

Wolfgang Schivelbusch, *The railway journey: The industrialization of time and space in the 19th century* (1986), 50–56.

Excursion: The Space of Glass Architecture

The railroad reorganizes space. In architecture, a similar reorganization occurs with the introduction of glass and steel as new building materials. The railroad machine ensemble multiplies speed and capacity of traffic; steel and glass multiply the capacity of roofed structures. Both the railroad and the glass buildings are direct expressions of the multiplied productivity brought about by the industrial revolution. The railroad brings new quantities of goods into circulation; the edifices of glass architecture — railroad stations, market halls, exhibition palaces, arcades — serve as places of transit and storage. The spatial capacity of glass architecture stands in a similar relation to the capacity of traditional architecture as the railroad's capacity stands to that of preindustrial transportation. This is due to the greater strength and resistance to stress

characteristic of steel, the necessary complement to glass, compared to the previously utilized building materials. According to Alfred Gotthold Meyer, steel, in terms of stress resistance, is forty times as strong as stone, ten times as strong as wood.¹ The combination of steel as the carrier and glass as the filler leads to a reappraisal of all previously recognized architectural principles; Meyer expresses it as follows:

1) *The reappraisal of strength and mass.* By means of mathematical calculation, it is possible to determine the statistically possible minimum of material required for a given structure, using a material that has hitherto unheard-of powers of resistance. The opposing forces are rationally divided into vectors of push and pull and then dealt with by appropriately formed cross sections. The result is strength without mass.

2) *The reappraisal of spatial boundaries.* The wall masses shrink to thin boundary surfaces. The contained space no longer functions in terms of walls and vaults: it stands on its own, and does so inside as well as outside, without intermediaries.

3) *The reappraisal of light and shadow.* New purposes demand maximal interior light: thus we get the glass roof, and with it, a diffuse light without contrast, lacking plastic definition of form, but also lacking painterly indefiniteness.

