iron buildings were themselves creating an entirely new field of aesthetic expression. *Exchanges* charts the commercial and cultural interactions that took place between British iron foundries and clients in far-flung locations such as Argentina, Jamaica, Nigeria and Australia. Expressing colonial control as well as local agency, iron buildings struck a balance between pre-fabricated functionalism and a desire to convey beauty, value and often exoticism through ornament. *Transformations* looks at the place of the aesthetics of iron architecture in the late nineteenth and early twentieth centuries, a period in which iron ornament sought to harmonize wide social ambitions while offering the tantalizing possibility that iron architecture as a whole could transform the fundamental meanings of ornament.

Taken together, these chapters call for a re-evaluation of modernism’s supposedly rationalist interest in nineteenth-century iron structures, one that has potentially radical implications for the recent ornamental turn in contemporary architecture.

**Paul Dobraszczyk** is a lecturer in Art History at the University of Manchester and his research covers a wide variety of subjects, including ornament and iron, visual representations of London’s Victorian sewers, and the relationship between real and imagined urban ruins. He has published widely on these subjects, including *Iron, Ornament and Architecture in Victorian Britain* (Ashgate, 2014), *London’s Sewers* (Shire, 2014) and *Into the Belly of the Beast: Exploring London’s Victorian Sewers* (Spire, 2009). His latest book, *The Dead City: Urban Ruins and the Spectacle of Decay* will be published by IB Tauris in 2017.

**Peter Sealy** is a PhD candidate at Harvard University, where he is a Frank Knox Fellow. His dissertation charts the productive utility of photography’s claim to factuality as it explored increasingly spatial qualities in late nineteenth-century architectural publications. An exposé of this argument will appear in Blackwell’s *Companion to Nineteenth-Century Architecture*. He co-authored (with Martin Bressani) an article on the photographs in Charles Garnier’s *Le Nouvel Opéra*, published in *Art and the Early Photographic Album* (CASVA, 2011). He holds architecture degrees from McGill University and the Harvard GSD; previously, he worked at the Canadian Centre for Architecture in Montréal on exhibitions including *Actions* (2008) and *Journeys* (2010).

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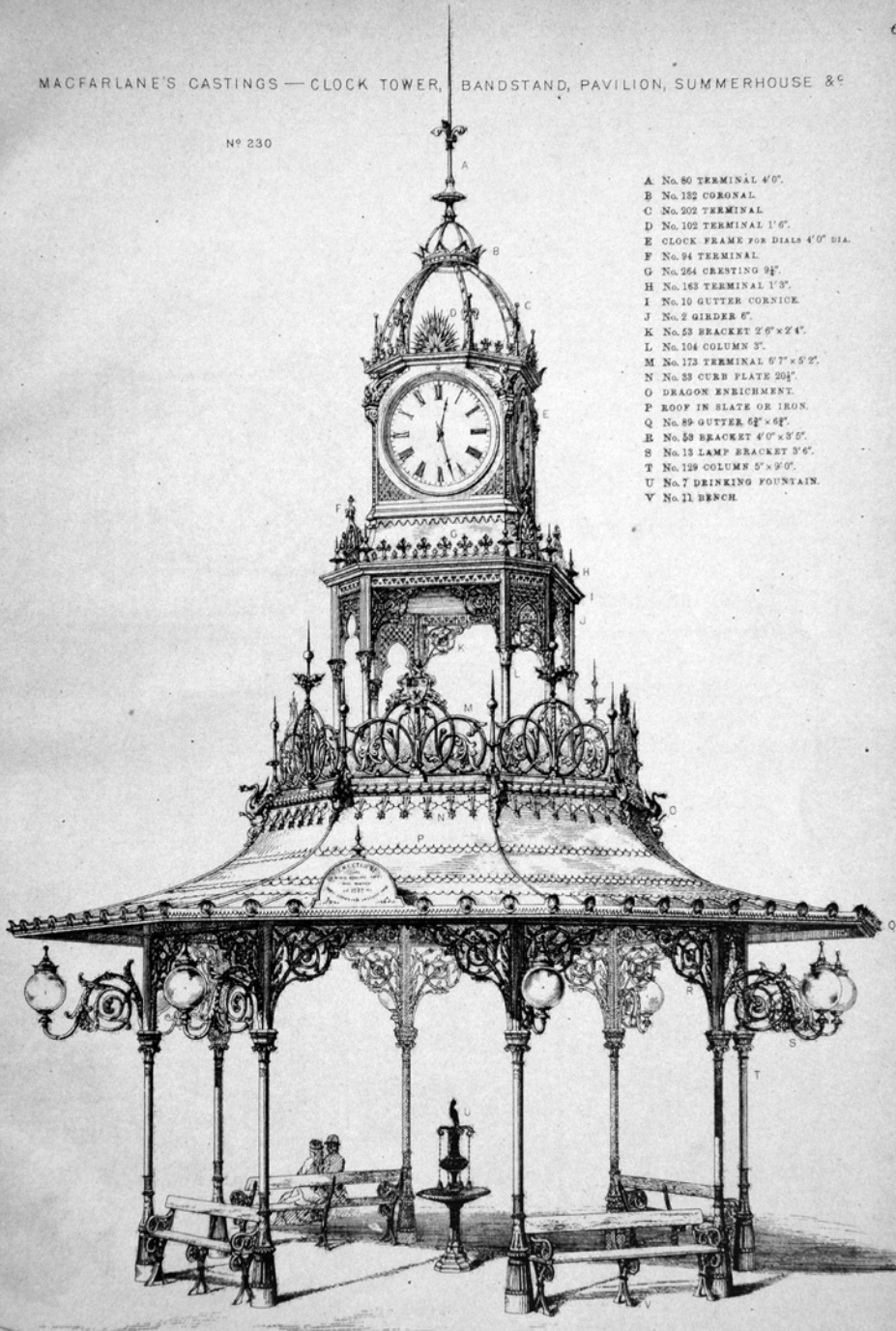
## Introduction: Architecture Unbound

*Paul Dobraszczyk and Peter Sealy*

In 1941, when the first edition of Sigfried Giedion's (1888–1968) monumental *Space, Time and Architecture* was published in the United States, the International Style had already left its indelible mark on the architectural world.<sup>1</sup> What Giedion added in his publication was a sense of that new tradition's complex origins in nineteenth-century culture, tracing its genealogy back to mid-century experimentation with iron construction, as exemplified in Joseph Paxton's (1803–65) Crystal Palace (1851; see Figure 1.3).<sup>2</sup> All that Giedion celebrated in the Crystal Palace – the realisation of a “new conception of building” based on pre-fabricated, standardised and mass-produced iron elements – he regarded as an embryonic form of architectural modernism, one that would eventually lead to the rectilinear forms and spatial openness of the International Style in the 1920s and 1930s: an approach completely devoid of any conventional architectural ornament. Yet, as acknowledged by Giedion, the constructive use of iron in buildings like the Crystal Palace was also very far from modernism's ideological commitment to functionalism; using contemporaneous responses to the Crystal Palace, Giedion also brought out the magical effect it had on its first visitors, who were enraptured by its interior spaces, particularly the aesthetic effect of the bold colours applied to the ironwork. Such a strange coming together of industrialised mass-production and magical aesthetics would remain a uniquely nineteenth-century architectural phenomenon.

