



Das lange 19. Jahrhundert (1780–1914)

Teil I: 1780–1850

Stefan M. Holzer, ETH Zürich

Jahrhundert des Eisens:
Die Voraussetzungen



Französische Ofenplatte aus Gusseisen



Bauteile aus Schmiedeeisen, 18. Jh.

Gusseisen vs. Schmiedeeisen



Gusseisen:

- Hoher Kohlenstoffanteil
- Formgebung: direkter Guss in Sandform
- Materialeigenschaften: hart, spröde, hohe Druckfestigkeit (vgl. Stein)
- Ggf. nur einstufiger Herstellungsprozess (Roheisen = Gusseisen)



Schmiedeeisen („Stahl“):

- Niedriger Kohlenstoffanteil
- Formgebung: Umformen durch Schmieden
- Materialeigenschaften: zäh, Druck- und Zugfestigkeit gleich hoch (vgl. Holz)
- Zweistufiger Herstellungsprozess (Roheisen -> Schmiedeeisen)

Rot-
eisenstein
(Hämatit)
 Fe_2O_3



Brauneisen-
stein
(Limonit)
 $\text{Fe}(\text{O})\text{OH}$

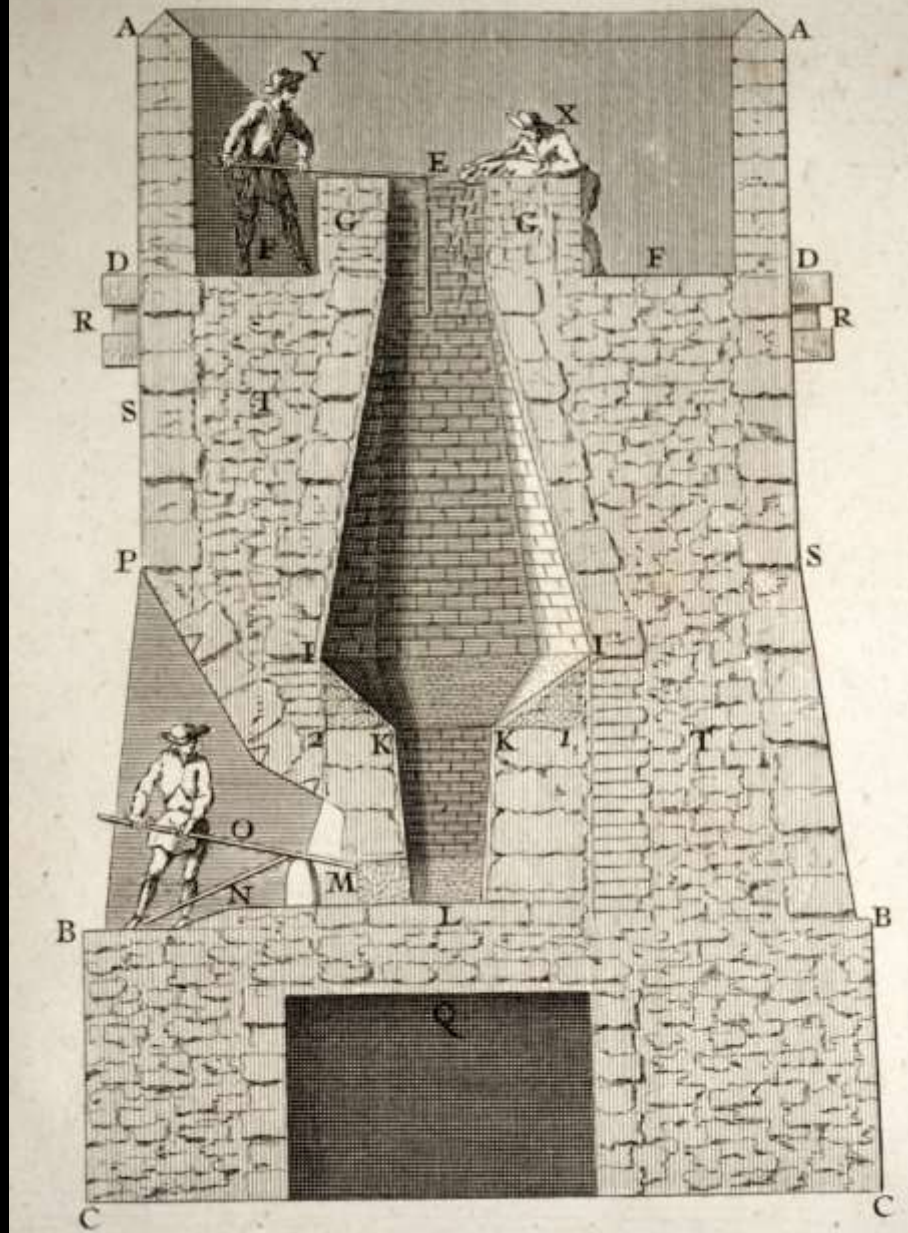


Spateisen-
stein
(Siderit)
 FeCO_3

Pyrit
 FeS_2



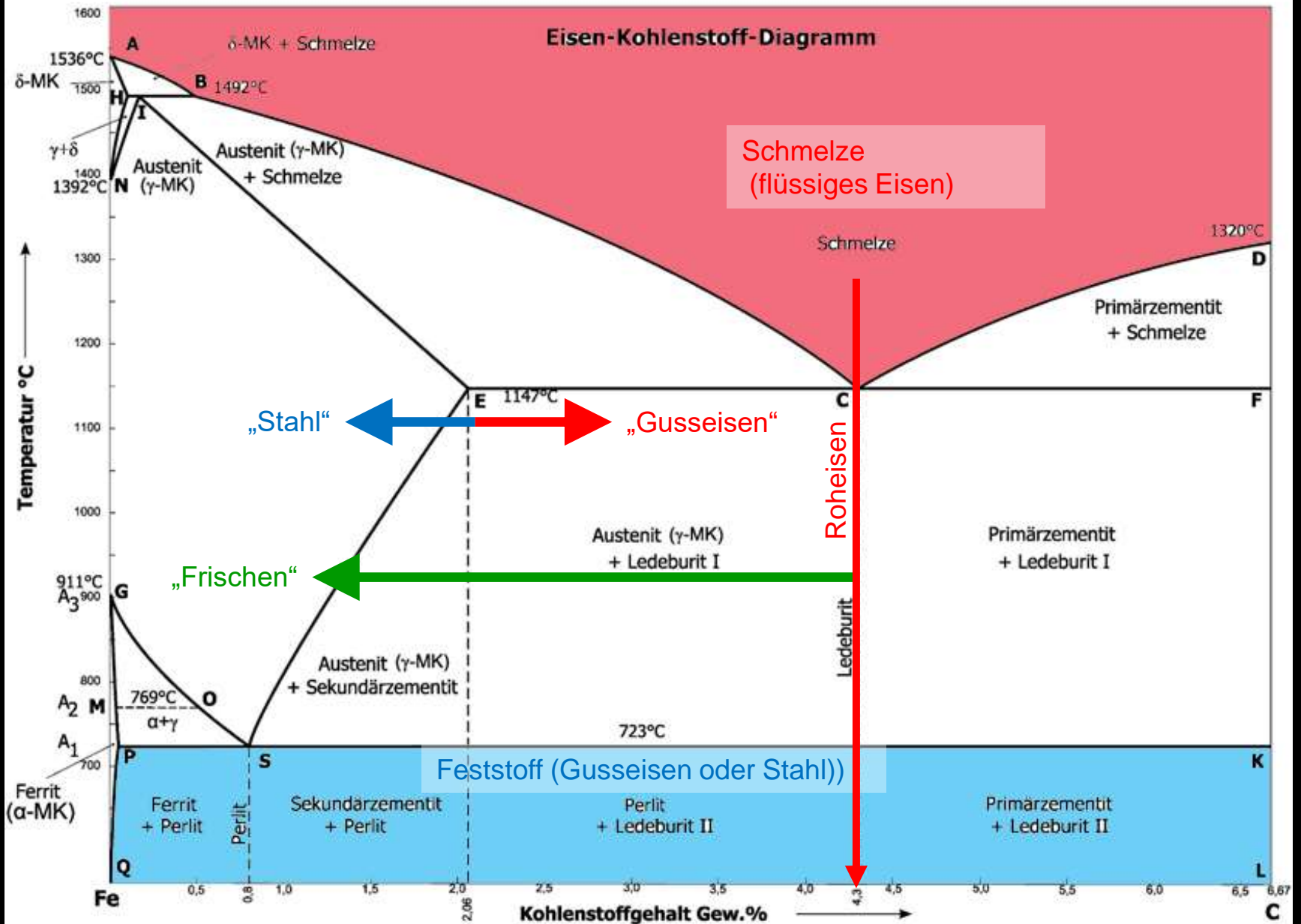
fig. 1.^{re}



Hochofen, Reduktion des Eisenoxids, ermöglicht Produktion von flüssigem Roheisen etwa ab 17. Jh. gebräuchlich (Courtivron/Bouchu 1762)



Herstellung von Holzkohle für die Eisenverhüttung in Meilern
(Duhamel du Monceau, *Art du Charbonnier*, 1770)



Eisen-Kohlenstoff-Diagramm und Herstellungsschritte



Direkter Guss von Roheisen aus dem Hochofen
(Encyclopédie 1765)

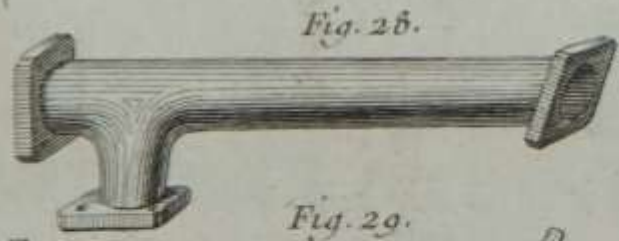


Fig. 28.



Fig. 29.



Fig. 30.

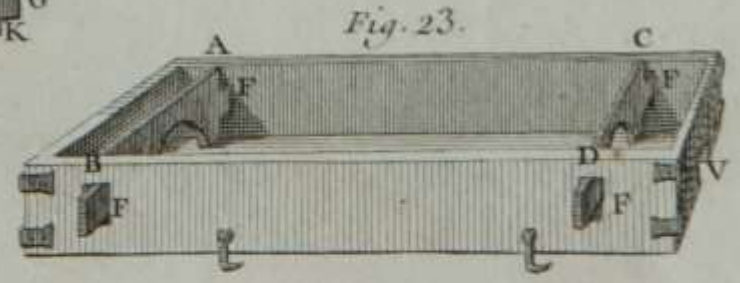


Fig. 23.

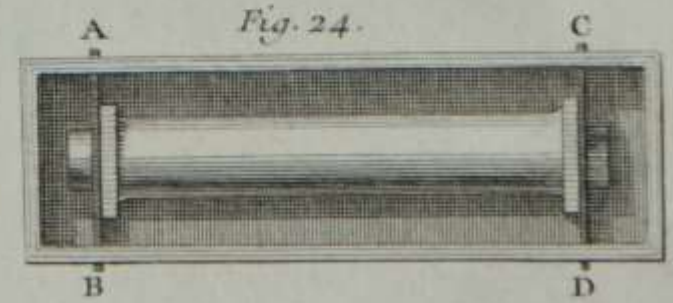
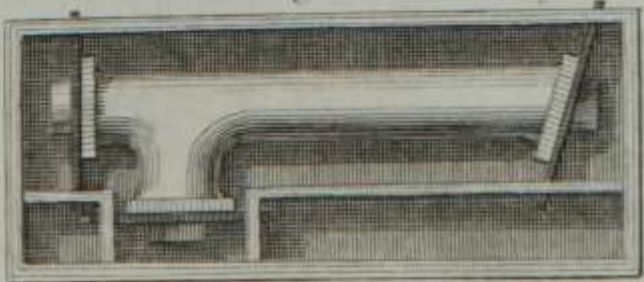


Fig. 24.

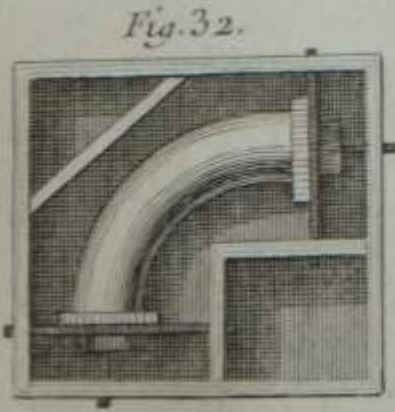


Fig. 32.

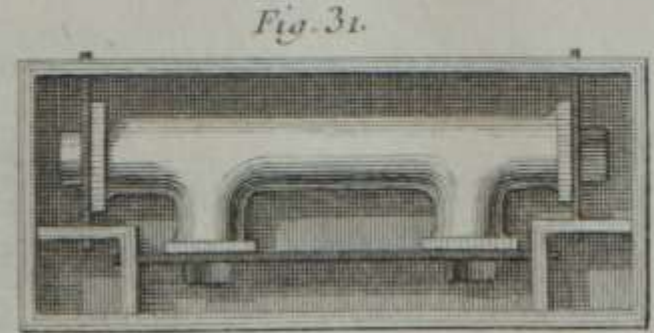


Fig. 31.



Fig. 26.

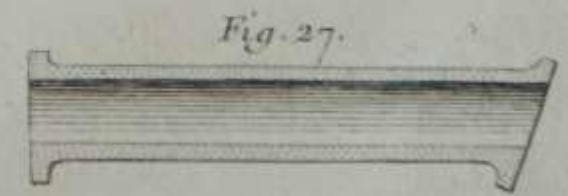
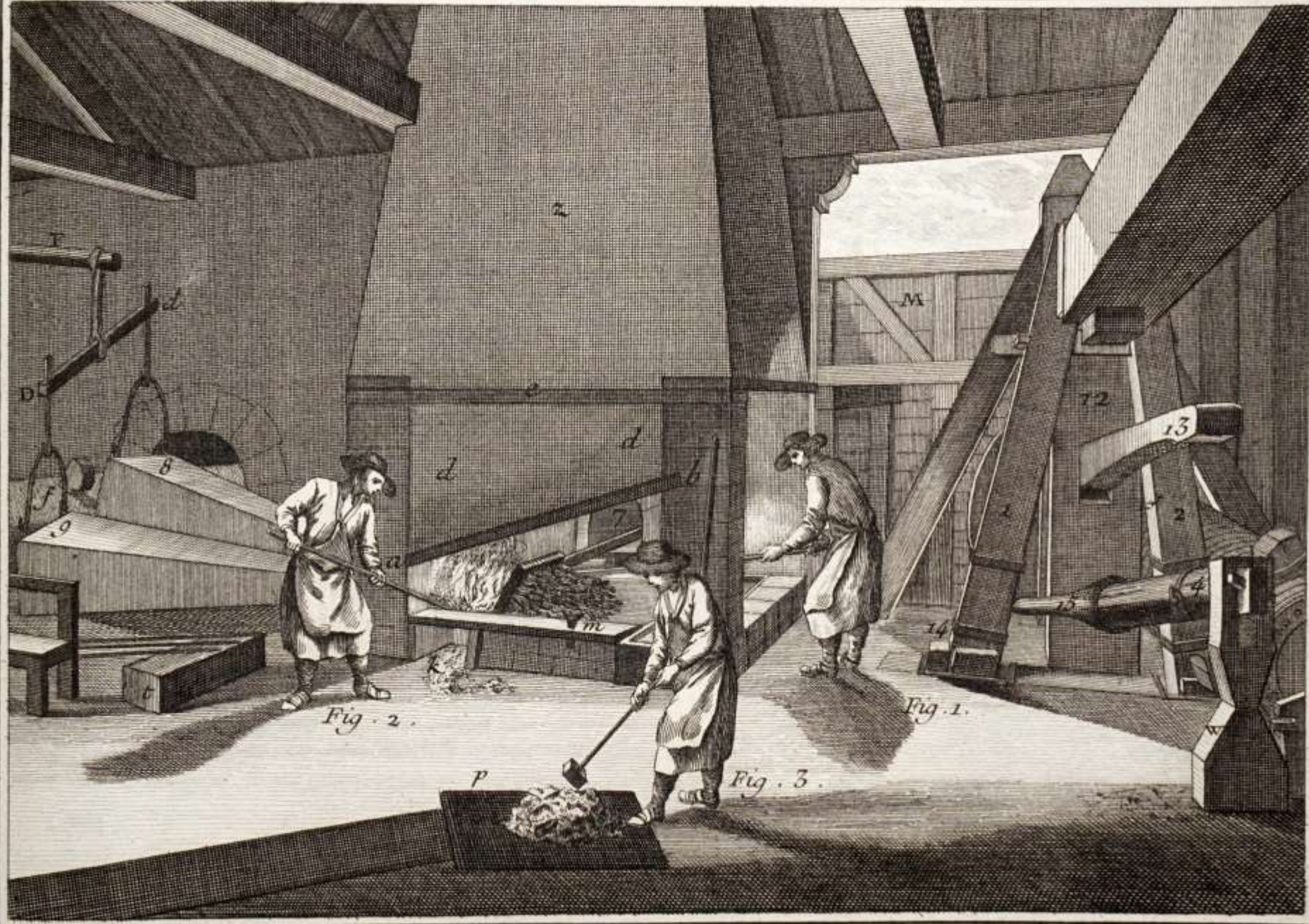


Fig. 27.