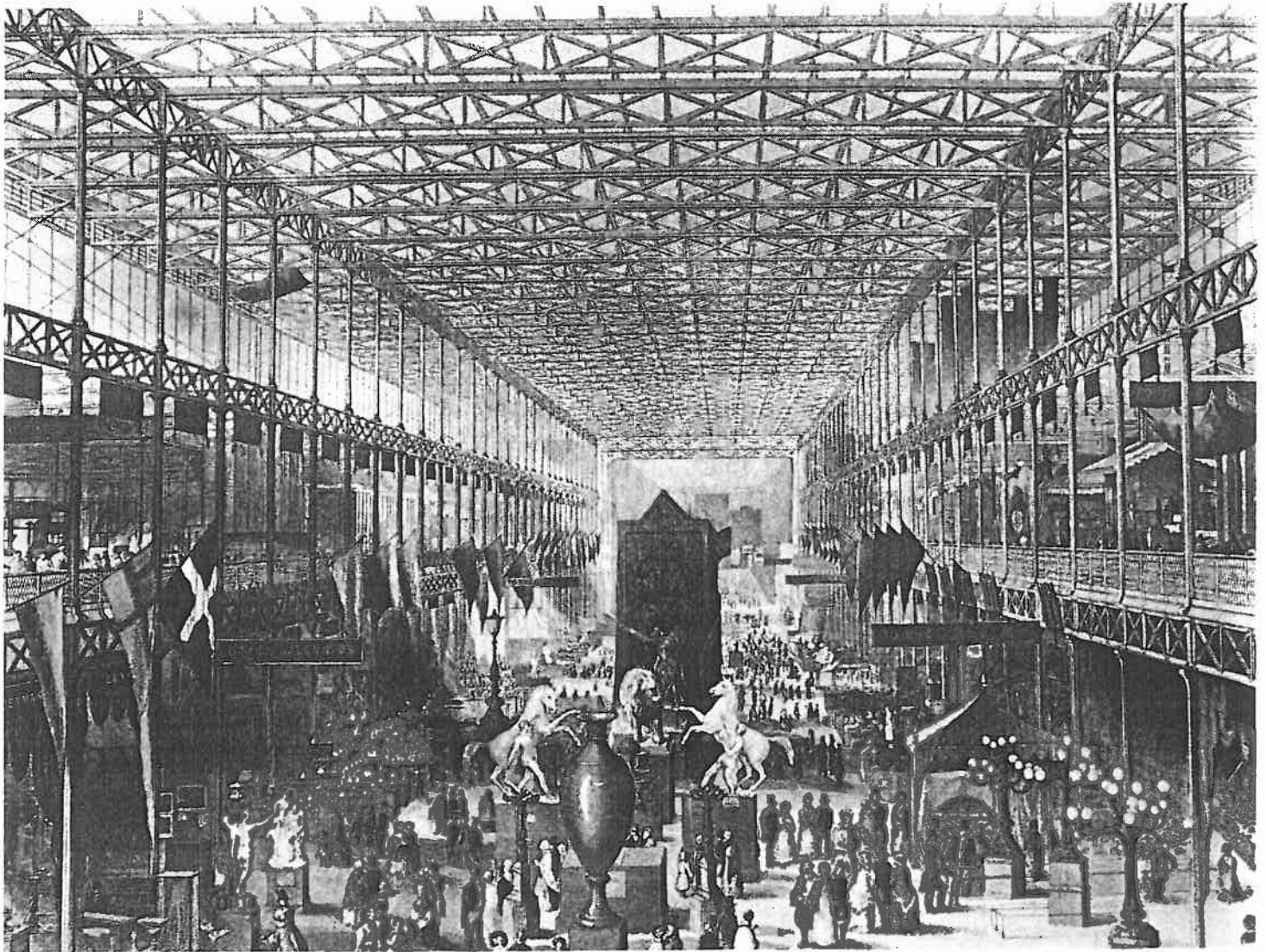
4) To greater extent than with other building materials, the effective form of glass and steel architecture is based primarily on the structure itself, with its ubiquitous logical pattern of girders: The essential thing is now *the line*, not the self-contained mass.² (Italics in original.)

To sum up: it is the very nature of glass architecture that puts an end to traditional architecture and its inevitable contrasts of light and shadow. As Meyer says, glass architecture creates a "light-space." "The striving for lightness," he writes, "is one of the main motivating forces in the developmental history of interior space. In the walls erected by stone or wood architecture, it could express itself only by breaking through the surfaces, in order to provide light for the interior; there was a conflict between light and shadow, between light and dark. It is, primarily, that contrast that gives us our sense of interior space and that gives a building its character, inside as well as outside."³

The Crystal Palace, erected for the World Exhibition in London in 1851, was the first true large-scale realization of glass and steel architecture; it caused perceptual shocks similar to those experienced by the first railway travelers. "The enormous areas of glass introduced into the vaulting," Giedion says, describing contemporary reaction, "almost blinded contemporary spectators, who were unaccustomed to the amount of light that was admitted."⁴

In his report on the 1851 World Exhibition, Lothar Bucher — an emigré after the German Revolution of 1848, and later a collaborator of Bismarck — gives a vivid picture of the dazzling effect of ferrovitreous architecture on the customary patterns of light and shadow perception:

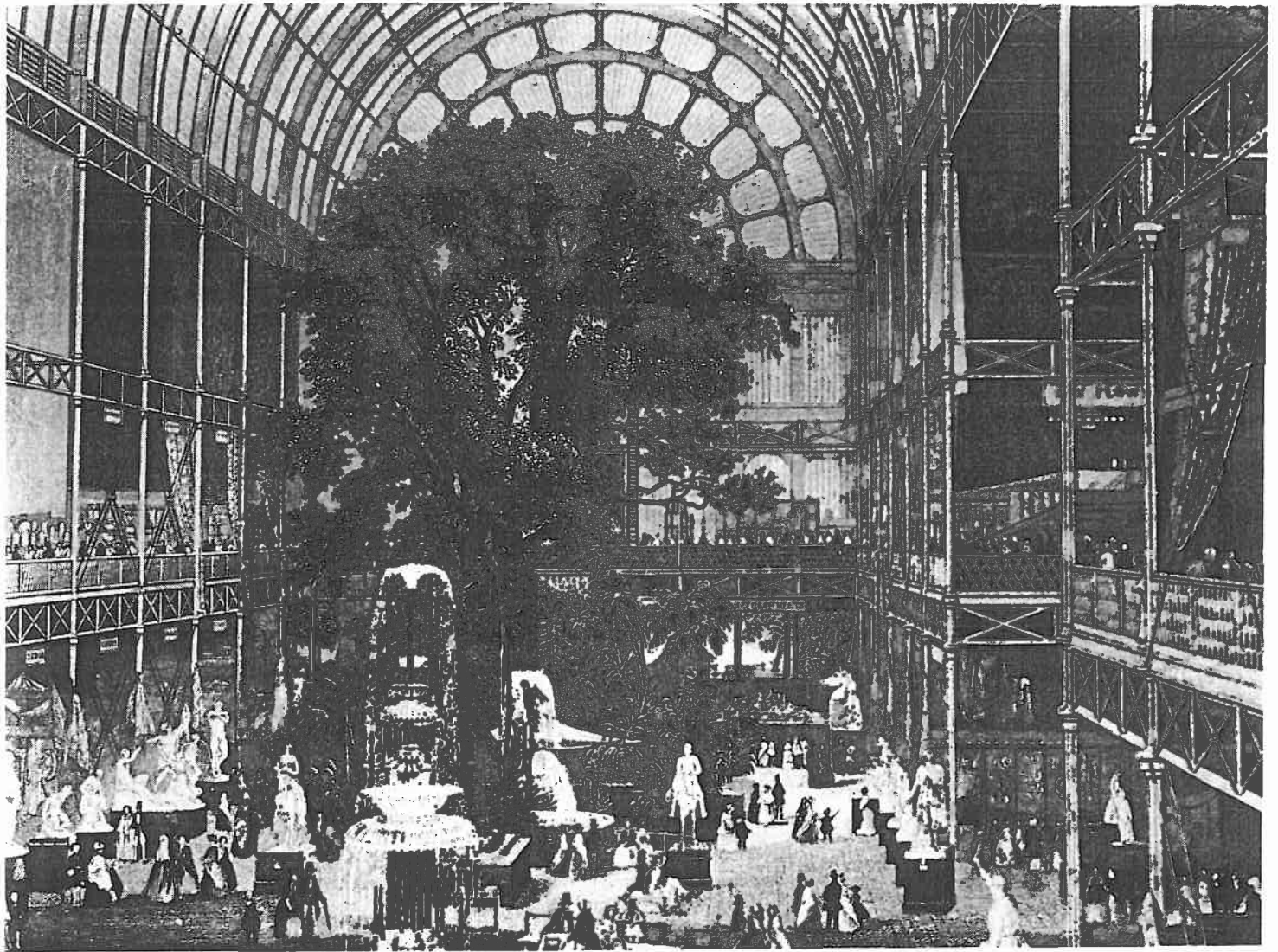
We see a fine network of symmetrical lines that does not, however, provide any clues whereby one could estimate its distance from the eye or the actual size of the mesh. The side walls stand too far apart to be taken in at a