Or would it? In this book, we contend that Giedion and others' genealogies of architectural modernism gloss over the complexities of the relationship between iron and architecture in the nineteenth and early twentieth centuries in favour of a reading that plays up only certain aspects of this relationship, ones that fit with their own ideological leanings. In particular, we want to suggest that the conventional reading of the International Style in architecture fails to account for a much more complex effect of iron in architecture that was global in its reach far earlier than the 1920s. As seen in catalogues published by iron founders in the 1880s (Figure 1.1), iron architecture – and particularly pre-fabricated cast-iron buildings – was being exported across the world, albeit mainly to countries that were part of, or adjunct

## MACFARLANE'S CASTINGS — CLOCK TOWER, BANDSTAND, PAVILION, SUMMERHOUSE &amp;c

N<sup>o</sup> 230

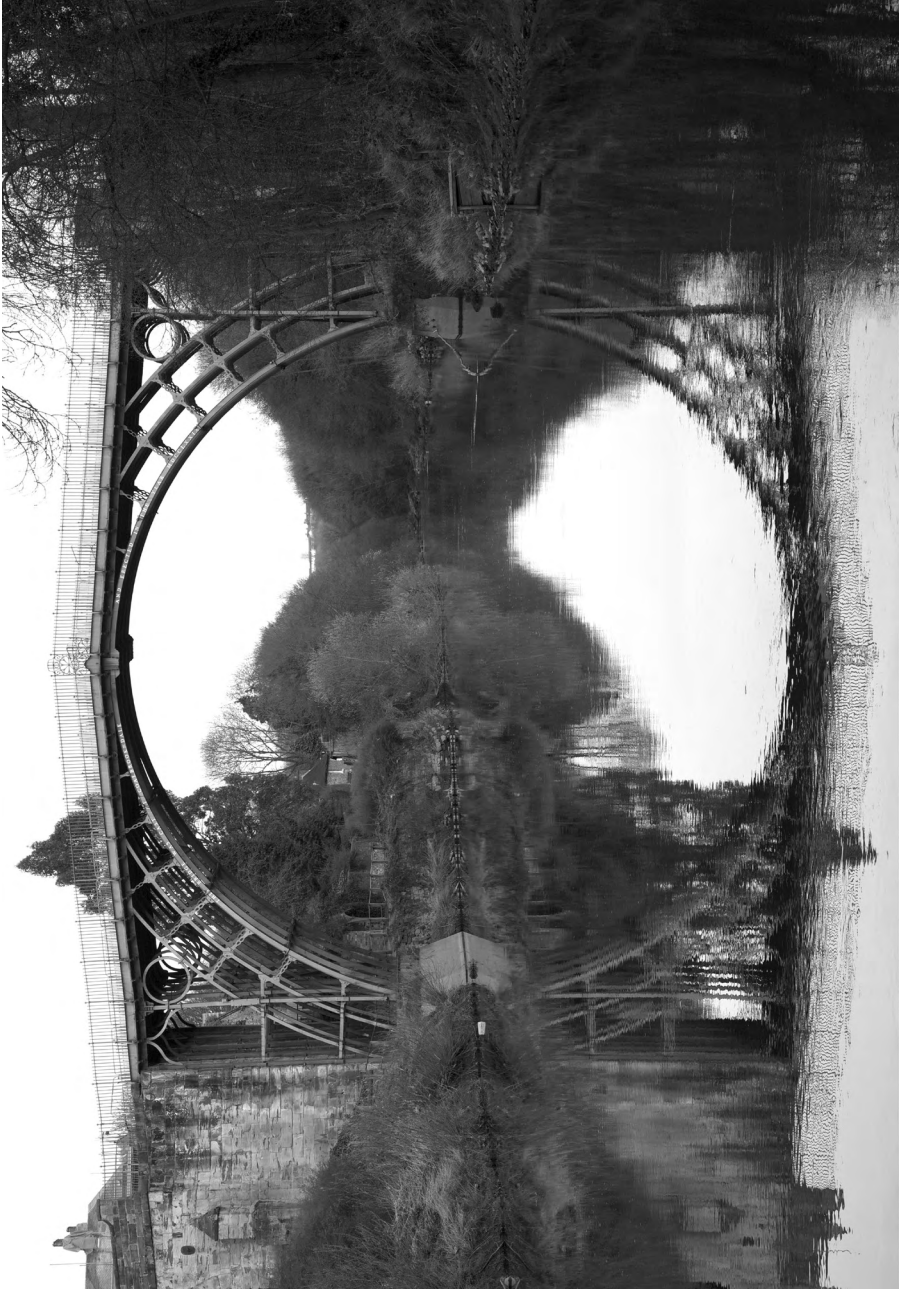
- A No. 80 TERMINAL 4'0".
- B No. 182 CORONAL.
- C No. 202 TERMINAL.
- D No. 102 TERMINAL 1'6".
- E CLOCK FRAME FOR DIALS 4'0" DIA.
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- H No. 163 TERMINAL 1'3".
- I No. 10 GUTTER CORNICE.
- J No. 2 GIRDER 6".
- K No. 53 BRACKET 2'0" x 2'4".
- L No. 104 COLUMN 5".
- M No. 173 TERMINAL 5'7" x 5'5".
- N No. 33 CURB PLATE 20".
- O DRAGON ENRICHMENT.
- P ROOF IN SLATE OR IRON.
- Q No. 89 GUTTER 6" x 6".
- R No. 58 BRACKET 4'0" x 3'0".
- S No. 13 LAMP BRACKET 3'6".
- T No. 128 COLUMN 5' x 9'0".
- U No. 7 DRINKING FOUNTAIN.
- V No. 11 BENCH.