Typische Gusseisen-Produkte des 18. Jahrhunderts: Rohre (Courtivron/Bouchu 1762)



Frischherd des 18. Jahrhunderts: aus Roheisen wird schmiedbarer Stahl („Schmiedeeisen“)
(Encyclopédie 1765)



Typische Schmiedeeisenprodukte: Nägel des 15.-18. Jh.

Industrialisierung der Eisenproduktion

- 1705 Innovationsschritt Kohlenkoks statt Holzkohle
- 1784 Innovationsschritt „Puddeln“ statt Frischherd

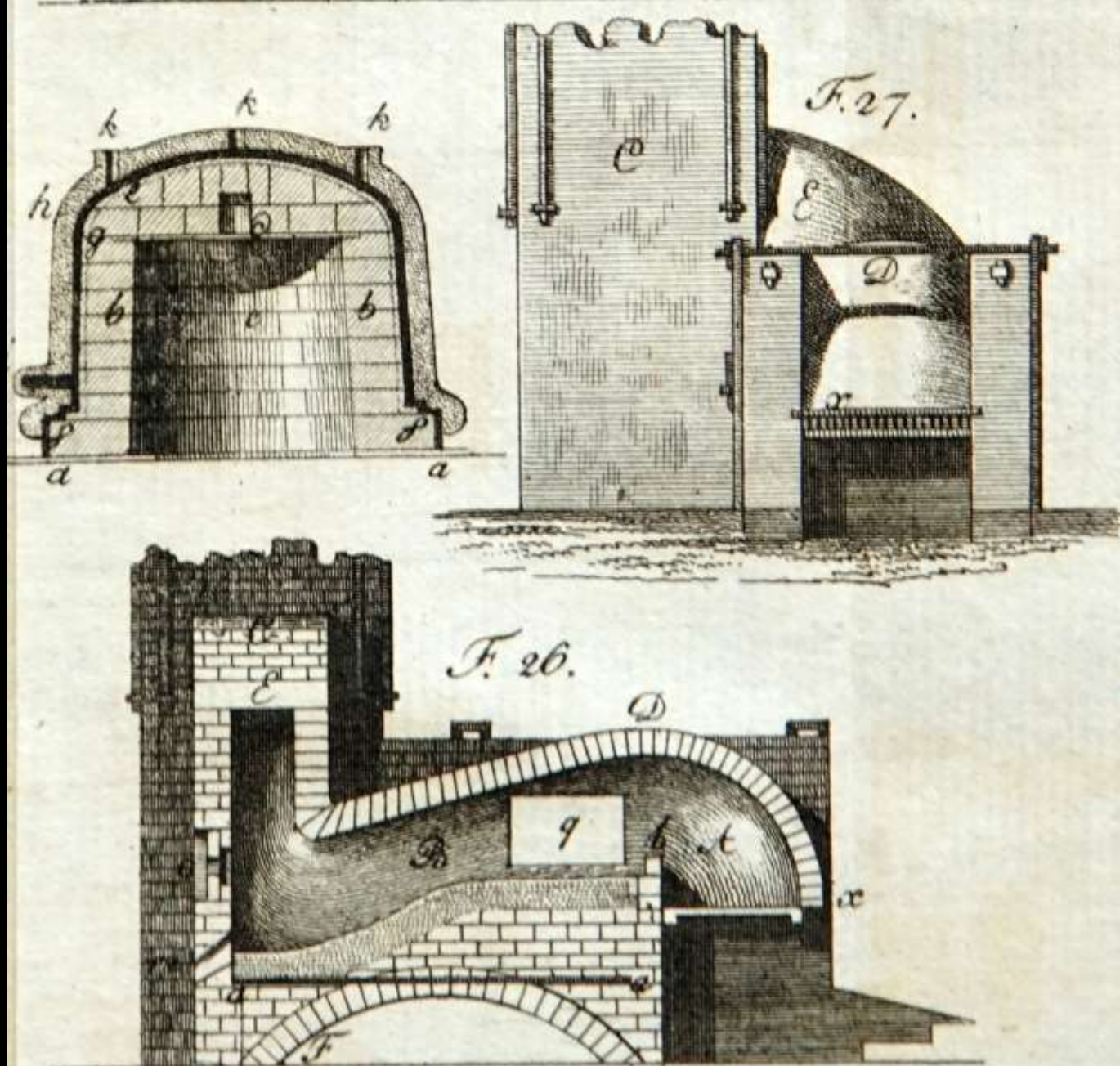


A VIEW of the Upper Works at Coalbrook-Dale, in the County of SALOP. T. Smith 1758 according to the Original.
Designed and Engraved by G. Perry and

Roheisenproduktion mit *Koks* im Hochofen (Abraham Darby I, ab 1705)
(Francis Vivares, A View of the Upper Works at Coalbrook-Dale, Kupferstich, 1758)



Coalbrookdale (Shropshire) um 1800, hier wird 1784 durch Henry Cort das „Puddeln“ erfunden
(Ph. J. Lutherbourg, *Coalbrookdale at Night*, 1801)



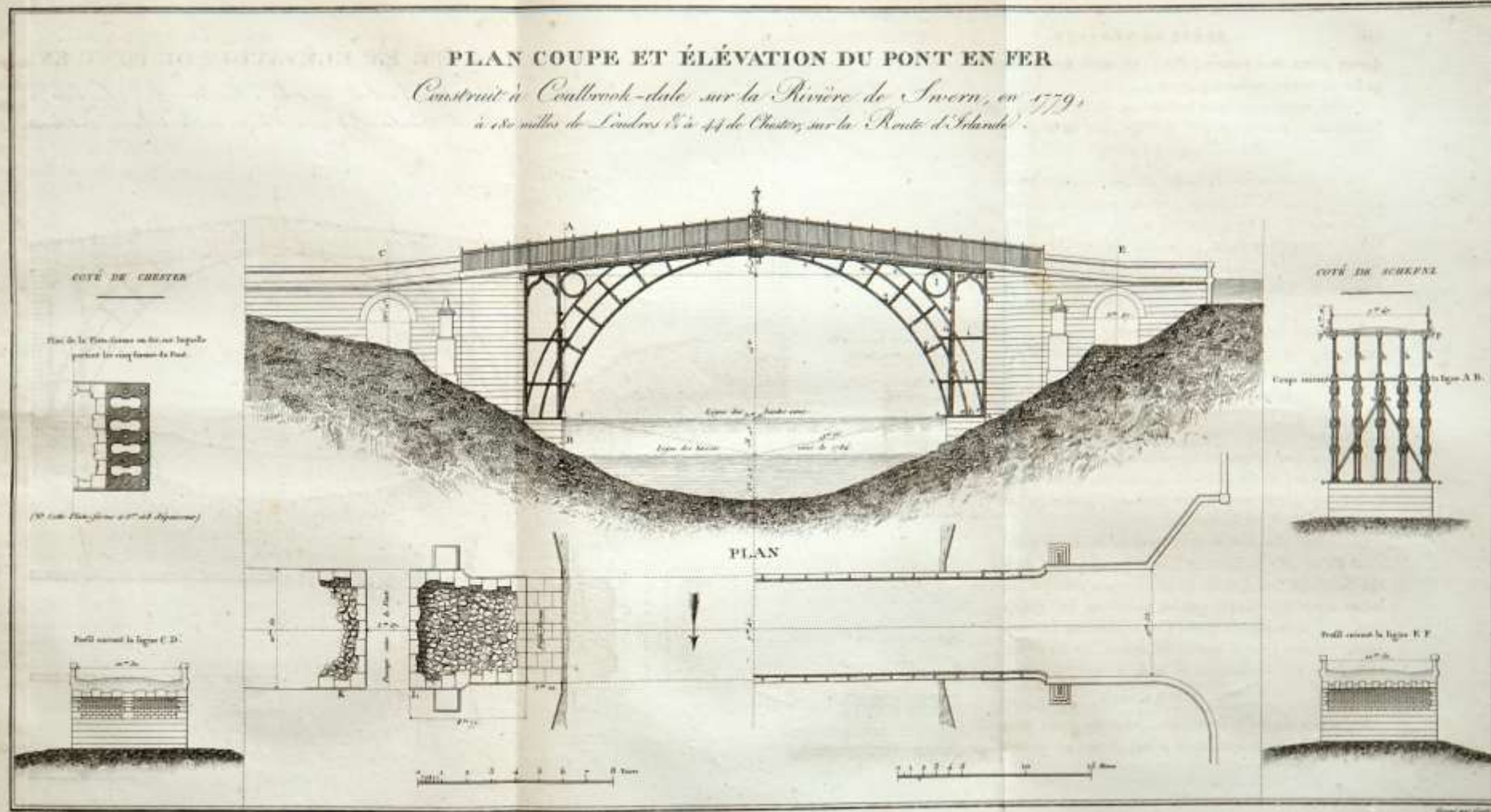
Puddlings-Flammofen: Frischen unter kontrollierten Bedingungen
(Karsten 1816)

England und die Folgen

Bauen mit Gusseisen: von der Bogenbrücke zur Industriehalle

PLAN COUPE ET ÉLÉVATION DU PONT EN FER

*Construit à Coalbrook-dale sur la Rivière de Severn, en 1779,
à 80 milles de Londres & à 44 de Chester, sur la Route d'Étandre.*

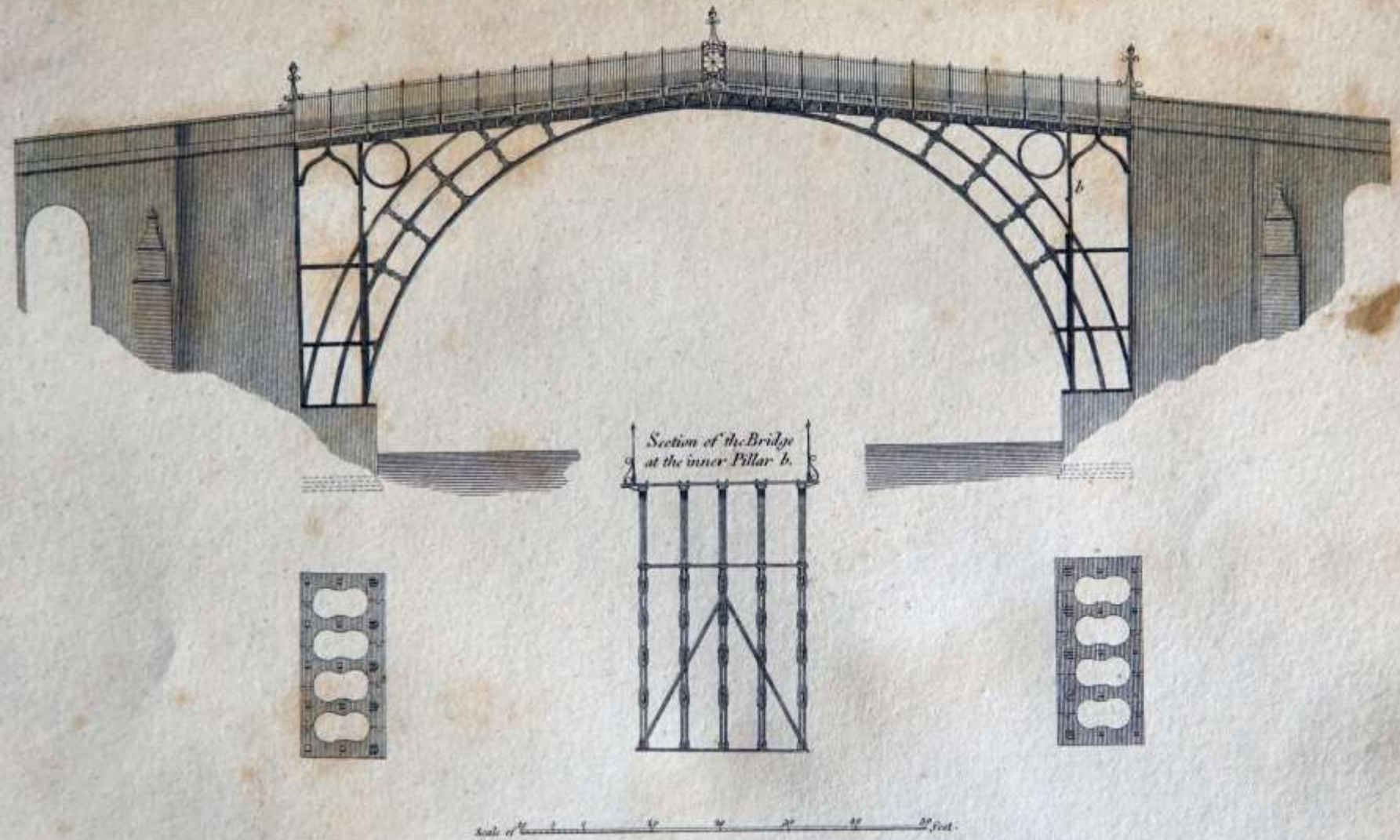


Abraham Darby III, Gusseisen-Brücke über den Severn in Coalbrookdale, 1779
(Lesage 1810)

BRIDGE.