*Space in Glass
Architecture: The Crystal
Palace, 1851.*

The shock in perception created by the interior space is analogous to the perception shock of a railroad trip. From a contemporary description of the Crystal Palace: "We see a delicate network of lines without any clue by means of which we might judge their distance from the eye or the real size. The side walls are too far apart to be embraced in a single glance. Instead of moving from the wall at one end to that at the other, the eye seeps along an unending perspective which fades into the horizon..." (L. Bucher).
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glance, and instead of meeting a facing wall, the eye moves upward over an endless perspective, or one whose end appears diffuse and blue. We do not know whether that mesh hovers a hundred or a thousand feet above us, or whether the ceiling is flat or formed by a number of small parallel ceilings; this is due to the total absence of shadows, which normally aid the psyche in comprehending the impression received by the optical nerve. If we let our gaze slowly move downward again, it encounters the filigreed girders, painted blue, far apart from each other at first, then moving ever closer, then superimposed on each other, then interrupted by a shining band of light, and finally dissolving in a remote background in which everything corporeal, even the lines themselves, disappears and only the color remains. Looking at the side walls, we orient ourselves, by seeking out, from among the profusion of carpets, tapestries, animal skins, mirrors, and a thousand other draperies, a single uncovered pillar — so slender that it does not seem to be able to hold up any weight, but is there only to satisfy the eye's need to recognize a support; we can estimate its height by comparing it to some person passing by, and by observing a second and a third one above it.⁵



The impression of glass architecture can be summed up in one word: evanescence. The uniform quality of the light and the absence of light-shadow contrasts disorient perceptual faculties used to those contrasts, just as the railroad's increased speed disorients the traditional perception of space. The motion of the railway, proceeding uniformly and in a straight line, is experienced as abstract, *pure* motion, dissociated from the space in which it occurs. Analogously, the space of ferrovitreous architecture appears as pure abstract light-space, dissociated from all customary architectural form, a space without qualities and contrasts. Richard Lucae describes the space of the Crystal Palace as an "artificially created environment" that "no longer is a space," and continues with an elegant simile: "As in a crystal, there no longer is any true interior or exterior. We have been separated from nature, but we hardly feel it. The barrier erected between us and the landscape is almost ethereal. If we imagine that air can be poured like a liquid, then it has, here, achieved a solid form, after the removal of the mold into which it was poured. We find ourselves within a cut-out segment of atmosphere. . . . It is, in my opinion, extraordinarily difficult to arrive at a clear perception of the effect of form and scale in this incorporeal space."⁶

World Exhibition Pavilions — Hot-Houses of 19th Century Industry.

Here the Crystal Palace is manifestly reminiscent of a hot-house: a fully-grown tree found on the construction site has been incorporated into the enclosed space. In addition, an abundance of decorative plants, mostly palm trees, are interspersed with the actual exhibits. The total impression is one of a space which harmoniously combines palm trees, industrial products, machinery, etc.: Industry as a gigantic hot-house.