I.1 Multipurpose structure illustrated in the sixth edition of Macfarlane's catalogue, vol. 2, 1882, p. 679. Reproduced by permission of David S. Mitchell.

to, the British and French colonial empires. Yet, as is immediately obvious in the catalogue illustration, the aesthetics of these buildings could not be more different than the functionalist purity of architectural modernism. With their profusion – even excess – of cast-iron ornament, this kind of iron architecture seems to directly challenge Giedion’s reading. Yet it was precisely these kinds of buildings that defined what a global style of iron architecture might have looked like at the end of the nineteenth century. It may not fit our contemporary tastes, but it nevertheless warrants our attention as an important if undervalued part of iron’s impact upon the aesthetics of architecture. So, this book will redirect attention upon this rich but neglected subject, bringing out, for the first time, the global reach of iron architecture in the long nineteenth century, encompassing Britain and continental Europe, the British colonial and informal empire, and the United States. Each of the chapters offers a unique and original perspective on iron’s architectural use in this period and, together, they chart iron’s rise to global prominence, from the first debates on how iron could be incorporated into architecture’s traditional aesthetics to the modernist cleaving of its structural and ornamental uses. The result is the sketching of a very different genealogy (or, rather, genealogies) of iron architecture, one that embraces its extraordinary range of aesthetics in the period before the development of architectural modernism, and one that might contribute to new understandings of architectural ornament that have emerged in the age of digital design.<sup>3</sup>

## THE ORIGINS OF METALLIC ARCHITECTURE

The widespread introduction of metals in construction – first cast and wrought iron, then steel – made arguably the most indelible impact upon architecture in the long nineteenth century. The production and use of iron has a long history dating back before antiquity, but the potential of the material was transformed in Britain in the early period of the Industrial Revolution, from a material produced on a relatively small scale serving local needs to a leading national industry, used to make all kinds of utensils, machinery and even entire buildings.<sup>4</sup> The establishment of the Coalbrookdale ironworks by Abraham Darby (1678–1717) in 1707 revolutionised the commercial potential of cast iron, with the company pioneering industrial production of the material for the manufacture of household and industrial goods, military ordnance and machine parts.<sup>5</sup> As the name suggests, cast iron is distinct from its sister material, wrought iron, in that it is produced from patterns and moulds rather than shaped by a smith at a forge.<sup>6</sup> At first, specialist industrial manufacturers of cast iron like Darby tended to focus on the mass production of domestic utensils, but as the Coalbrookdale works expanded and knowledge about the material properties of cast iron developed – particularly its load-bearing strength and resistance to fire – it began to be used in engineering and building structures: in the world’s first iron bridge, erected by Darby near Coalbrookdale in 1779 (Figure I.2); as a replacement for internal timber supports in mills and warehouses; and as a supporting framework for increasingly large-scale pumping engines.<sup>7</sup>

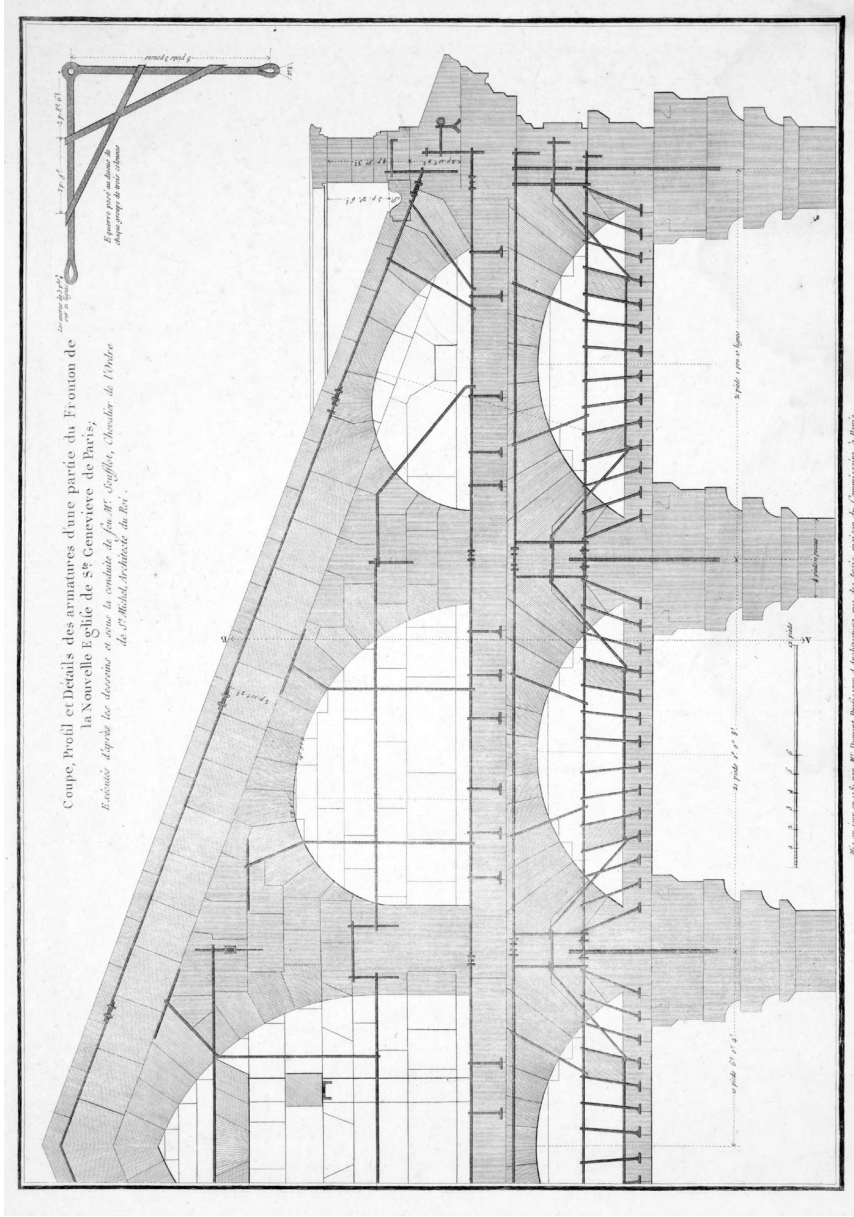


1.2 Abraham Darby, the world's first completed iron bridge near Coalbrookdale, Shropshire, 1779. Photograph by Paul Dobraszcyk.