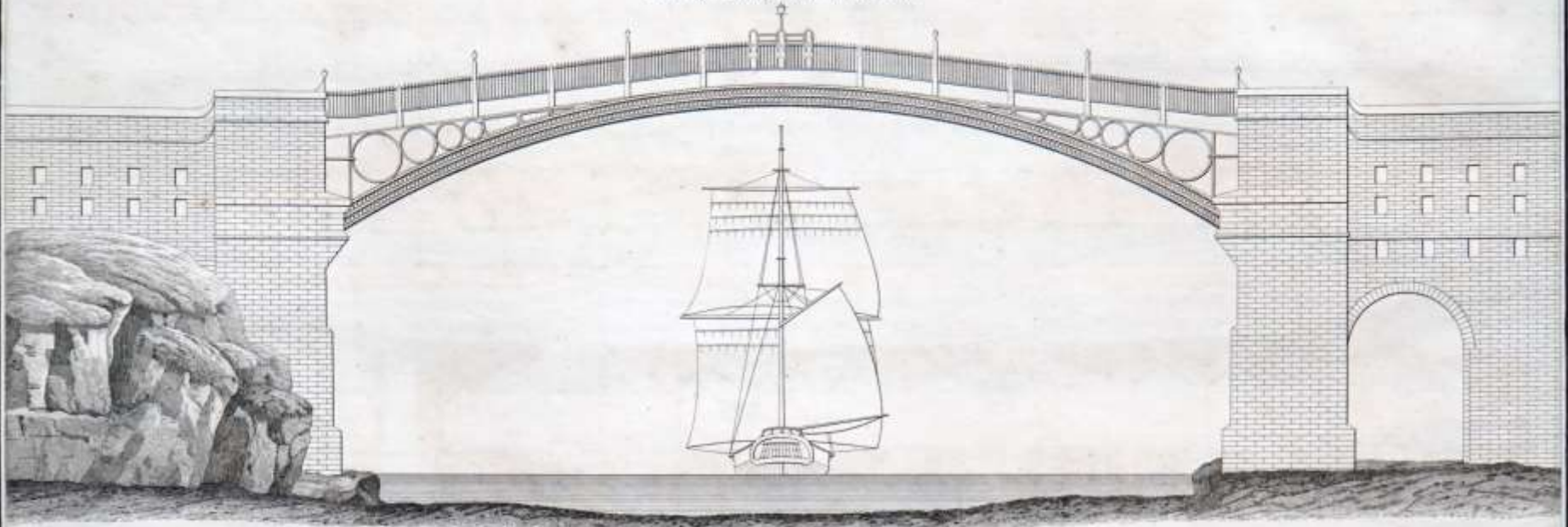
PLATE XCI.

PLAN ELEVATION and SECTION of the FIRST IRON BRIDGE built over the RIVER SEVERN near COALBROOK DALE in the COUNTY of SALOP.



Abraham Darby III, Gusseisen-Brücke über den Severn in Coalbrookdale, 1779
(Telford, Edinburgh Encyclopedia, 1835)

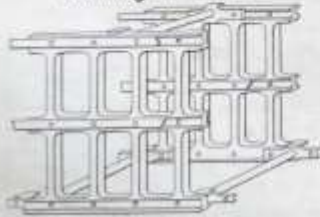
Pont de Sunderland sur le Wear.



Pont de Sunderland.
(Coupe à la Clef.)



Assemblage des Ferres.



Pont de Coalbrookdale.



Pont
de Coalbrookdale.



Elevation



Plan.

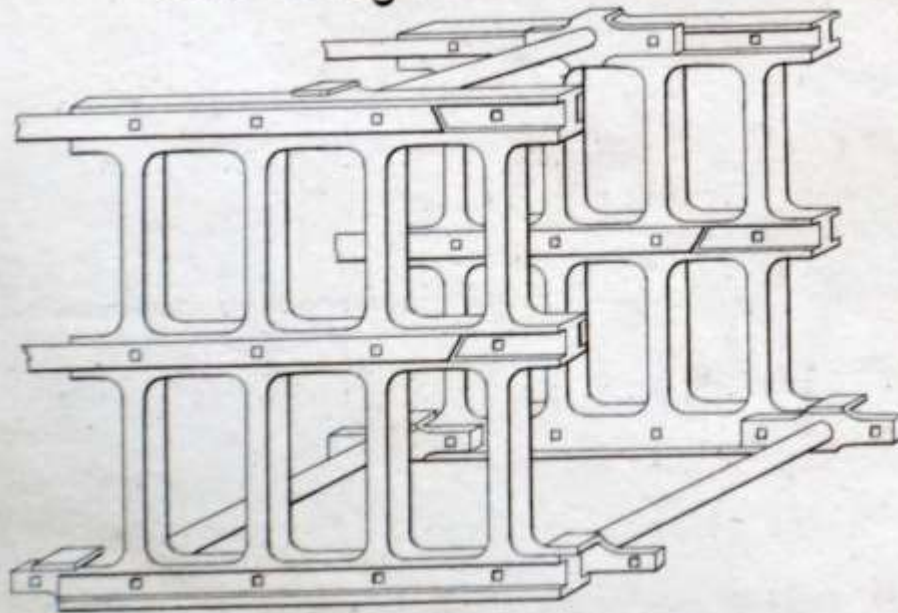
Sunderland, Gusseisen-Brücke über den Wearmouth (Thomas Paine, 1796)
(Dupin 1824)

Pont de Sunderland.

(Coupe à la Clef.)



Assemblage des Fermes.



Sunderland, Brücke über den Wearmouth (1796), Detail der Gusseisen-“Keilsteine“
(Dupin 1824)



Bath, Gusseisen-Brücke in den Sydney House Gardens (1800)



Bath, Gusseisen-Brücke in den Sydney House Gardens (1800)



Chepstow, Gusseisen-Brücke über den Wye (1816)



Chepstow, Gusseisen-Brücke über den Wye (1816)



Tewkesbury, Mythe Bridge über den Severn (Thomas Telford, 1826)



Tewkesbury, Mythe Bridge über den Severn (Thomas Telford, 1826)



Tewkesbury, Mythe Bridge über den Severn (Thomas Telford, 1826)



Giesshalle der Sayner Hütte bei Koblenz, Deutschland (1826-30)



Giesshalle der Sayner Hütte bei Koblenz, Deutschland (1826-30)



Giesshalle der Sayner Hütte bei Koblenz, Deutschland (1826-30)



Giesshalle der Sayner Hütte bei Koblenz, Deutschland (1826-30)



Giesshalle der Sayner Hütte bei Koblenz, Deutschland (1826-30)

A

PRACTICAL ESSAY

ON THE

STRENGTH OF CAST IRON,

INTENDED FOR THE ASSISTANCE OF

ENGINEERS, IRON MASTERS, ARCHITECTS, MILLWRIGHTS,
FOUNDERS, SMITHS, AND OTHERS ENGAGED IN THE
CONSTRUCTION OF MACHINES, BUILDINGS, &c.

CONTAINING

PRACTICAL RULES, TABLES, AND EXAMPLES;

ALSO AN ACCOUNT OF SOME

NEW EXPERIMENTS,

With an Extensive Table of the

PROPERTIES OF MATERIALS.

ILLUSTRATED BY FOUR ENGRAVINGS.

BY **THOMAS TREDGOLD,**

CIVIL ENGINEER;

MEMBER OF THE INSTITUTION OF CIVIL ENGINEERS;
AUTHOR OF ELEMENTARY PRINCIPLES OF CARPENTRY; THE
ARTICLE JOINERY IN THE SUPPLEMENT TO THE
ENCYCLOPEDIA BRITANNICA, &c.

—“ The same Truth, which is a Principle in science, becomes a
Rule in art.” *Playfair.*

Taf.

London:

PRINTED FOR J. TAYLOR,
AT THE ARCHITECTURAL LIBRARY, 59, HIGH HOLBORN.

1822.

MEMOIRS

OF THE

LITERARY

AND

PHILOSOPHICAL SOCIETY

OF

MANCHESTER.

Second Series.

VOLUME V.

London:

PRINTED FOR BALDWIN AND CRADOCK,

BY HENRY SMITH, 20, ST. ANNE'S-SQUARE, MANCHESTER.

1831.



THEORETICAL
AND
EXPERIMENTAL RESEARCHES

TO ASCERTAIN THE

STRENGTH AND BEST FORMS

OF

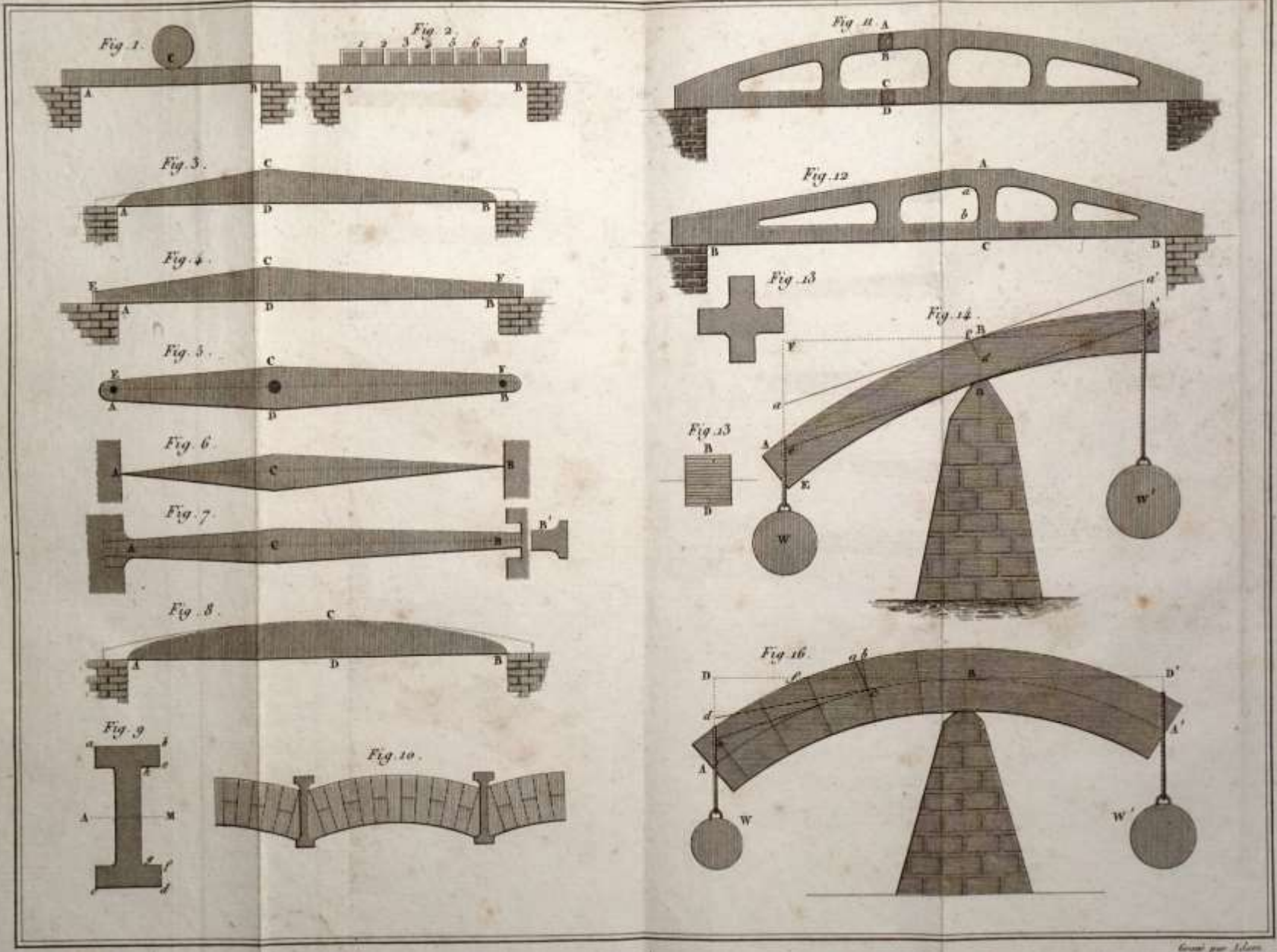
IRON BEAMS.

BY MR. EATON HODGKINSON.

(Read April 30th, 1833.)

THE very frequent use of iron beams for supporting the floors of factories, and of other places crowded with people, renders it extremely desirable that the best information should be obtained with respect to the strength of this material, in order to insure, without a great superfluity of metal, the requisite stability. In a case so deeply involving the loss of life, and where a failure would be attended with such serious consequences, hardly too much research can be applied. The scientific character of the subject also imparts to it additional

Grenzen des Gusseisens und die Suche nach der besten Form
(Tredgold 1822 und Hodgkinson 1831)



Günstige Formen gusseiserner biegebeanspruchter Träger (Tredgold 1822/26)

I. EXPERIMENT.

Beam with equal rib at top and bottom.
Dist. between supports, 4ft. 6ins. Depth of beam, 5½ins.

Dimensions of cross section, at place of fracture, in inches and parts.

Area of top rib = $1.75 \times .42 = .735$
Area of bottom rib = $1.77 \times .39 = .690$
Thickness of vertical part, between the ribs, } = .29.



Area of above section = 2.82 inches.

Weight of Casting = 36½ lbs.

Breaking weight 6678lbs. = 59 cwt. 70 lbs.



The form of fracture is represented by the line bnr , where $tr = .6$, and $bn = 2.5$, the figure being a side view of the beam.

To find the strength per inch of cross section, we have, dividing the breaking weight by the area, $\frac{6678}{2.82} = 2368$ lbs. per inch. This quantity in each

* All the sections in these experiments are laid down of 1 their real lineal dimensions in order to afford ocular comparison.

Breaking weight = 7368lbs. = 65 Cwt. 88lbs.
It broke obliquely about 4 inches from the middle, the top inclining to it.

The form of fracture at the top of the beam was nearly the same as in Experiment 1; here $tr = .55$ inches: see second figure to that experiment.

To find the strength per inch of section, as in the last experiment, we have $\frac{7368}{2.87} = 2567$ lbs. per inch.

Comparing this as above with the result of experiment 4, gives $2584 - 2567 = 17 =$ defect.
∴ Loss in strength = $\frac{17}{2584} = .0066$ or $\frac{1}{152}$.

III. EXPERIMENT.*

Beam with top to bottom rib as 1 to 4.
Dist. between supports, 4ft. 6ins. Depth of beam, 5½ins.

Dimensions of cross section in inches.

Area of top rib = $1.07 \times .30 = .32$
Area of bottom rib = $2.1 \times .57 = 1.2$
Thickness of } = .32.
vertical part. }

Area of cross section = 3.02.

Weight of casting = 40 lbs.



* At the preceding experiments and at several of the latter ones, Mr. John Kennedy was present, as well as Mr. Ewart who attended them generally.

The beam twisted a little before breaking: this however was not usually the case in the other beams from the same model.

Form of fracture as in figure, $tr = .75$.



Hence strength per inch of section = $\frac{6970}{3.2} = 2584$ lbs.

V. EXPERIMENT.

This casting had its top rib a parabolic arch and the top and bottom ribs nearly equal in section, with equidistant ordinates only between them.

Dist. between supports and depth of beam as before.

Dimensions of ribs in inches.