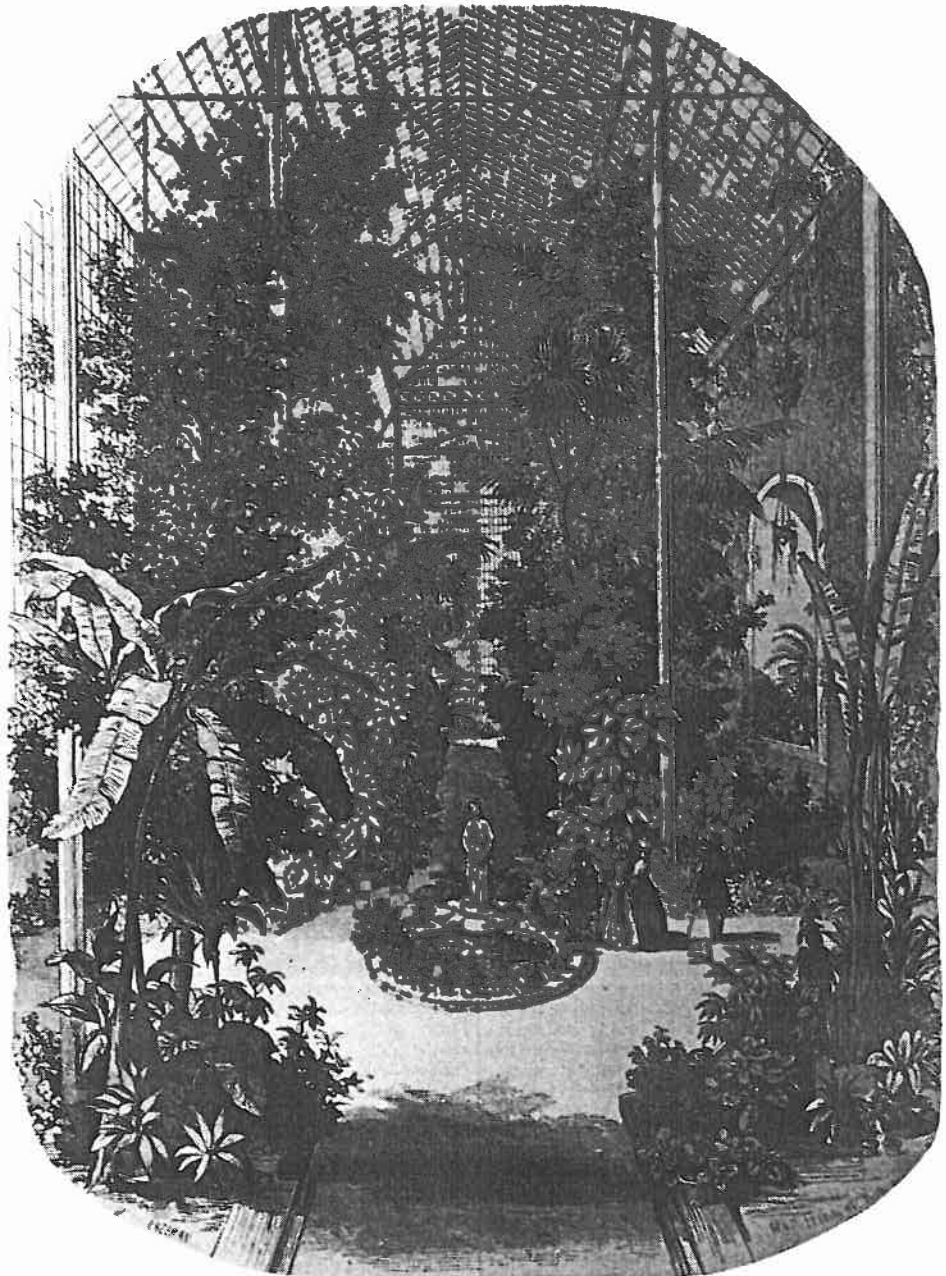
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Glass Architecture and Exotic Plants: Jardin des Plantes, Paris, 1840's.

19th Century glass architecture originated from garden architecture.

Joseph Paxton, the architect of the Crystal Palace in London, had been a garden architect; the Crystal Palace itself is a gigantic version of the hot house which Paxton built for the "Victoria Regis" waterlily.

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In dissociating light and atmosphere from the context of the natural overall atmosphere by means of "an almost ethereal" barrier, ferrovitreous architecture creates a novel condition. Light and atmosphere are now perceived as independent qualities, no longer subject to the rules of the natural world in which they had hitherto manifested themselves. This process is comparable to the experience of *pure* speed on the railroad, that is, speed perceived as an independent quality because it is divorced from the organic base of horsepower. (In the beginning of the twentieth century, the human voice is subjected to that same process of dissociation from its natural habitat, its natural condition, by the microphone and the radio.)*

*I owe this realization to Hans-Thies Lehmann who applies the thought successfully in his analysis of Bertolt Brecht's early poetry.