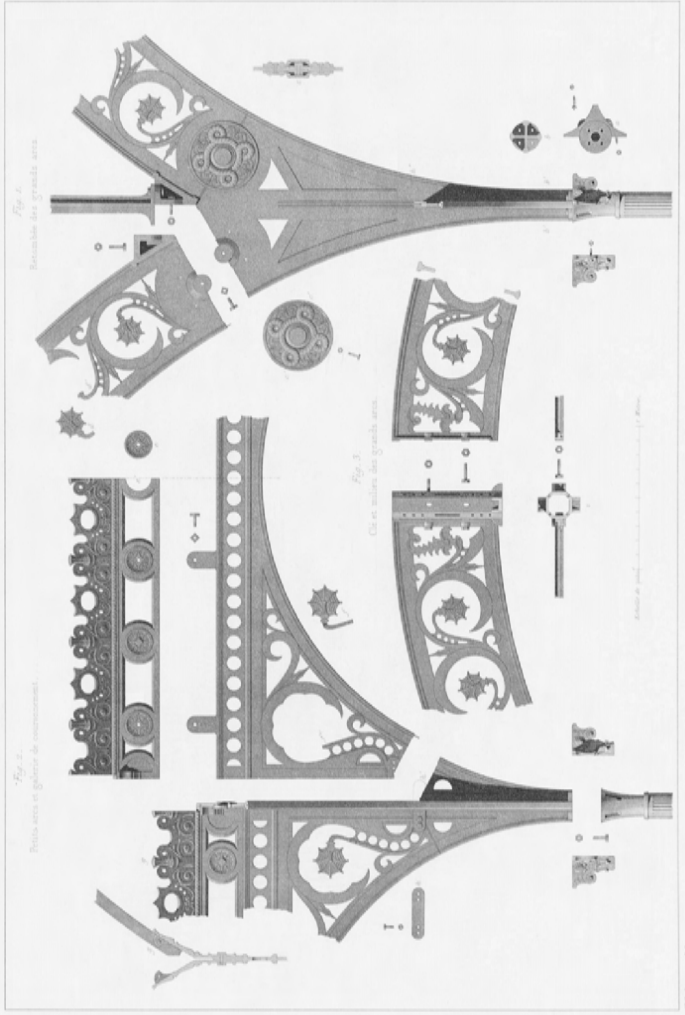
At the same time, the emergence of specialised engineering education in France saw similar experiments with both wrought and cast iron as a structural support in both bridges and buildings, the former including the first-ever (failed) attempt to construct a cast-iron bridge at Lyon in 1755,<sup>8</sup> the latter arguably the first architectural use of iron in the roof framework of the new Salon Carré of the Musée du Louvre in Paris in the 1760s.<sup>9</sup> French architects had also used iron in a daring way to support otherwise impossibly long spans – but in masonry constructions. Perhaps inspired by his interest in the opposition of bone and flesh in human and animal anatomy, Claude Perrault's colonnade (1667–70) for the east façade of the Louvre featured a comprehensive system of iron reinforcement supporting its stone colonnade and entablature.<sup>10</sup> Sophisticated construction techniques were used to produce a purified, classical aesthetic, whose wide intercolumniations would be impossible without iron's tensile strength. Together with Jean-Baptiste Rondelet, Jacques-Germain Soufflot designed a similar system – on a larger scale – to support the portico for his Church of Sainte-Geneviève (1755–91) (Figure I.3).<sup>11</sup> Such hybrid deployments of iron's tensile strength as a silent but needed partner for masonry's traditional physical presence not only complicate interpretations of the French rationalist tradition, but also stand as precursors to *fin-de-siècle* attitudes towards reinforced concrete (see below).

In the first half of the nineteenth century, the constructive use of cast iron in architecture and engineering proliferated in both Britain and continental Europe, whether evidenced in John Nash's (1752–1835) Regency columns disguised with plaster or in parts of the supporting structure of his Brighton Pavilion (1815–21); increasingly ambitious conservatory designs in conjunction with glass such as Charles Rohault de Fleury's greenhouse in Paris's Jardin des Plantes (1834–36) and, later, Joseph Paxton's Great Stove at Chatsworth (1836–40); Henri Labrouste's (1801–75) wrought-iron roof framework and cast-iron columns in the Bibliothèque Sainte-Geneviève (1843–50) in Paris (Figure I.4); and numerous road, canal and, later, railway bridges across Europe.<sup>12</sup> This stage of experimentation with cast iron in construction culminated in the building of Paxton's Crystal Palace in 1851, which was the first truly public building to fully exploit the constructive potential of cast iron in combination with glass.

The Crystal Palace not only thrust the question of iron architecture into the public sphere but also made a decisive impact on the way in which architects across Europe and the United States would go on to attempt to solve the aesthetic problems posed by the material. At the same time, the limitations of cast iron – its brittleness and weakness in tension – were increasingly occupying the minds of engineers, particularly when several long-span railway bridges collapsed in the 1840s.<sup>13</sup> This led to the development of industrial processes of manufacturing wrought-iron beams to replace cast iron in parts of structures that were most susceptible to lateral forces (usually roof components). Thus, in the second half of the century, when the constructive use of iron proliferated in almost every building type, from railway stations to market halls, the two types of iron – wrought and cast – were regularly used together in combinations that drew upon their complementary strengths, with cast iron doing the supporting work, mainly in columns and spandrels, and wrought iron the tensile work in roof beams and trusses. At the same time, cast iron began



I.3 Gabriel Pierre Martin Dumont's etching of Jacques Germain Soufflot's Église Sainte-Genève, Paris. Cross-section, profile and detail of the armature of part of the pediment, 1781, etching on paper, 41.2 x 56.7 cm. DR1984:1607, Collection Centre Canadien d'Architecture/Canadian Centre for Architecture, Montréal.



BIBLIOTHÈQUE SAINTE-GENÈVE, À PARIS.  
 Dessinée par M. CLAR BALS, architecte.

I.4 "Details of the cast iron arches from the reading room, Bibliothèque Sainte-Genève, Paris," in *Revue Générale de l'Architecture et des Travaux Publics*, vol. 11 (Paris: Paulin et Hetzel, 1853), plate 32. W.R484, Collection Centre Canadien d'Architecture/Canadian Centre for Architecture, Montréal.

to be used as a structural framework for entire buildings, initially in the building frontages developed by Daniel Badger (1806–84) and James Bogardus (1800–74) in the United States in the late 1840s, and later in the world's first high-rise buildings in Chicago and other American cities.<sup>14</sup> Finally, steel began to be economically mass-produced from the 1880s onwards, being widely used thereafter as a more economic framing material than either cast or wrought iron, and resulting in the obsolescence of iron as a constructive material around the turn of the twentieth century.<sup>15</sup> Yet, even as steel took over as a constructive material in countries with well-developed industrial economies, less-developed countries (and particularly those associated with the British Empire) continued to import iron buildings well into the twentieth century, giving iron founders in Britain a commercial lifeline in the 1920s and 1930s, before the collapse of the empire sealed their fate.

### ORNAMENT AND IRON

In one sense, thanks to historians such as Giedion and others, the history of the constructive use of cast and wrought iron in architecture and engineering is a well-known story, mainly on account of its being seen as a precursor to the full embracing of steel's structural potential by architectural modernism.<sup>16</sup> Yet, as already stated above, this is a one-sided picture of the complexities involved in both architects' and engineers' approach to the aesthetic possibilities of iron construction. For all architects (and, to some extent, engineers) working in the nineteenth century were driven by two powerful but contradictory impulses. On the one hand, the critical category of truth, originating in the scientific revolution of the seventeenth century, argued for structural and material integrity in architecture.<sup>17</sup> For most nineteenth-century architects, history in architecture meant ornament, the latter being the primary means by which a building was invested with historical associations and meanings. This way of thinking did not receive any sustained questioning until the very end of the nineteenth century. Meanwhile, truth in architecture was increasingly equated with structure, or the function of a building, an idea that would come to dominate modernist architects' thinking in the first half of the twentieth century. Into this contradictory nineteenth-century culture of building, iron both intensified and further problematised the relationship between historical meaning and structural truth in architecture, for not only was iron a new constructive material that revolutionised the structural possibilities of architectural form, demanding a new kind of "truth" to materials, but it also had no historical precedent in terms of architectural ornament, and was therefore problematic in terms of its perceived lack of associative meaning.<sup>18</sup>