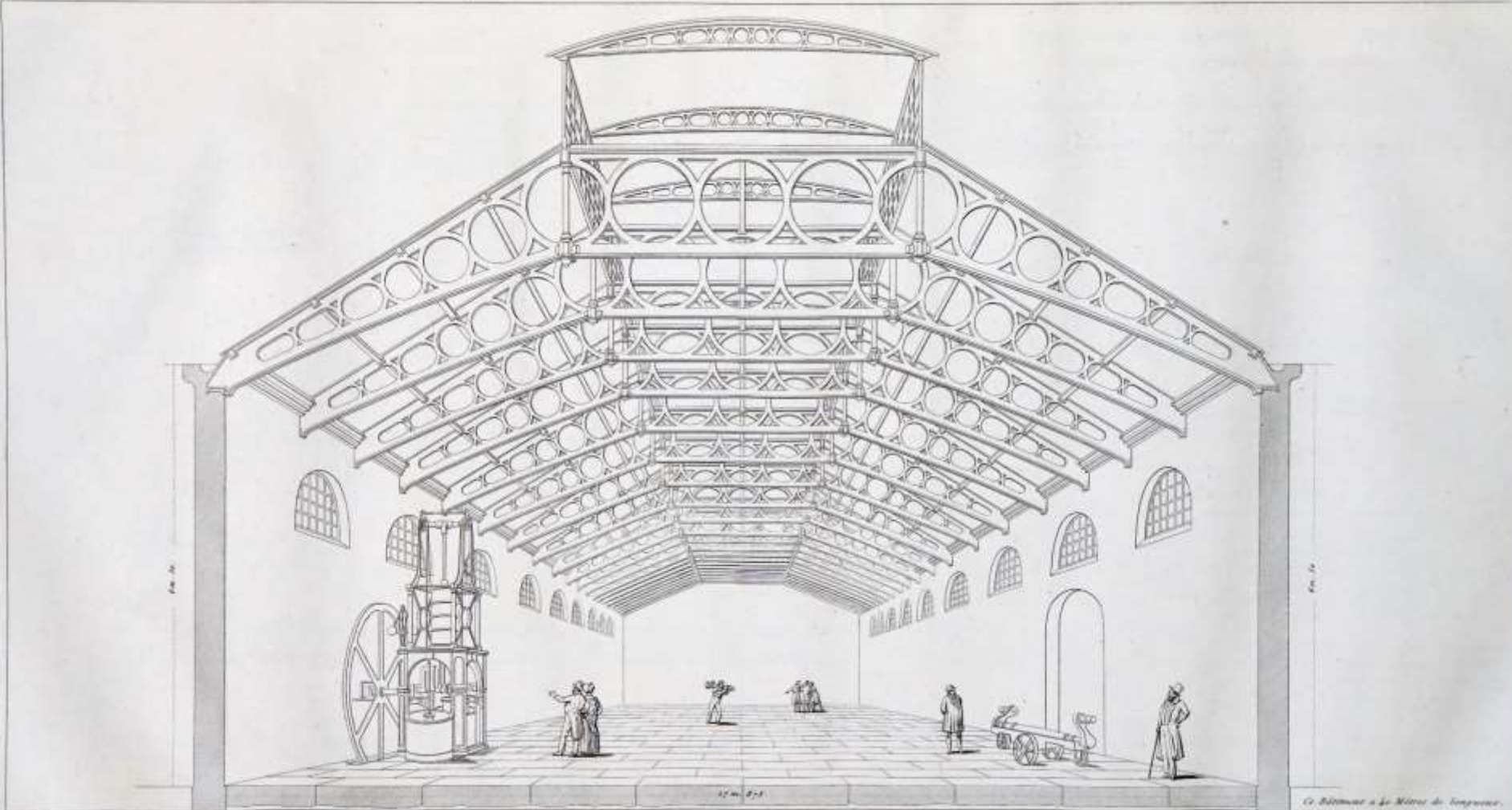
Area of top rib = $2.2 \times .56 = 1.23$
Area of bottom rib = $2.2 \times .53 = 1.17$.

Weight of casting = 41½ lbs.

Breaking weight = 5528lbs. or less: see next expt. This weight however is but $\frac{2}{3}$ of what was borne by the common beam in the last experiment.



It broke by separating, near the first ordinate,



Pl. 29. Eck. Architect.

La Charpente de ce Comble est en fonte de fer.

Ce Bâtimens a 40 Mètres de longueur.

M. Eck.

Fabrikhalle von Henry Maudslay mit Gusseisendach, um 1825 (Eck 1836)

Fazit Gusseisen

- Wegen der Materialeigenschaften Anlehnung an Steinkonstruktion (Bogentragwerke)
 - Keine echte Revolution des Bauwesens

Kontinent

Klassizismus nach altgriechischem Vorbild



Arc-et-Senans, Saline de Chaux (Claude Nicolas Ledoux, 1775–79)

Klassizismus – vom römischen zum griechischen Vorbild



Paris, Rotonde de la Villette (Claude-Nicolas Ledoux, 1785)

Klassizismus – vom römischen zum griechischen Vorbild



Paris, Saint-Denis-du-Saint-Sacrément (Hippolyte Godde, 1826–35)

Klassizismus – vom römischen zum griechischen Vorbild



Berlin, Altes Museum (Karl Friedrich Schinkel, 1822–23)

Klassizismus – vom römischen zum griechischen Vorbild



München, Glyptothek am Königsplatz (Leo v. Klenze, 1816–30)

Klassizismus – vom römischen zum griechischen Vorbild

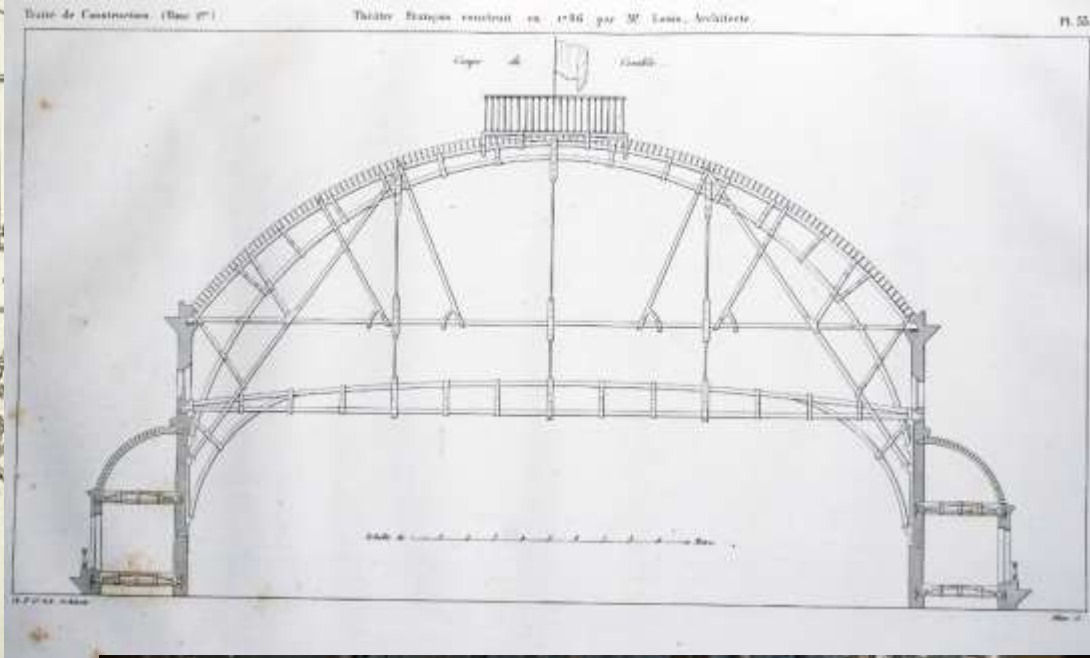
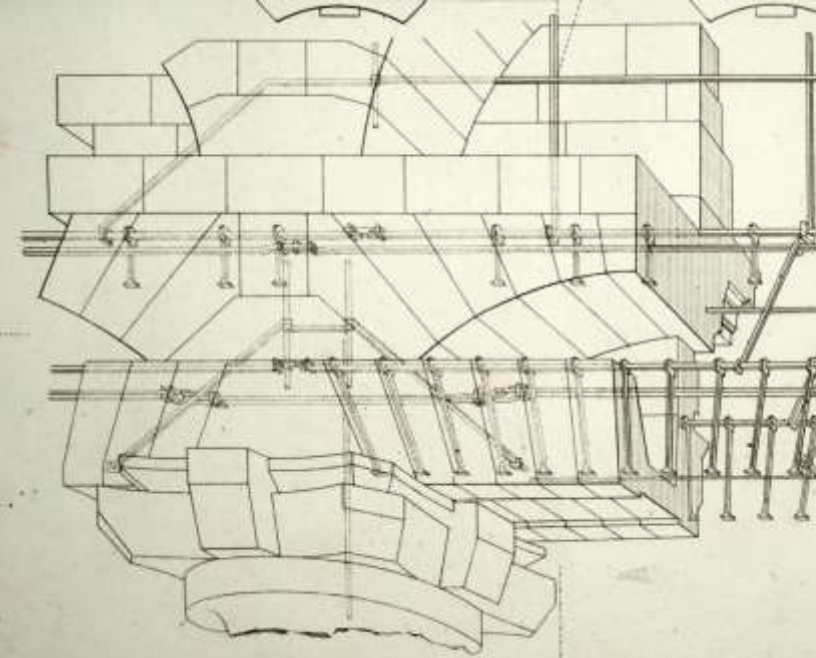


München, Propyläen am Königsplatz (Leo v. Klenze, 1846–62)

Klassizismus – vom römischen zum griechischen Vorbild

Kontinent

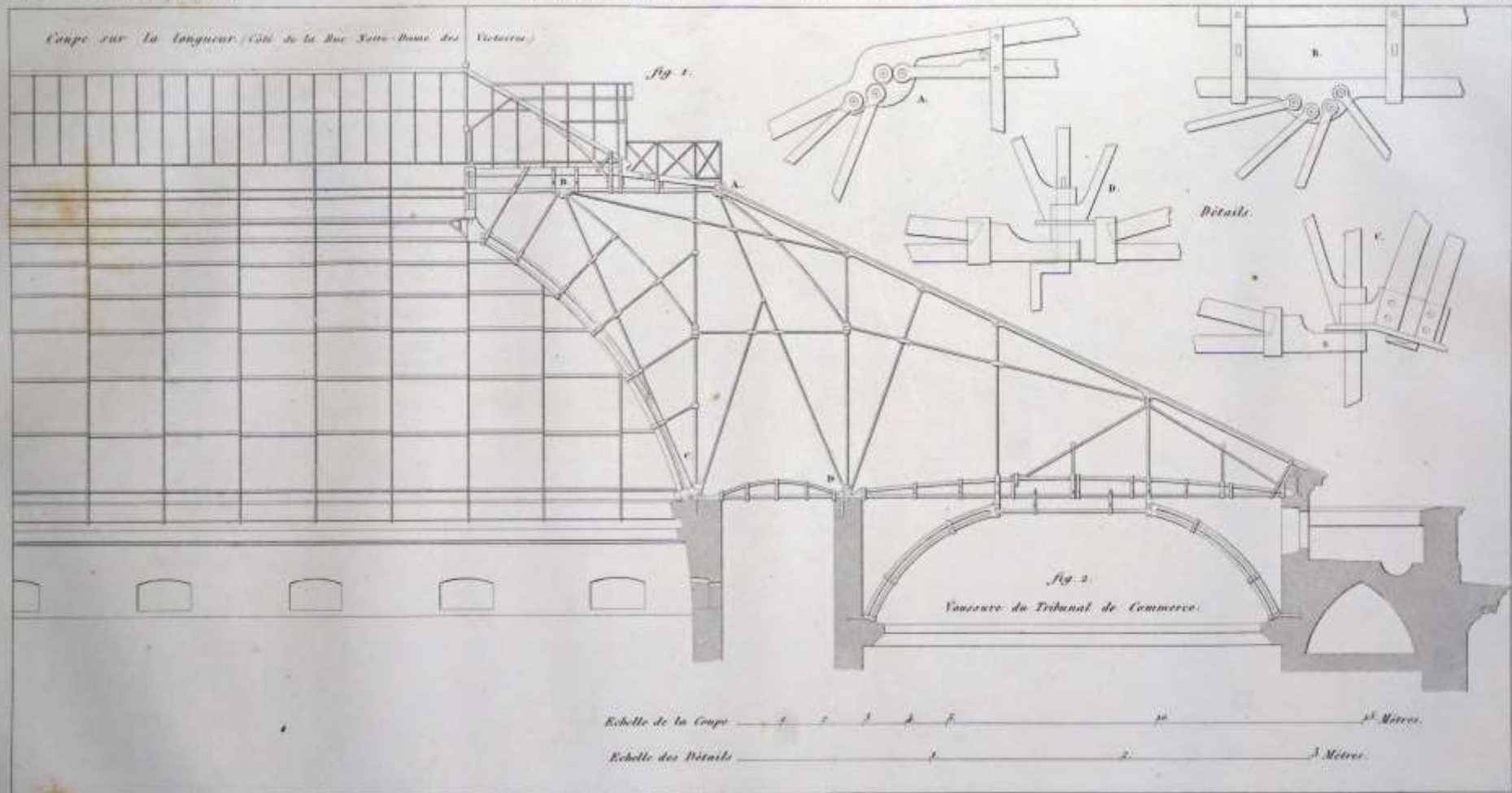
Bauen mit Schmiedeeisen hinter klassizistischer Fassade



Französische Tradition und Innovation:
Massivbau mit Eisenbewehrung, Bauen mit hohlen Tontöpfen



Paris, Börse (Brongniart und Labarre, 1821-27)

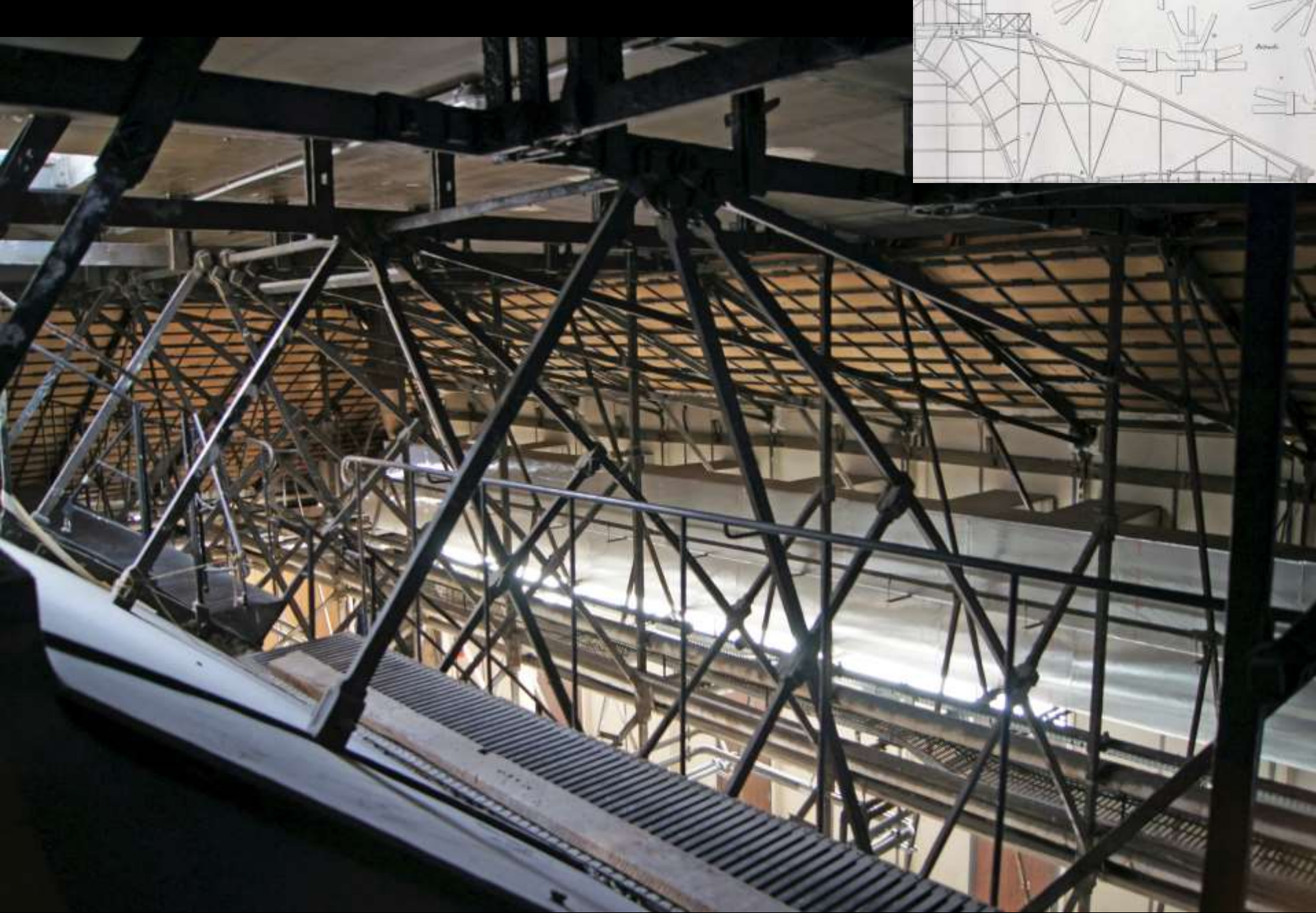


Ch. L. C. Eck, Architecte

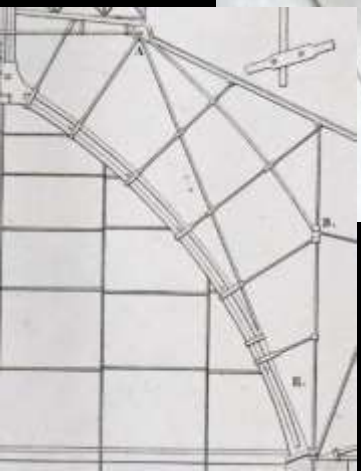
Ferronnerie par M^r Albouy

Albouy

Paris, Dachkonstruktion der Börse (1821-27)
(Eck 1836)