Considering the newly gained independence of light from nature and the dissolution of corporeality that characterize Bucher's and Lucae's perceptions of the Crystal Palace, one might call their descriptions "Impressionist." Max Raphael's definition of the Impressionists' method of painting corresponds, in detail, to their perceptions of the inner space of the Crystal Palace: "a dissolution of the object, in its closed form as well as in its inherent significance within the atmosphere; a cancellation of the material concepts, e.g., the local color, the line of three-dimensional form, in favor of a relationship with light; an emphasis on appearance that simultaneously removes it into distance; the removal of space from the realm of visual representation."⁷ Siegfried Giedion⁸ understands the effect of the Crystal Palace on its contemporaries as objectively Impressionist in intention, and makes a connection between Turner's painterly objectives and those of the architect of the Crystal Palace; that seems far-fetched, but it does seem justifiable to view Impressionism as a codification of a certain nineteenth-century perception of an evanescence whose most powerful material manifestations are the railroad and ferrovitreous architecture.⁹

This digression on the novel spatiality of that architecture would not be complete without a reference to the developments that led to its demise. The Crystal Palace is the culmination and termination of ferrovitreous architectural functionalism: it is followed, in the latter half of the century, by restorative developments. Ferrovitreous methods of construction are relegated to tasks of roofing and dome-building. Builders revert to the erection of massive and pompous stone fronts: these cover up the ferrovitreous constructions which cannot yet be abandoned entirely, due to the lighting requirements of large interior spaces.

By the turn of the century, as it becomes possible to generate inexpensive artificial electric light by industrial means, ferrovitreous architecture becomes redundant. The need for large structures for the display, storage, and merchandising of commodities remains, but the dependence on natural light disappears. The ferrous mode of construction, which remains necessary for the stability of large rooms and buildings, detaches itself from the vitreous aspect and takes the form of steel skeletons for edifices that are once again constructed in the traditional massive materials.

Artificial electric light as a mass phenomenon originates and achieves its most extended potential in the United States of Edison's day. It is another giant step in the direction of independence from nature. Although ferrovitreous architecture was an initial development in that same direction, it was still dependent upon and oriented toward nature, in that it attempted to maximize the use of natural light. The new, artificially lighted type of enclosed space requires the very opposite — the minimization of glass windows. No longer is daylight an exploitable raw material: now it is an uncertain factor that should be eliminated, as Matthew Luckiesh points out in his work *The Lighting Art*, published in 1917: "Natural light does not possess the potentiality that artificial light does because it is generally less readily controlled and adapted to the problems."¹⁰ Windows are not only sources of irregular, unreliable, and difficult-to-control natural light, they also present problems of expenditure. Luckiesh: "The cost of natural light for indoor illumination is considerable because of the floor and wall area that has to be sacrificed for window space; in

addition there are various minor factors which increase the cost of natural light indoors."¹¹

The solution that determines the future development of commercial building spaces is *artificial light*, i.e., the production of the same amount of light that filled the inner space of vitreous architecture *by technical means*. "In considering future applications of artificial daylight it is well to note that even when natural daylight is available *it cannot be brought into interiors without cost*. The construction of the daylight entrance is more expensive than ordinary roofing and blank walls."¹²

In less than a century, the problem of lighting undergoes two revolutionary transformations. In the first half of the nineteenth century, ferrovitreous architecture dissolves the elements of traditional architecture in order to gain natural light. This is followed, as a result of the development of artificial light, by a movement in the opposite direction, by a closing off of interior spaces *against* uncontrollable daylight, a tendency leading to the elimination of windows and glass buildings.¹³

This second turn did not have anything like the effect on contemporary consciousness and perception that the "light-space" of glass architecture had. It is not difficult to see why this was so: glass architecture dissolved the traditional forms because it had to fulfill a dual function — it was architecture as well as lighting technology. It was a technical and architectural surrogate for the artificial light that was not yet available. It prepared the way for artificial lighting by making the natural light appear artificial. (This process is comparable to the previously mentioned development of the water wheel which initially receives its regular water supply by means of a steam-powered water pump before it is replaced by the steam engine.)