Yet, for architects who embraced iron in architecture, there was a long tradition of the ornamental use of iron in other contexts. From the medieval period onwards, both cast and wrought iron had been used to produce a variety of objects that were often given ornamental forms, including firebacks, railings, balconies and gates. The late seventeenth and early eighteenth centuries saw a flowering in English decorative wrought iron, influenced by the publication of architectural treatises and specialist books of engravings such as Jean Tijou's *A New Booke of Drawings* (1693), a change in architectural fashion and a surge in demand for ornamental gates, railings

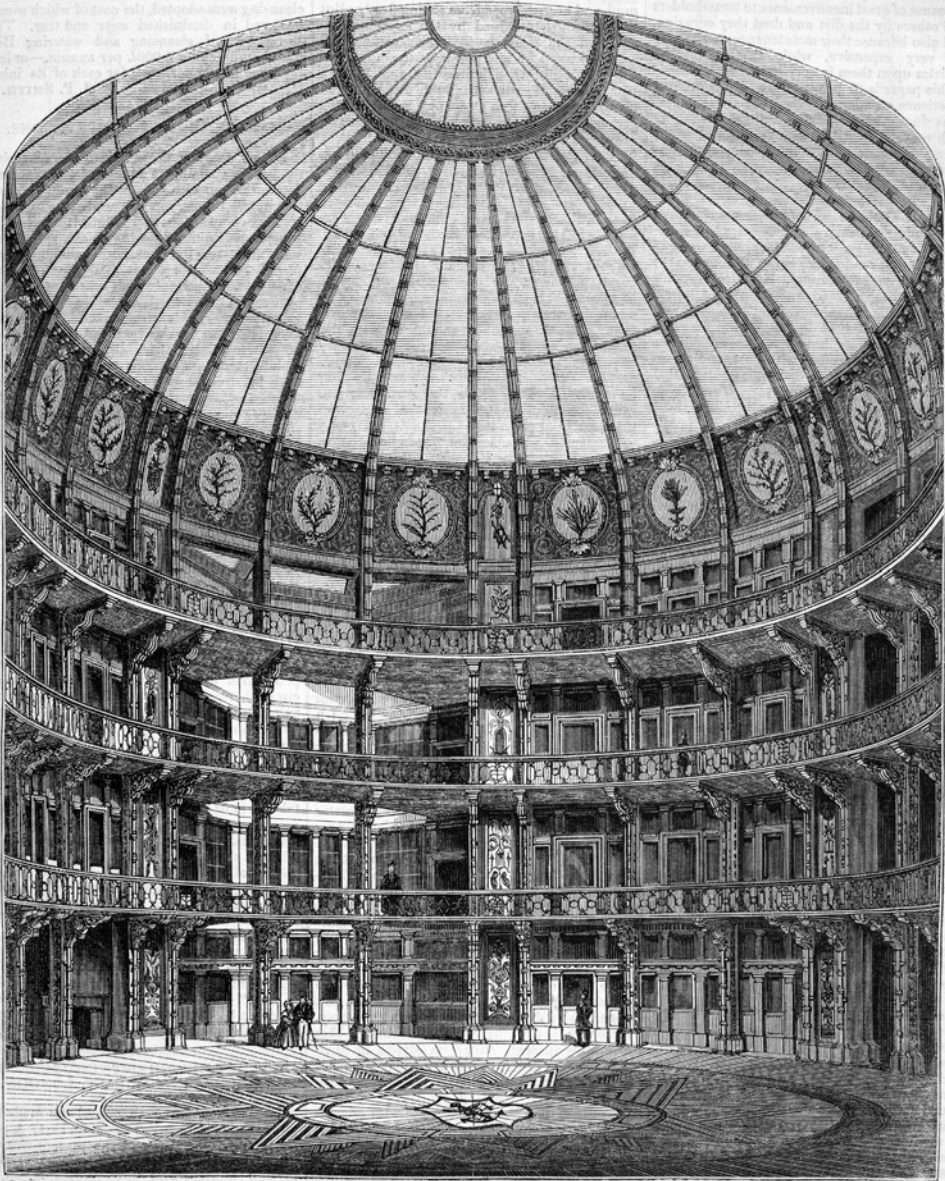
and balconies that came with the series of building booms in urban areas in the eighteenth century.<sup>19</sup> Soon after Darby established the first commercial iron foundry in 1707, cast iron challenged the dominance of wrought iron in this decorative tradition, but it was not until the late eighteenth century that the casting technique had evolved to the point at which the intricate forms of wrought-iron decoration could be imitated in cast iron, and these developments were led by the Carron Company in Scotland and several foundries in Saxony and Prussia (see Chapter 3).<sup>20</sup> By 1851, as the many ornamental cast-iron objects on show at the Great Exhibition demonstrated, specialist foundries in Paris and Berlin were producing high-quality decorative objects in cast iron that challenged the perceived advancements in British industrial art, as exemplified by the Coalbrookdale Company.<sup>21</sup> From then on, until the end of the nineteenth century, the production of ornamental iron for architectural use was increasingly dominated by Scottish manufacturers, particularly the extraordinary rise of architectural iron founders like Walter Macfarlane, based in Glasgow.<sup>22</sup> Buoyed by an expanding export market, these foundries continued producing ornamental ironwork well into the twentieth century – long after the structural use of iron had been mostly supplanted by steel.

Even as historians of architectural modernism, such as Giedion, seem at pains to dissociate the structural and ornamental use of iron in nineteenth-century buildings, there was never such a pronounced separation between these distinct architectural applications of the material. On the one hand, ornamental iron founders like Macfarlane increasingly fused ornament and structure in their products, particularly in the last quarter of the century, when they were producing entire buildings made out of assemblages of individual ornamental cast-iron components. On the other hand, the nineteenth-century dictate that architecture should be both ornamental and structurally honest led some architects to experiment with iron in creating buildings that brought together structure and ornament in new combinations: early examples include John Burley Bunning's Coal Exchange (1848–49; Figure I.5) in London, which featured an interior rotunda supported on cast-iron columns that were also moulded into ornamental rope shapes;<sup>23</sup> and Labrouste's wrought-iron roof framework and cast-iron columns in the Bibliothèque Sainte-Geneviève (1843–50) in Paris, which attempted to develop an entirely new type of ornament appropriate to iron but also grounded in the classical language of architecture (see Figure I.4).<sup>24</sup> While the slender forms of iron columns and beams dramatically broke with the canonical proportions of classical architecture (see Chapter 10), ornament offered a more fertile ground for their reconciliation.