Paris, Dachkonstruktion der Börse (1821-27)
Dachkonstruktion



Paris, Dachkonstruktion der Börse (1821-27)
Detail der radialen Streben



Paris, Dachkonstruktion der Börse (1821-27)
Anschlussdetail mit Quadratmuttern und Montagemarkierungen



Paris, Dachkonstruktion der Börse (1821-27)
Anschlussdetail mit Quadratmuttern und Montagemarkierungen



Paris, Dachkonstruktion der Börse (1821-27)
Anschlussdetails der „Speichen“



Paris, Dachkonstruktion der Börse (1821-27)
Kuppelschale aus Tonhohlkörpern



Walhalla bei Regensburg
(Leo v. Klenze 1836-40)



Walhalla bei Regensburg: Innenraum der Cella
(Leo v. Klenze 1836-40)



Walhalla bei Regensburg: Dachwerk über dem „Adyton“: eisernes „Bogenhängewerk“
(Leo v. Klenze und „Mechanicus Manhard“ 1836-40)



Walhalla bei Regensburg: Dachwerk über dem „Adyton“
(Leo v. Klenze und „Mechanicus Manhard“ 1836-40)



Walhalla bei Regensburg: Dachwerk über dem „Adyton“: Auflager des Bogentragwerks
(Leo v. Klenze und „Mechanicus Manhard“ 1836-40)



Walhalla bei Regensburg, „Adyton“: Anschlussdetail mit Keil und Gegenkeil, „Abbundmarken“
(Leo v. Klenze und „Mechanicus Manhard“ 1836-40)



Walhalla bei Regensburg, Dachwerk über dem „Adyton“: abgehängte Eisen-Draht-Putz-Decke
(Leo v. Klenze und „Mechanicus Manhard“ 1836-40)

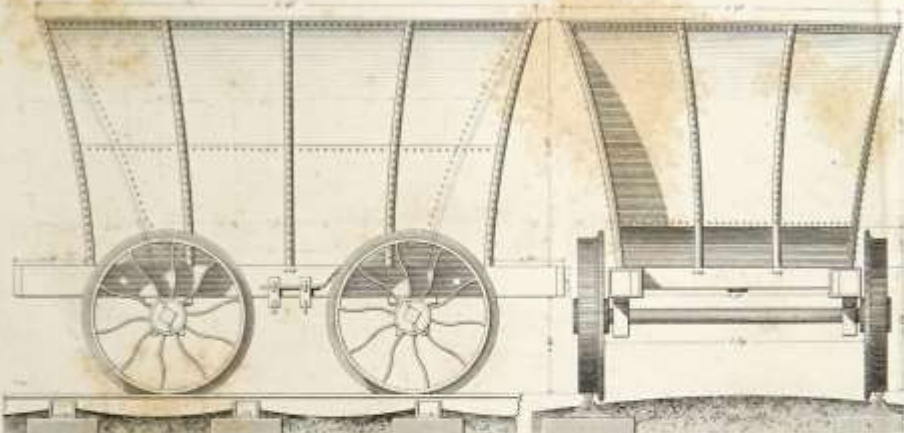
Die Eisenbahn und die Folgen

Chariot en tôle employé sur le chemin de fer de Darlington à Stockton

Elevation latérale

Fig. 1.

Elevation de face

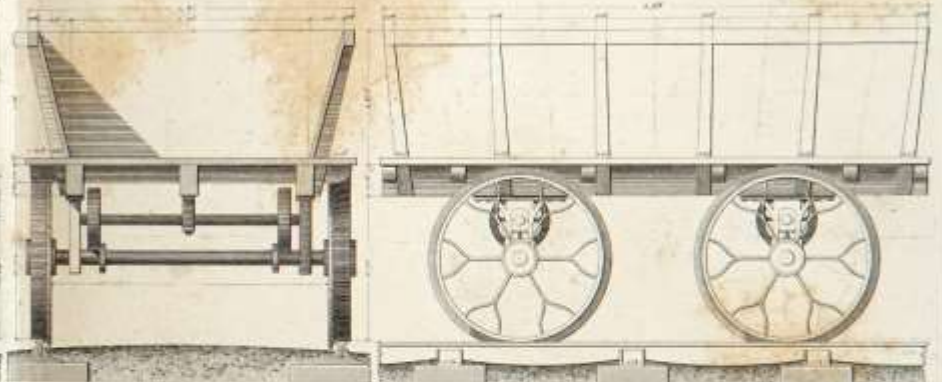


Chariot à double essieu employé sur le chemin de fer de Bolton à Leigh

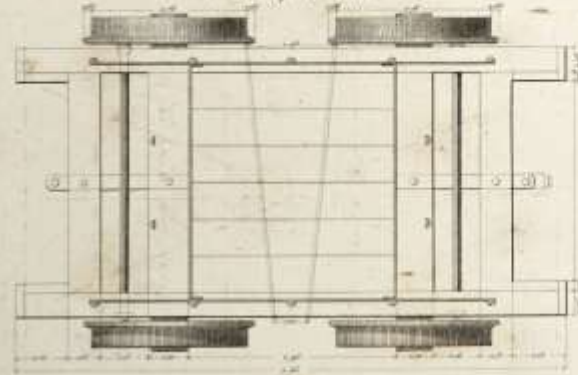
Coupe transversale

Fig. 2.

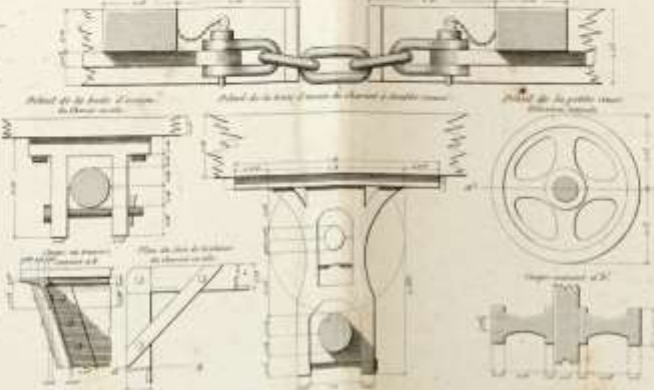
Elevation latérale



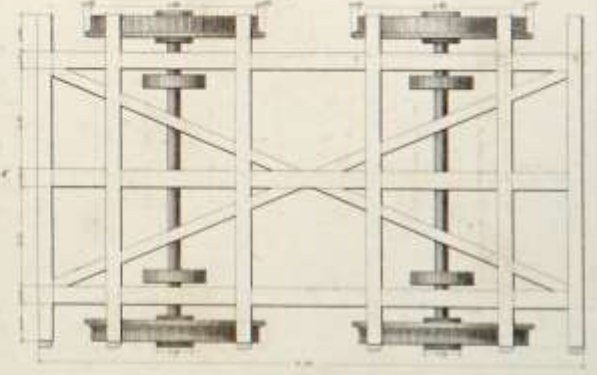
Plan du Corps de Chariot



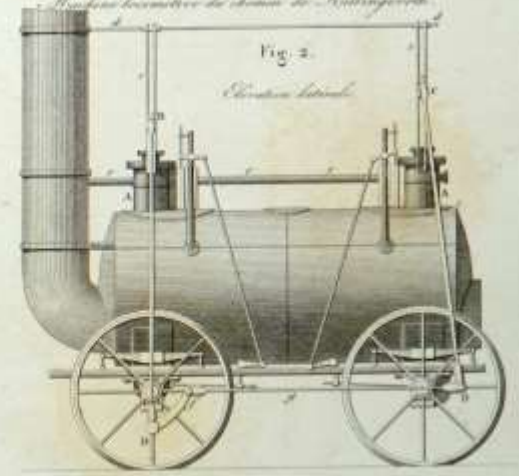
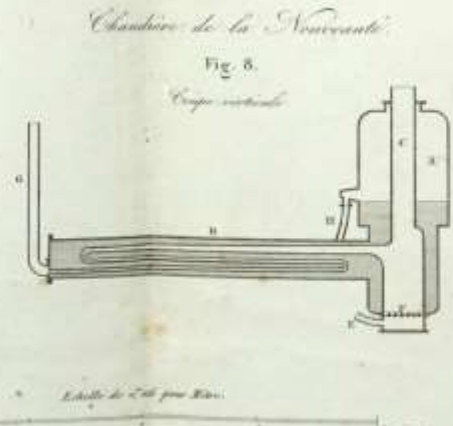
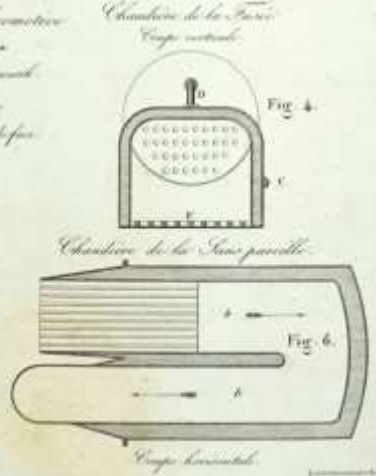
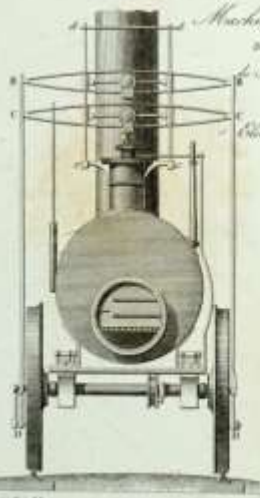
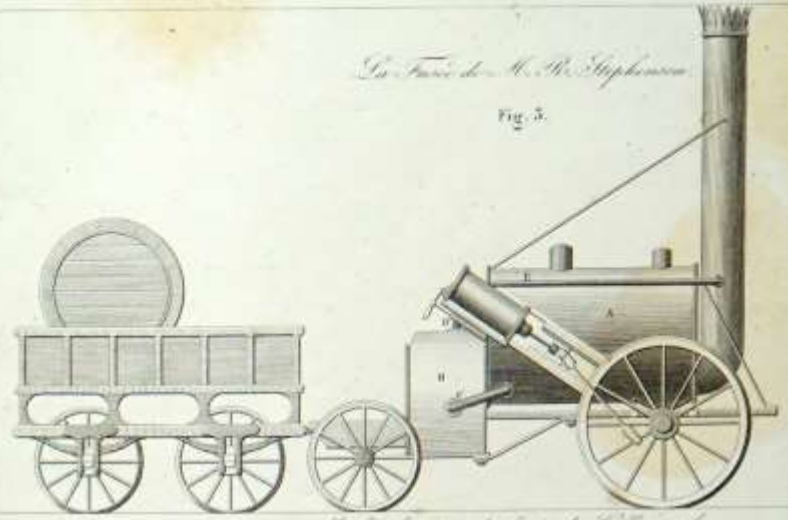
Plan de la Chaine de deux wagons



Plan du Corps de Chariot



Die ersten Eisenbahnen mit Lokomotivbetrieb: George Stephenson's Stockton-Darlington Railway (1825) (Wood 1831/1834)



Dampflokomotiven der ersten Generationen. Rechts oben Stephenson's „Rocket“ (Wood 1831/1834)



George & Robert Stephenson's „Rocket“ (1829), Siegerin der Rain Hill Competition (London, Science Museum)

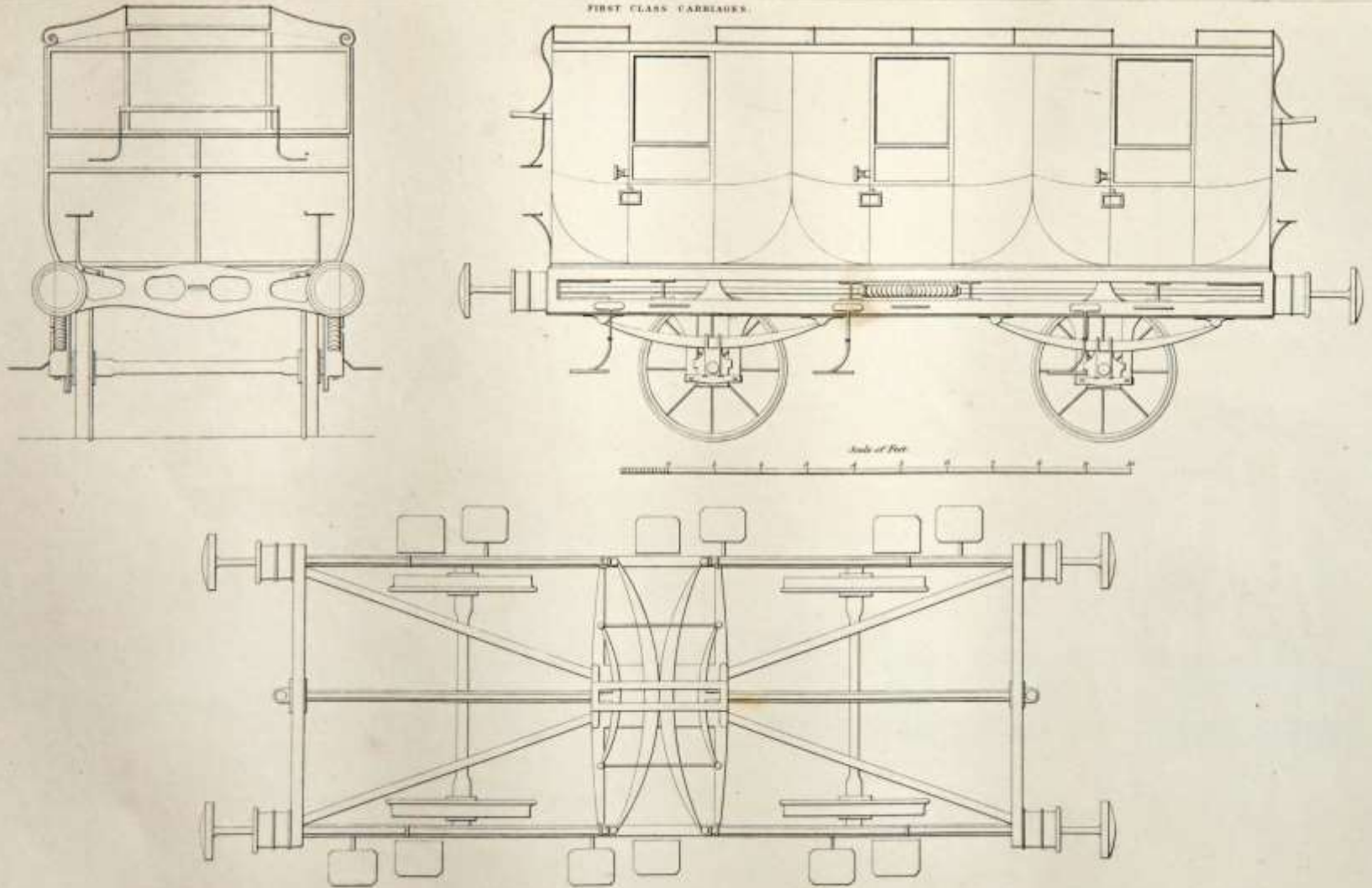


Die Eisenbahn Liverpool-Manchester (1830), erste grosse Personen- und Frachteisbahn
(Mount Olive Cutting, S. Flachet 1835)

LONDON AND BIRMINGHAM RAILWAY.

Plate 33

FIRST CLASS CARRIAGES.



John Wash, Architectural Library - 18 Dept. of Science

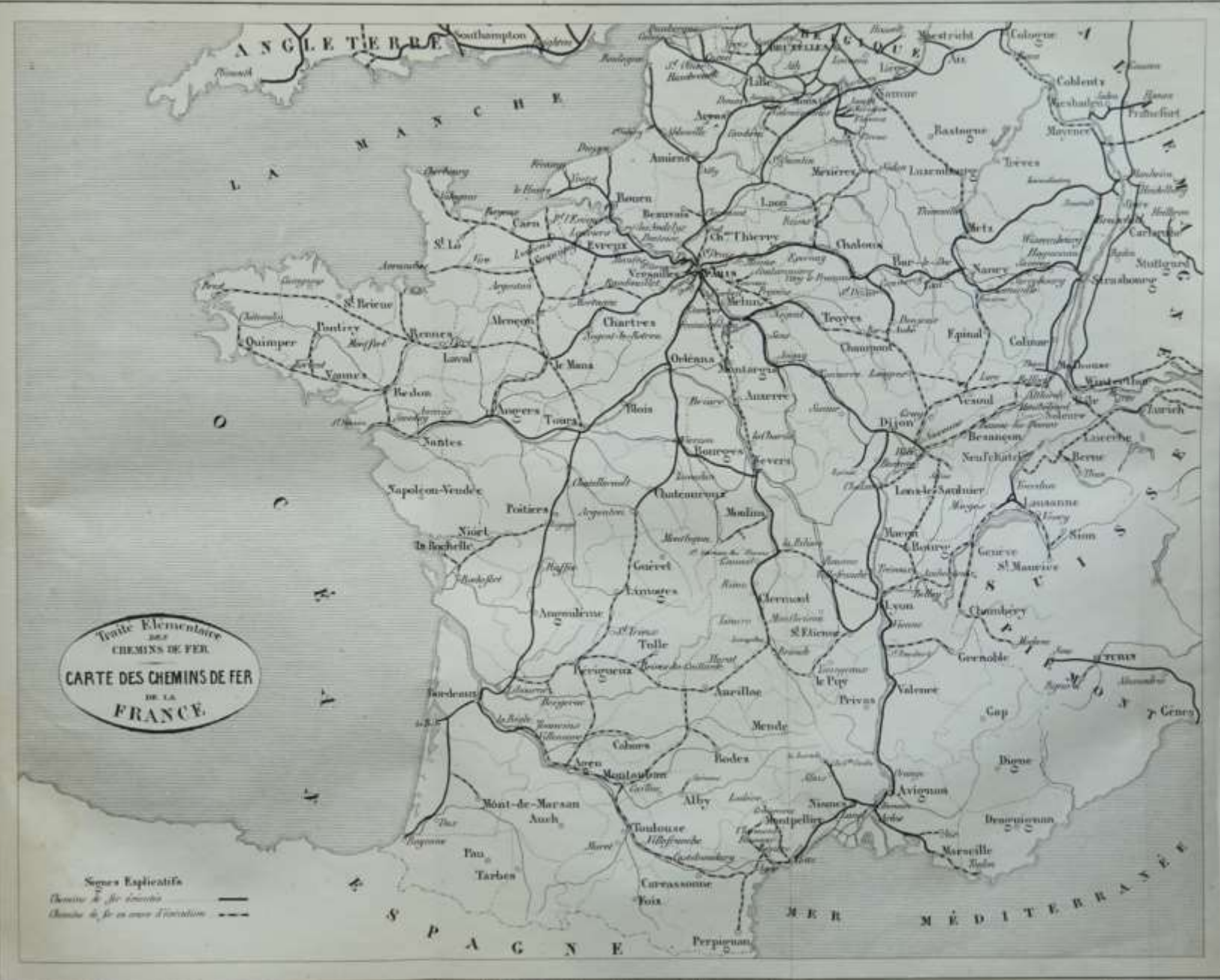
Die Personenwägen der Eisenbahn London-Birmingham (Gesamtstrecke eröffnet 1838)
(Simms 1838)

Traité Élémentaire
DES
CHEMINS DE FER
—
CARTE DES CHEMINS DE FER
DES
ILES BRITANNIQUES



Carte par Perdonnet, 1855. Révisée par le Bureau des Chemins de Fer.
Édité par R. B. Langley, Libraire à la Cour, 1855.
Lith. Lacomme & Co.

Eisenbahnen in England um 1855 (Perdonnet 1855)



Paris par Anst. 177 Rue des Beveuglies 18

Édité par M. H. Langlois-Leclercq Libraire R. des Mathurins 171 et 173

Lith. Lemerle et Fils

Eisenbahnen in Frankreich um 1855 (Perdonnet 1855)



Eisenbahnen im deutschsprachigen Raum um 1855 (Perdonnet 1855)

Zweckbau – von der Markthalle zur Eisenbahnhalle
Die „eigentliche“ Architektur des 19. Jh.?

(1815–1846)



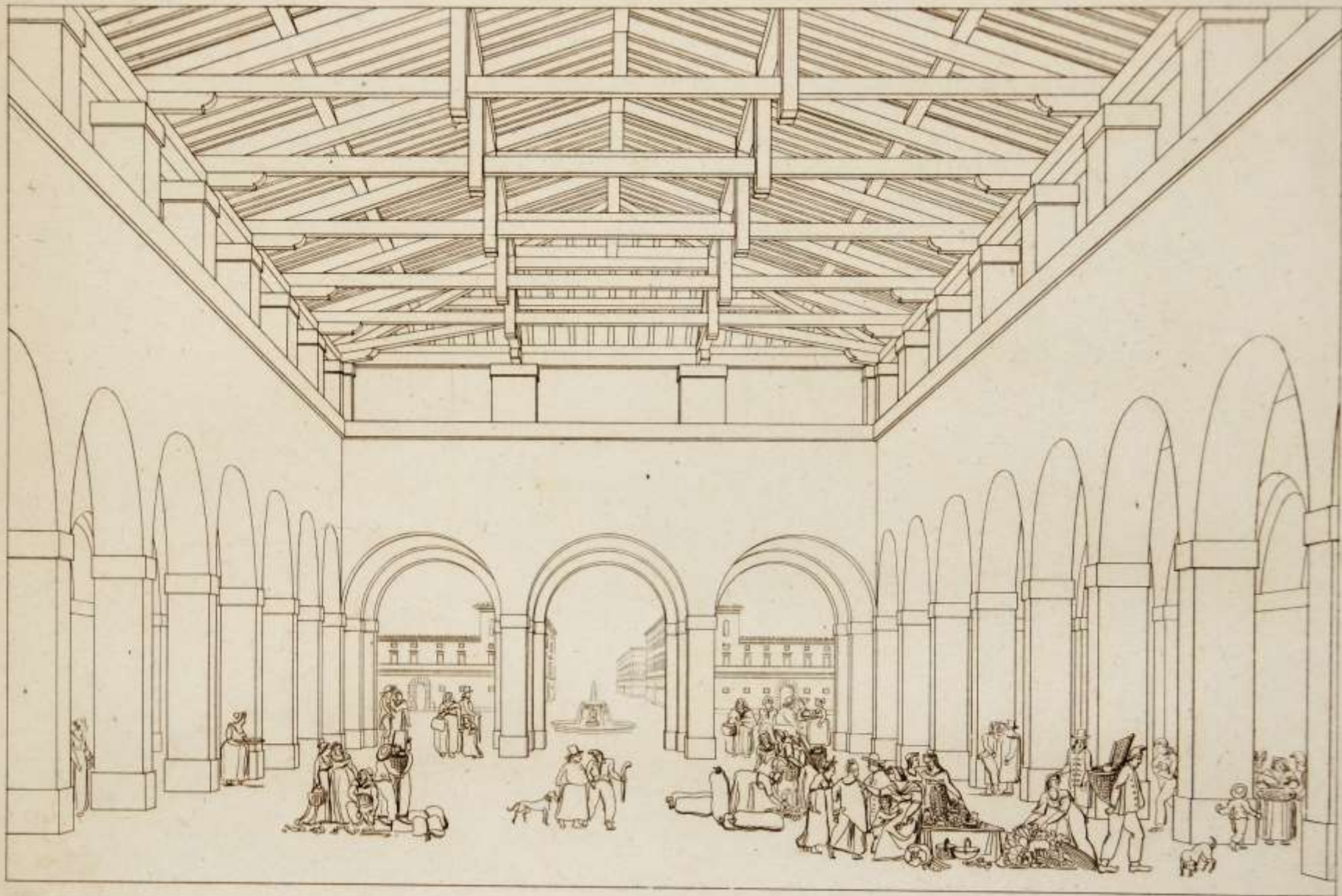
Bourg-sur-Gironde, Waschhaus (1828)



Bourg-sur-Gironde, Waschhaus (1828) mit Pfettendachbinder



Paris, Marché Saint-Germain (1817; heute Rekonstruktion)



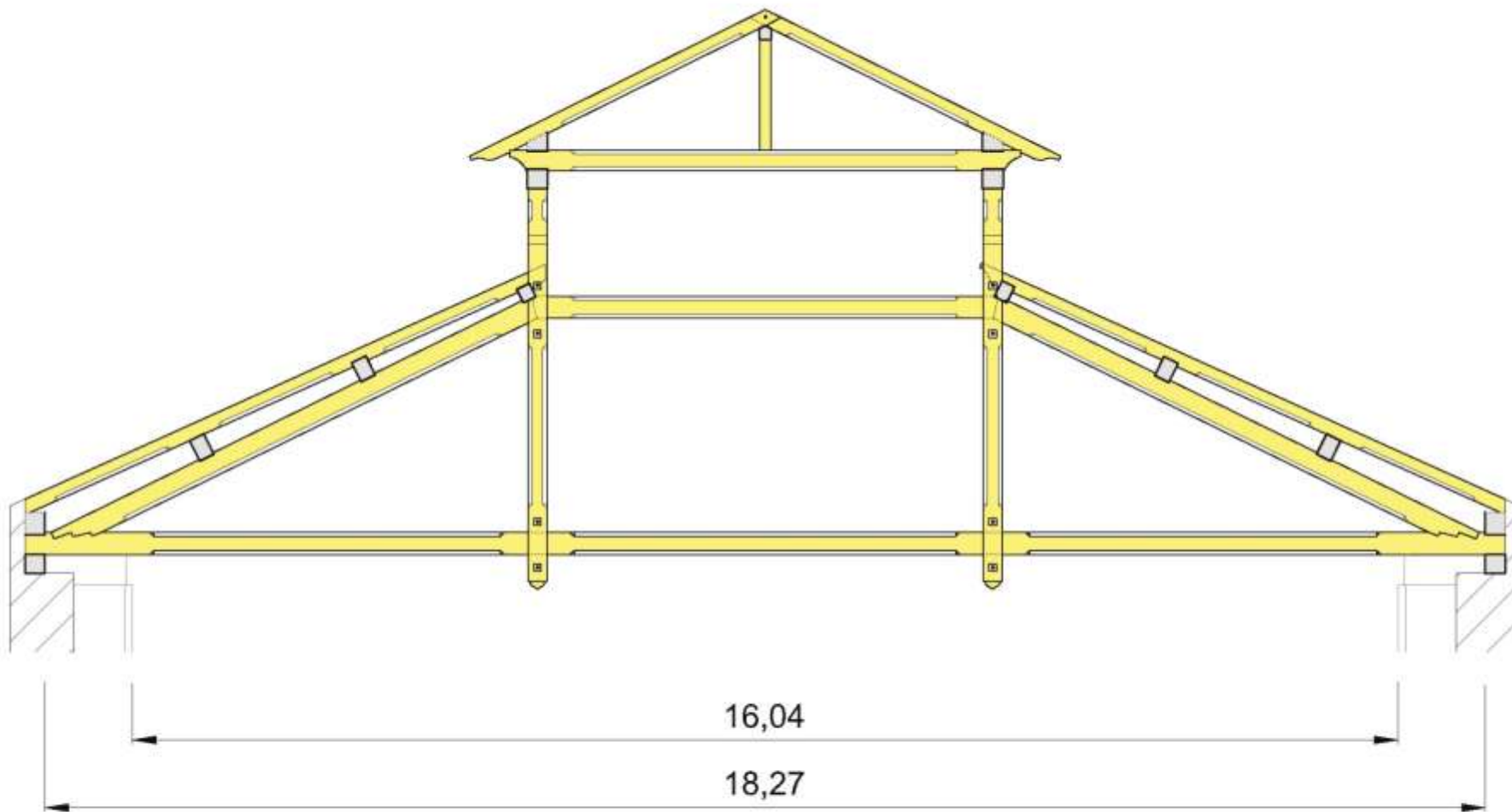
Projets de Marchés.