As this book will demonstrate, the second half of the nineteenth century was characterised by a plethora of buildings that employed the two different types of iron in ways that defied (and continue to defy) conventional definitions of both structure and ornament, how the two should be related and what forms ornament in iron should take. These include: iconic public buildings, such as the Crystal Palace (see Chapter 1) and the University Museum (1855–60) in Oxford (Chapter 2); structures more defined by their embracing of engineering principles in iron construction, such as Victor Baltard's (1805–74) Halles Centrales (1853–70) in Paris (see Chapter 10) or New York City's early twentieth-century bridges (Chapter 11); and iron architecture exported from Britain to many of its formal and informal

THE LONDON COAL EXCHANGE, THAMES-STREET.

MR. BUNNING, F.S.A., ARCHITECT.



I.5 "The London Coal-Exchange," *Builder*, 29 September 1849, p. 462.

colonies, including Nigeria, Egypt and India (Chapter 5), Argentina (Chapter 6), Jamaica (Chapter 7) and Australia (Chapter 8). Taken together, this wide range of architectural applications of iron both challenges and complicates conventional assessments of the aesthetics of iron architecture in the nineteenth century, leading to a richer understanding of what is often pictured as a reductive relationship between structure and ornament in iron.

## THE RECEPTION OF IRON ARCHITECTURE

The constructive and decorative use of iron in architecture in the nineteenth century was set against a background of often vitriolic responses from both critics and architects alike. Iron's new-found superabundance – the material's very unboundedness – as well as its extraordinary adaptability provoked a range of critical responses to its use in architecture across the nineteenth century.<sup>25</sup> In Britain, these were centred on three main objections: first, to cast-iron ornament as a “sham” form of decoration because it imitated the handiwork of wrought iron and yet was machine made;<sup>26</sup> second, to the repetitive aesthetic of iron architecture, whether mass-produced cast-iron ornament or what were widely regarded by architects as the ugly structures produced by engineers who had little interest in conventional architectural aesthetics;<sup>27</sup> and third, the visual appearance of iron buildings, which were regarded as defective in that their thin iron columns and trussed roofs did not offer enough of a sense of durability and visual strength to give them aesthetic value.<sup>28</sup> Periodically centring on public buildings that introduced iron into their construction (the Crystal Palace and South Kensington Museum (1855) being notable examples), these critical voices (often led by John Ruskin) were convinced that iron could play no part in the formation of a new style of architecture that would elevate the utilitarian values of industrial culture (see Chapter 1).<sup>29</sup> Indeed, central to all of these criticisms in Britain – and there were many throughout the Victorian period – was a deep-rooted ambivalence, and in many cases outright hostility, towards industrialisation. With its basis in industrial production, iron was seen as symbolic of industrialisation as a whole, and therefore embodied its worst horrors: the enslavement of the individual artist and craftsmen to machines; the overturning of centuries of tradition in favour of a rigid system of brute economics; and the despoliation of the environment by the ruthless exploitation of its resources. French architects were less likely to adopt such an anti-industrial bent; under the rigorous dictates of Beaux-Arts academicism, most chose to conceal their structural use of iron behind classical veneers. The visual insubstantiality of iron columns, so at odds with the classical tradition, was to be the main French criticism of iron structures.<sup>30</sup>

Yet, responding to and defying these criticisms, there were some architects who actively embraced iron as a material that would unlock new aesthetic potentials for architecture, ones that would reflect (and celebrate) the industrial age rather than react against it. So, responding to the notion of cast-iron ornament as a sham, the architect Henry Whitaker argued that ornament was itself a form of deceit (very much like feminine cosmetics) and that iron ornament was no different from that in

other materials and could “humanise” the industrial basis of iron production; *fin-de-siècle* Art Nouveau, with its sinuous forms melding structure and decoration, would later be defended on such terms.<sup>31</sup> As for the perceived repetitiveness of machine-made ornament, some architects argued that the mass-production that created such an aesthetic might be regarded as a fundamentally democratising influence in that it spread aesthetic pleasure from the few to the many.<sup>32</sup> Finally, responding to the perceived insubstantiality of iron construction, some architects and critics argued that in order to appreciate the new aesthetic of iron in architecture, a new form of artistic education was necessary, one that embraced the radically different visual appearance of iron buildings from their counterparts in traditional building materials like stone or brick.<sup>33</sup> In Britain, these progressive attitudes towards iron and architecture resulted in a wide variety of experimental projects in the second half of the nineteenth century, including a succession of theorisations (and buildings) that were based on: the creation of a new hybrid iron style of architecture, achieved through the unification of the increasingly divided disciplines of architecture and engineering; a hybrid ornamental style that developed perforated patterns in both cast and wrought iron (and exemplified in Isambard Brunel (1806–59) and Matthew Digby Wyatt’s (1820–77) Paddington Station, 1852–54 (see Figure 9.3)),<sup>34</sup> a system of painting structural and ornamental ironwork that achieved new ornamental effects (as seen in Owen Jones’s (1809–74) colour scheme for the interior of the Crystal Palace, discussed in Chapter 1);<sup>35</sup> or a radically different kind of “osteology” of architecture, mirrored in the human skeleton and taking its cue from Gothic vaulting (as seen in the University Museum in Oxford, discussed in Chapter 2).<sup>36</sup>

In France, the latter conception would take centre stage in one of the most celebrated theoretical treatises on architecture published in the nineteenth century: Viollet-le-Duc’s (1814–79) *Entretiens Sur l’Architecture* (1863). In its pages, Viollet-le-Duc argued that Gothic buildings offered a model for nineteenth-century iron architecture because their forms were skeletal and diagrammatic (see also Chapter 2). He developed a notion of the Gothic that submitted questions of architectural style (and therefore decoration) to the principle of structural rationalism. As part of his *Entretiens*, Viollet-le-Duc suggested designs for architectural uses of iron that were based firmly in its material properties – his unexecuted proposal for an iron-vaulted concert hall clearly expressing these principles (Figure 1.6). Unlike the majority of his counterparts in Britain, Viollet-le-Duc envisaged an evolving language of architectural form that was based on the structural aesthetics of Gothic buildings, with iron perhaps leading to a new kind of Gothic rationalism.<sup>37</sup> As anticipated by the *Building News* in Britain in 1857, an updated Gothic architecture in iron would achieve unprecedented heights and spans.<sup>38</sup> This approach would perhaps be most perfectly realised not in a new breed of iron churches (only ever partially realised) but, rather, in the great railway sheds built across Europe from the 1850s (see Chapter 9) and later in the United States, as well as in perhaps the most iconic nineteenth-century iron structure, Gustav Eiffel’s (1832–1923) tower, erected for the 1889 Exposition Universelle in Paris.<sup>39</sup>