Augsburg, ehem. Bahnhofshalle (1840)



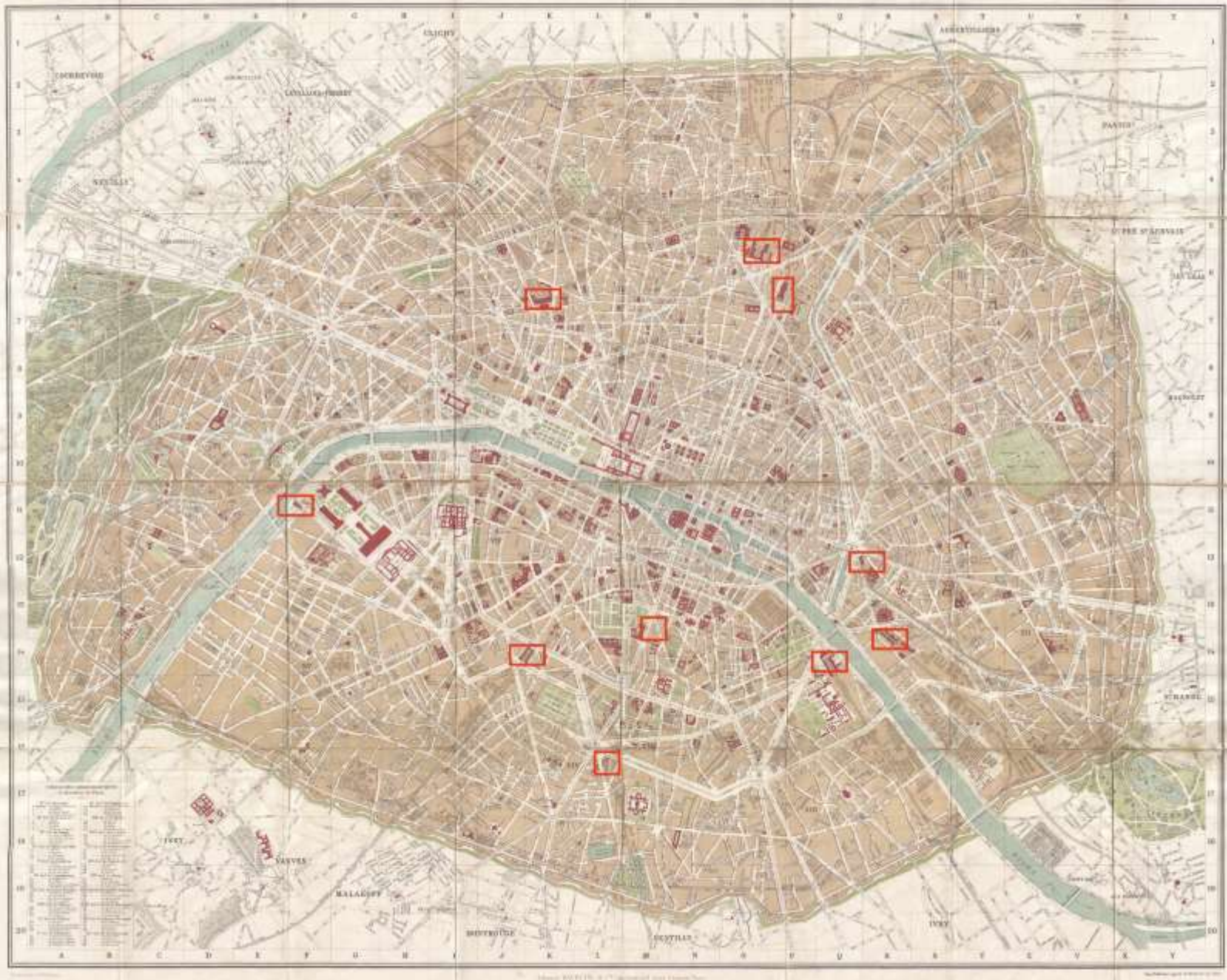
Augsburg, ehem. Bahnhofshalle (1840)



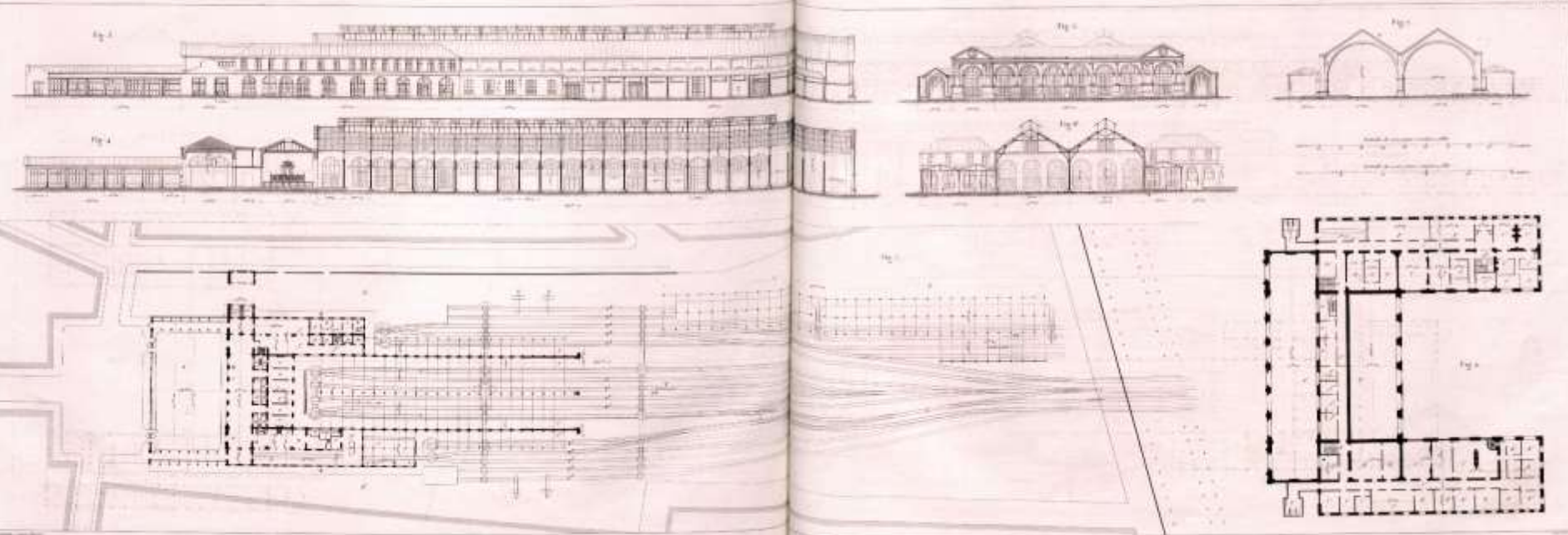
Augsburg, Straßenbahndepot
 ehemaliger Bahnhof (1840) M 150
 Systemskizze, vor Ort gemessen
 Anja Winnemann/ Stefan Hölzer
 Universität der Bundeswehr München

Augsburg, ehem. Bahnhofshalle (1840)

PLAN DE PARIS



Paris, die Bahnhöfe
(Plan v. Vuillemin 1894)

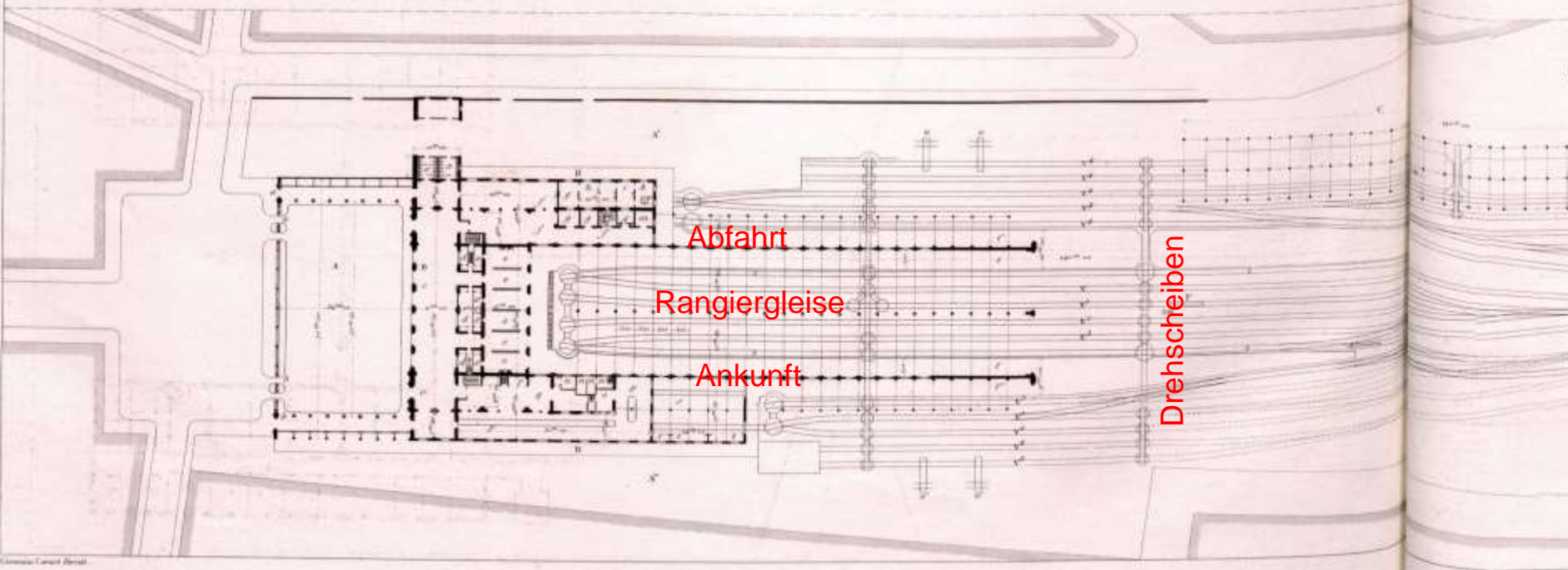
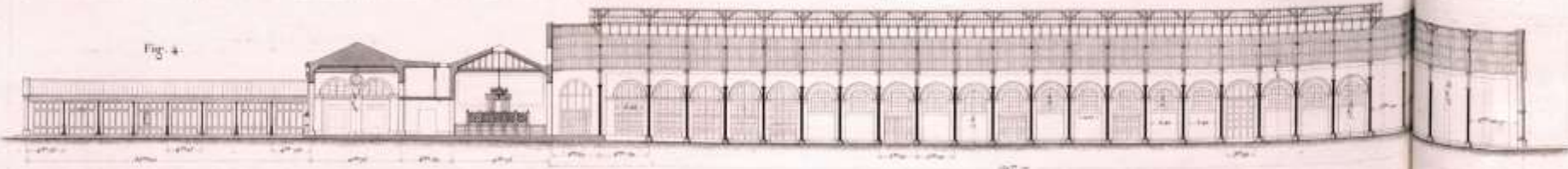


Paris, Gare du Nord (1846)
Gesamtdisposition (Perdonnet/Polonceau 1846)

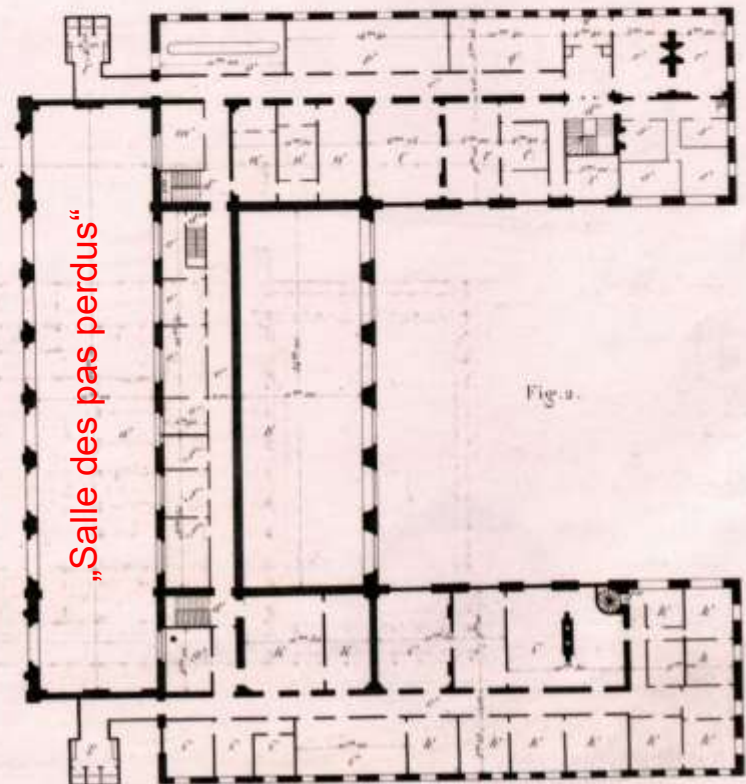
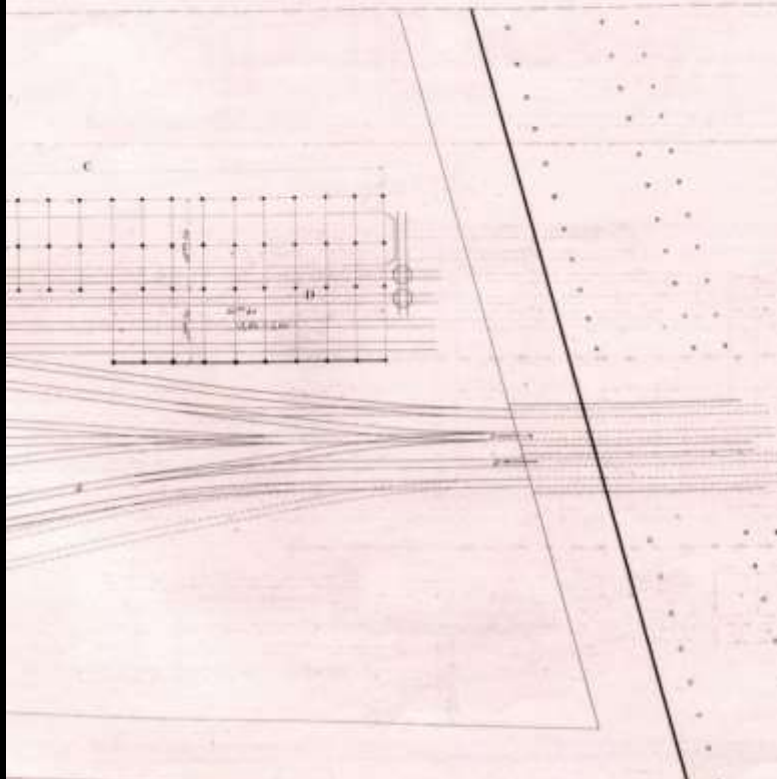
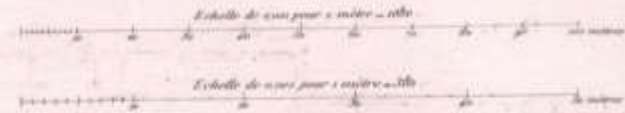
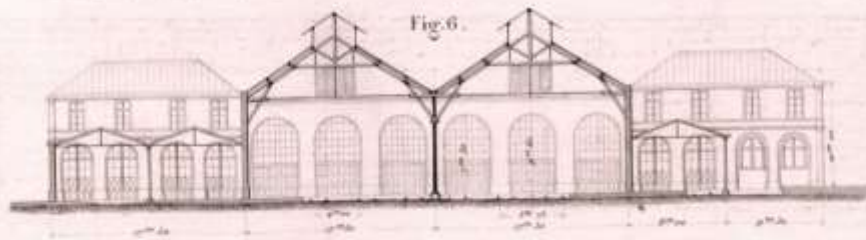
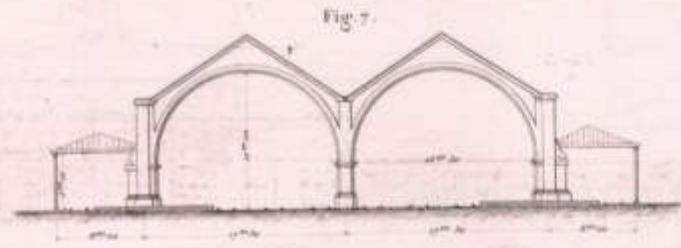
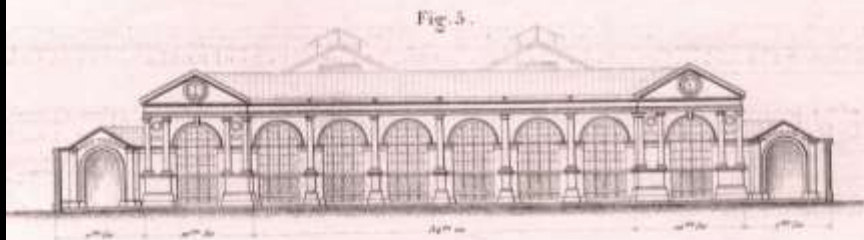
Fig. 3.



Fig. 4.



Paris, Gare du Nord (1846)
Gesamtdisposition (Perdonnet/Polonceau 1846)



Paris, Gare du Nord (1846)
Gesamtdisposition (Perdonnet/Polonceau 1846)

Fig. 5.