As evidenced by the pavilions erected for the Expositions Universelles of 1855, 1867, 1878 and 1889, France had a much more well-developed (and well-respected) engineering tradition than Britain and (contrary to modernist dogma) the architects formed at the *École des Beaux-Arts* tended to have a healthy grasp

of technology.<sup>40</sup> Debates about how iron could be assimilated within architecture generally addressed two issues: its incorporeality and its lack of an evident decorative system. While some architects were willing to appreciate iron structures as beautiful in their own right, others proposed a variety of positive solutions for infill and decoration, including polychromy, ceramics, hollow masonry blocks and reinforced concrete.<sup>41</sup> In this light, apostles of concrete construction such as Auguste Perret (1874–1954) belong to a common theoretical lineage grappling with the appropriate uses of iron in architecture.<sup>42</sup>

Viollet-le-Duc's understanding of architecture – and particularly Gothic architecture – as a tectonic system independent of moral, religious or even stylistic concerns never achieved any widespread acceptance in Britain; where it arguably had the greatest impact was in German discourse on iron construction that preoccupied architectural theorists in the second half of the nineteenth century. As outlined by Sokratis Georgiadis, the arguments put forward by Sigfried Giedion in the 1920s and 1930s came at the end of a long line of architectural theorists who had thought deeply about the implications of iron for the entire basis of the aesthetics of architecture.<sup>43</sup> Reacting to the Crystal Palace, German theorists were as divided in their responses as their counterparts in Britain. On the one hand – and in common with many in Britain – the architect Gottfried Semper (1803–79) argued that iron could never produce a “monumental” style of architecture because its very structural strength led to a dematerialised architecture of attenuated columns and insubstantial rods and cables.<sup>44</sup> Semper's only suggestion was to follow the example of Assyrian hollow-body construction and use iron for tubular columns and trusses.<sup>45</sup> On the other hand, the architectural historian and theorist Karl Bötticher (1806–89) argued for iron's place in the creation of a new style of architecture, principally by creating new forms alongside more conventional materials, with both brought together in a creative form of synthesis.<sup>46</sup> Bötticher's theories clearly had strong appeal to a younger generation of architects who were fascinated by the unprecedented spatial experiences engendered by iron construction. Far more than was the case in Britain, the question of the validity or otherwise of iron architecture preoccupied German architects and critics right up to the end of the nineteenth century, and even at the turn of the twentieth century architects such as Herman Muthesius (1861–1927) were arguing that only iron could produce an architecture that reflected the new economic and cultural conditions of industrial modernity.<sup>47</sup> However, Muthesius was clear that the *Sachlichkeit* (objectivity) manifested by the products of industry, from railroad stations to bicycles, would require architectural translation into *Sachliche Kunst* (realist architecture).<sup>48</sup> Thus, as Georgiadis demonstrates, architectural modernism and its principal historiographies emerged out of a long tradition of debate on iron construction which was centred on trying to think through the architectural implications of the material in relation to structural form, spatial aesthetics and functionality.

## RADICAL TRANSFORMATIONS

What emerged in German discourse on iron and architecture in the late nineteenth and early twentieth centuries was a radically different way of thinking about



1.6 Viollet-le-Duc, design for a concert hall, in *Entretiens Sur L'Architecture* (1863).

architecture itself, as the product of both the creative process of design and also the perceptual experiences of its users. The latter concern would become an important element in the monumental *Arcades Project*, the unfinished magnum opus of the literary critic and cultural theorist Walter Benjamin (1892–1940). This vast montage of nineteenth-century cultural criticism owes a debt to countless sources, not least of which was Giedion's early publication *Building in France, Building in Iron, Building in Ferro-Concrete* (1928), which Benjamin greatly admired.<sup>49</sup> Yet, Benjamin's reading of nineteenth-century architecture, grounded as it was in his highly idiosyncratic Marxist approach to history, was far more complex than Giedion's.<sup>50</sup> For Benjamin, iron was pre-eminently a material that created both rational *and* magical buildings. In his reading, even as architects and engineers strove for an approach that realised the full structural possibilities of iron construction, the results often took on an enchanted quality for their first users. Thus, the Crystal Palace was both a direct product of industrial modernity, with its rationalised processes of design and manufacture, and also widely perceived as a magical space that somehow reached back into a mythic past of fairy-tale constructions.<sup>51</sup> This double reading, paradoxical as it seems to us today, preoccupied Benjamin, who found in these magical readings an expression of what he termed a "wish image," or a profound, collective desire for a transformative experience within the world made by industrial modernity, one that was predicated on a desire for reconciliation – whether between the increasingly divided social classes or between technology and nature.<sup>52</sup> As explored by Peter Sealy in this volume (Chapter 10), Benjamin recognised that the most common form in which the wish image attached itself to industrial products was in decoration or ornament. In direct contrast to Giedion, Benjamin found value and meaning in such ornament which took many forms in relation to iron, whether the painted columns of the interior of the Crystal Palace; the decorative iron capitals in the early Paris arcades (Figure I.7); sculptural cast-iron objects displayed at the Great Exhibition (Figure I.8); or the myriad of ornamental products sold by iron founders in their catalogues (see Figure I.1). Such ornament, according to Benjamin, was not mere whimsy – a sign of a failure of nerve on the part of its designers, or an indictment of the regressive tastes of its consumers – but, rather, a key to unlocking (and ultimately awakening) the desires that found expression in the wider, dreamlike ornamental world of nineteenth-century industrial modernity.<sup>53</sup>

Benjamin's reading of ornament in relation to iron architecture raises questions about the lack of scholarship to date on the history of this subject. For, despite new studies of the history of iron, ornament and architecture in Britain, there remains no wide-ranging exploration of the international contexts in which this kind of iron architecture flourished in the nineteenth century.<sup>54</sup> What Benjamin's analysis demonstrates is that ornamental iron – and particularly the mass-produced cast-iron ornament that filled the pages of iron founders' catalogues in the late nineteenth century – represents an important meeting point of industrialised production and individual and collective desires. What iron founders were attempting to provide in the second half of the nineteenth century were both commercial products that could be mass produced (as potentially endless series of replicas) and also individualised objects of desire to cater for a highly differentiated



I.7 Ornamental cast-iron capitals in the Galerie Véro-Dodat (1826), Paris.  
Photograph by Paul Dobraszcyk.

THE ZOLLVERHIN DEPARTMENT.

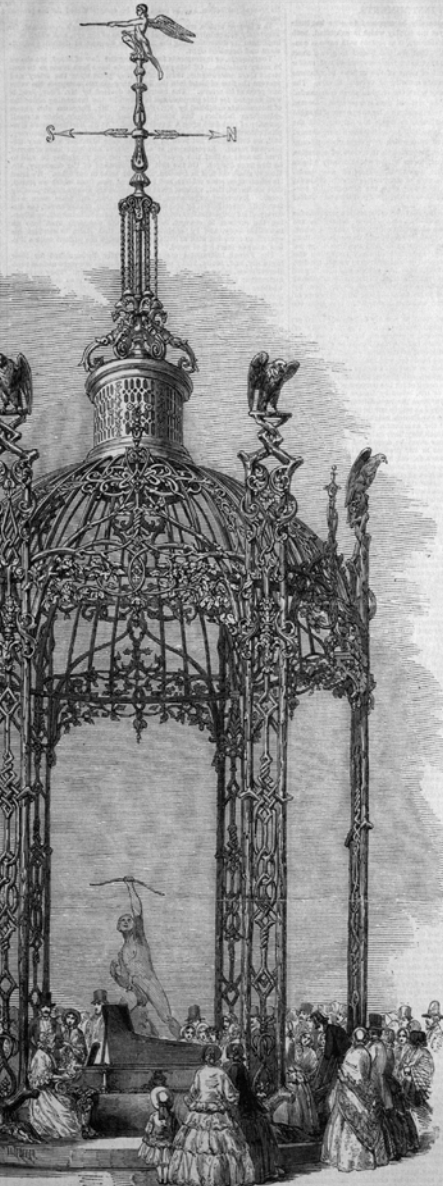
The engraving on the preceding page gives a comprehensive view of that portion of the Zollverein Department, the centre of which branch of right and left. The large tent-like object bounding the foreground in the east contains the famous Dante window from Milan; the equatorial statue in the rear is the monument to the King of Prussia; and in the foreground are the Annas, by King of Berlin, and the Slavonian Lion, which we have engraved and fully described in former Numbers. Amongst various objects of Sculpture, which have been very liberally contributed by the States belonging to the Zollverein.

MAUDSLAY'S COMBING PRESS.

The combing press is worked by a double cylinder driven by high pressure engine, on the shaft of which is a metallic pulley of 12 inches, and a 24-inch of 72 inches diameter respectively. The cylinder are each of 12 inches diameter, and the length of the shafts 12 inches. From the pulley of the engine a strong double leather strap passes to a drum of 12 inches diameter on the main shaft of the press, by which motion is given to the comb-head and other parts of the machine: the drum is attached to the engine fly-wheel, of 64 inches diameter. In combing process, as ordinarily used, either a screw or lever is employed to give motion to that part of the machine by which the necessary impressions are given to the metallic comb; but in the present instance the motion is obtained by means of an eccentric, by which a pressure is brought into action of 160 times the cross-head worked by the eccentric, which is concealed from view, has an alternate vertical motion of three-quarters of an inch. Underneath and attached to the cross-head are two rollers, the lower one of which contains the upper die, while the lower one is contained in a collar, which is held up by three radially placed springs pressing thereon, and forms the temporary resting-place for the blank undergoing the process of stamping. As proper intervals the collar is pressed down by two small levers or arms, having an alternate motion. The Blanks, twenty-eight in number, each of nearly one-eighth of an inch in thickness, are placed in a circular brass holder, from an opening in the bottom of which they are successively transferred to the lower die by means of a split curved arm, or tongue of ingenious construction, having two fingers at the end, by which the blank is held during the transfer from the holder to the lower die, when the curved arm is opened as an arm to the die, the distance between the centre of the holder and the centre of the die is five inches. The opening and shutting of the split-arm or tongue is effected by a vertical pin moving in a short slot formed in the stem of the curved delivery arm: the pin is attached to the end of a second horizontal arm or lever, which is worked by a vertical spindle in connection with an elliptical cam towards the top and front of the press. In case of a blank being larger than that of the received gauge, a safety spring is attached to the second horizontal arm, already mentioned, having its centre of motion on the vertical spindle, by which the error is detected without doing any injury to the machinery. By this press 60 double impressions are thrown off in a minute.

ORNAMENTAL IRONWORK DOME. BY THE COALBROOKDALE COMPANY, PALE COMPANY.

One of the most pretentious works in the Building in this Exhibition is without remarkably pretty detailing. The ceiling supports the reputation of the founders; but there are many and grave objections to the design, which is not so happy; the upper part is too relieved than the lower, which least requires spirit, and the capitals and vase are very bad. In the midst is a cast of J. Bull's "Eagle-Hooper." The eagle



THE IRON DOME EXHIBITED BY THE COALBROOKDALE COMPANY.—GROUP LISTENING TO ONE OF MESSRS. COLLARD'S PIANOFORTES.

transfixed by an arrow at the top (which must be considered an absurdly inexcusable error of bad taste.

The pianoforte in the Crystal Palace, more particularly the instruments placed in the West, contains in its construction one of the most attractive features of the Exhibition, and with their brilliant and novel sounds, fairly rivals the admiration of the father portion of the visitors. On the more fashionable days, crowds of aristocrats and aristocratic ladies may be found lingering around and within the east-end dome of the Coalbrookdale Company, listening to the tones of Collard's splendid grand pianoforte, which has here found a resting-place, the tasteful decorations of the instrument—in the style of Louis XV.—richly carved and gilt, the beautiful figure of the mottled oak of which the case is formed, contrasting strangely but most effectively with the more sober hues of the house containing it, the dome.

On the occasion of our visit we had the pleasure of listening to the performance of Madame Louisa Tipping, a lady with whom name the public should be more generally acquainted. Her performance in the same instrument also exhibited her talents in the same instrument. Her performance forms a most agreeable interlude, while they invite a brief repose from their fatigues, they, at the same time, afford them a rich and unexpensive treat.

GLASS WARE. BY POWELL.

The engraving on page 190 illustrates some of the specimens of glass ware manufactured by James Powell and Sons, of the Whitefriars Glass Works, London, viz. a large glass stand, with four glass burners, suitable for a jaded table, designed by Mr. Archibald Colquhoun, and a dessert service, designed by the same gentleman. Some of these articles can send from Wrenham Lake District, remarkable for its transparent brilliancy. At the same time is a specimen vase of celadon glass, produced by the oxide of uranium, first applied by Messrs. Powell in the coloring of glass many years ago, at which period it was sold at high as a guinea per ounce; but, from its having been long in general use, may now be purchased at a much less price per pound. Patent joints for glass tubing, applicable for conveyance of water, although when first, are also exhibited by the same manufacturer.

"SUSPENSION" BY VOISINIEU.

This is a pretty barrel-shaped prodigious in its hard construction, for the reception of flowers, and candles, which affords the means of decorating and lighting a room in a comparatively trifling cost.

FURNITURE. BY CLARK.

Our engraving (at page 190) represents two very rich and ambitious articles of furniture, by Clark, of Devonshire. The oblong centre-table is supported by a pillar composed of a group of three eagles in a row, highly chased, surrounded by oak leaves and acorns. The top is surmounted by a rich or mould moulding, and is divided into six compartments by branches in the same moulding, extending from the centre to the circumference. This, ornamented as it is, is the only joint which we object to in the table, deprecating as it does, its extension of surface. The intervals between the branches are filled with ball, highly ornamented. The work-table, which is in English walnut-tree wood, is supported upon elaborately-carved filigree standards, the top being inlaid with marquetry, on the upper and under surface. Altogether, this is an undeniably elegant piece of workmanship.

1.8 "The Iron Dome Exhibited by the Coalbrookdale Company," Illustrated London News, 9 August 1851, p. 193.