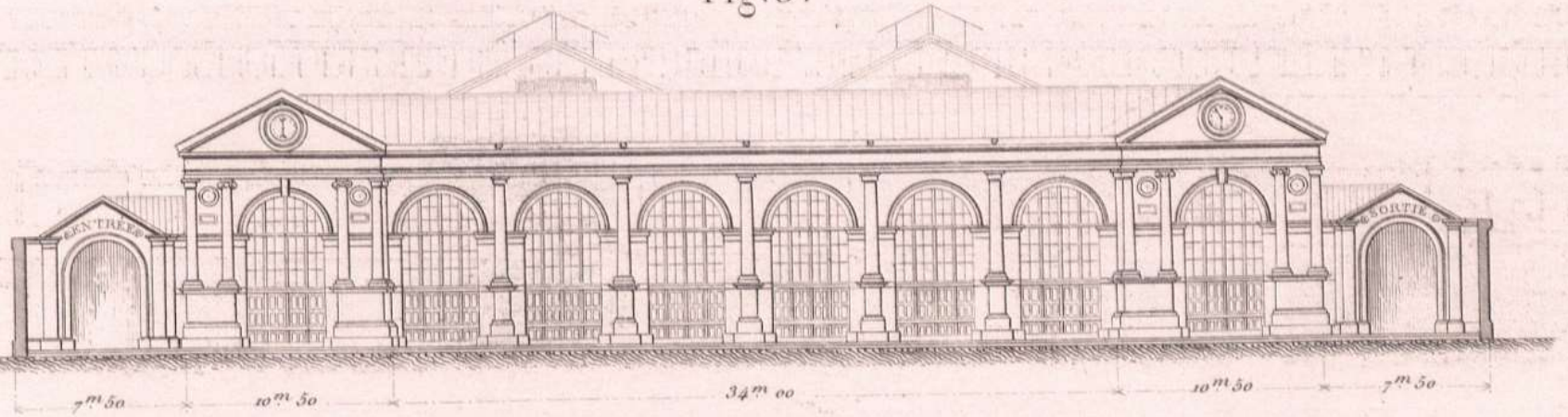
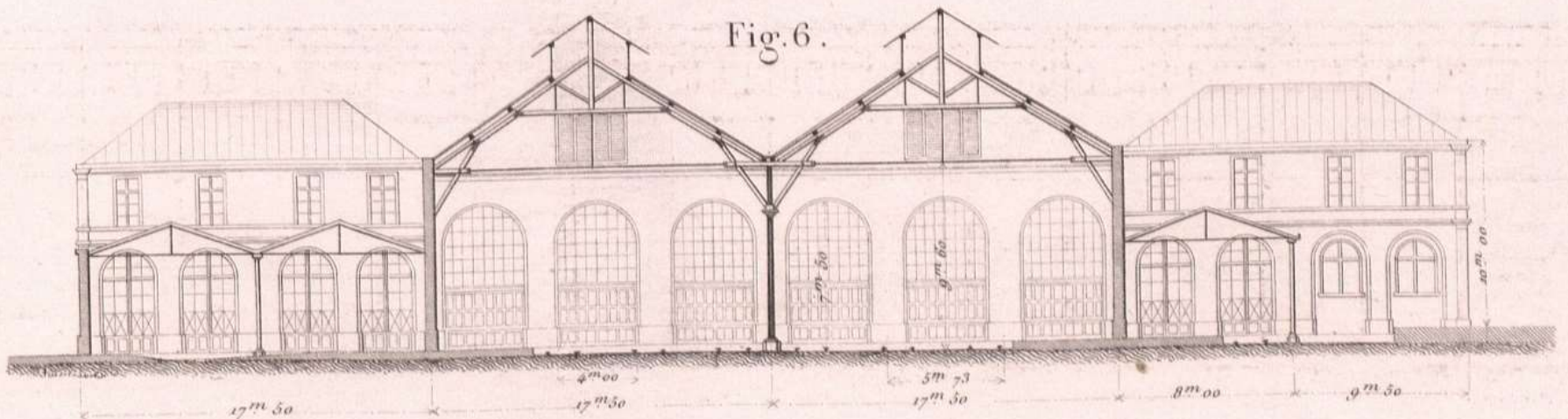
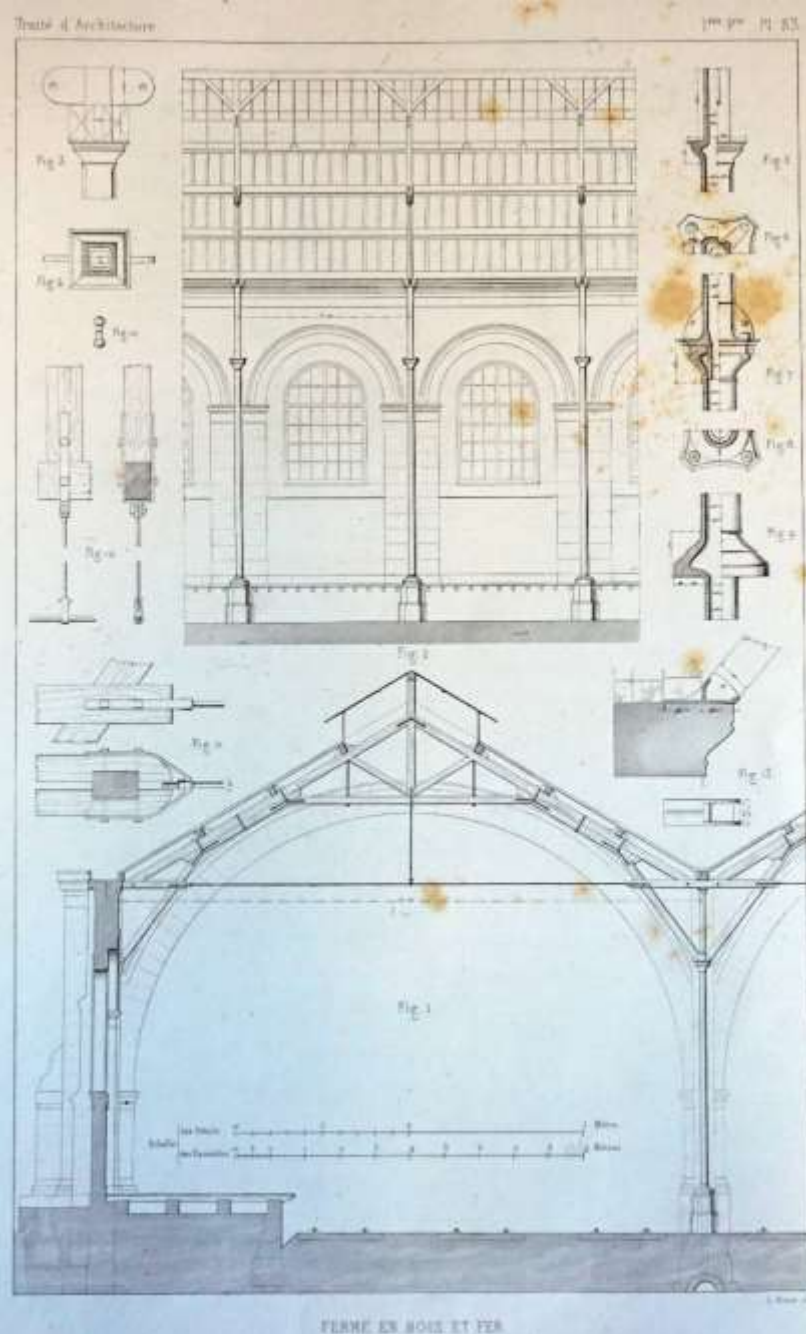


Fig. 6.

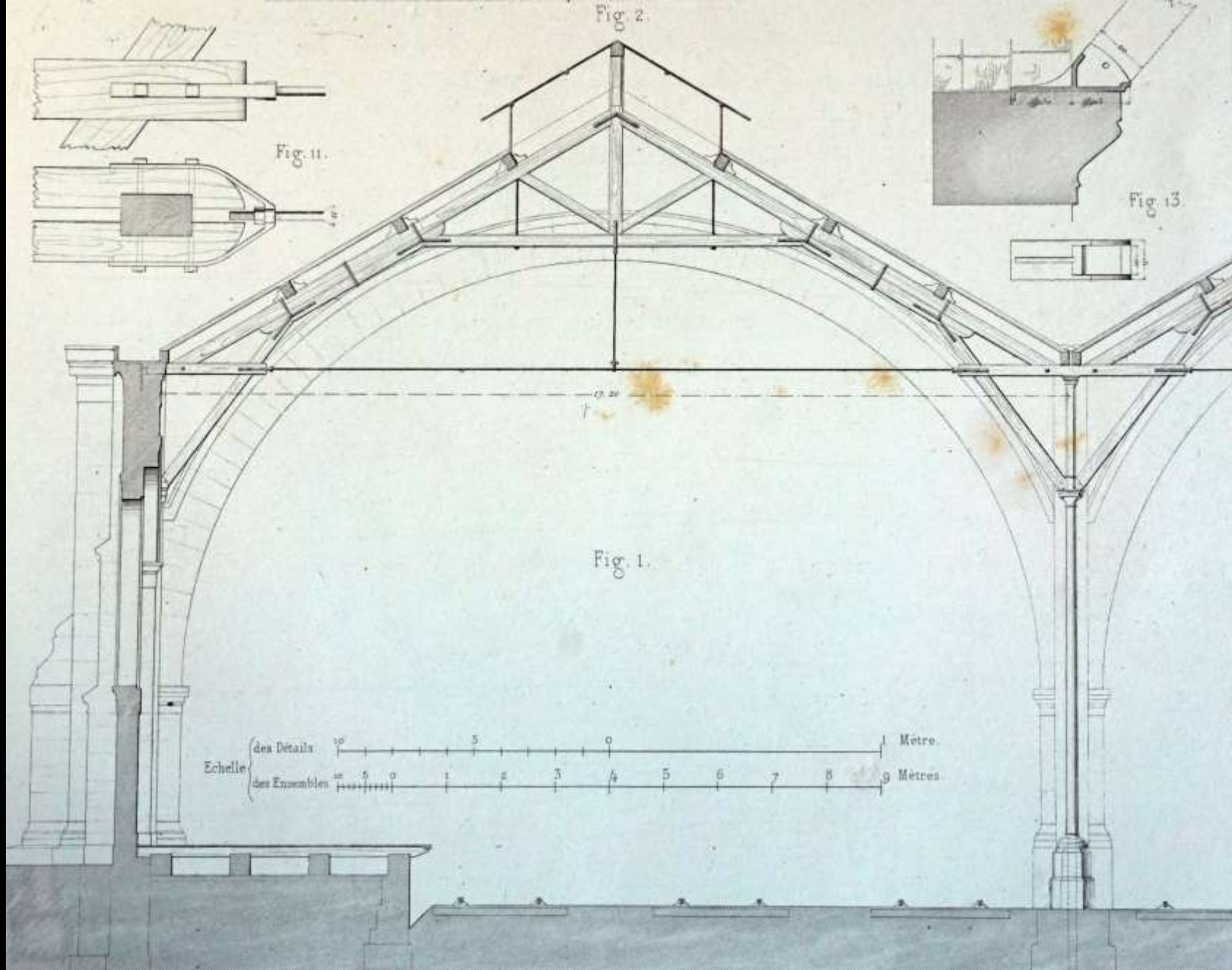


Paris, Gare du Nord (1846)

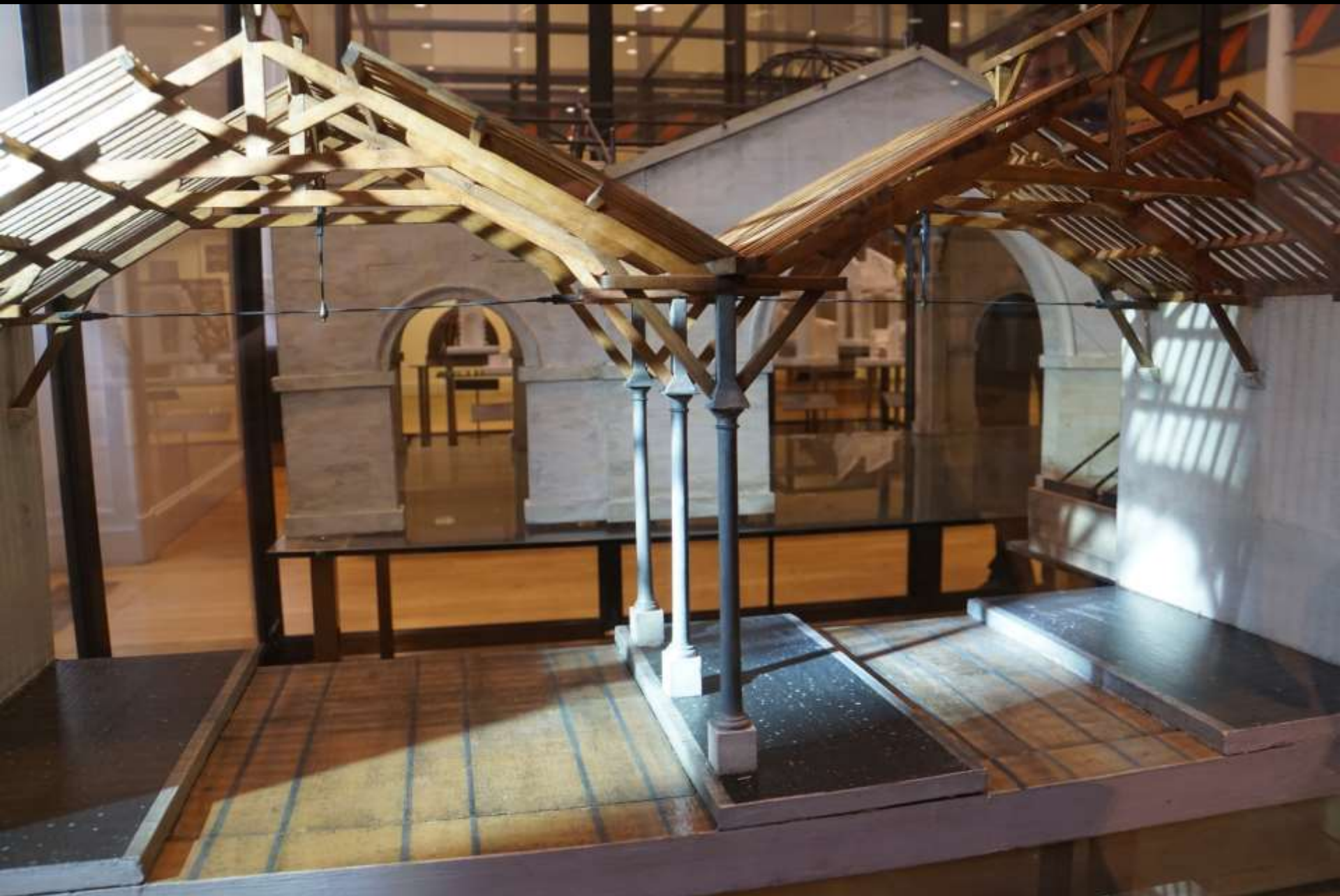
Fassade und Schnitt durch die Einsteigehalle (Perdonnet/Polonceau 1846)



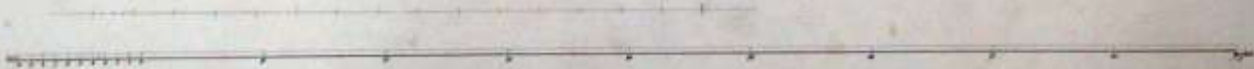
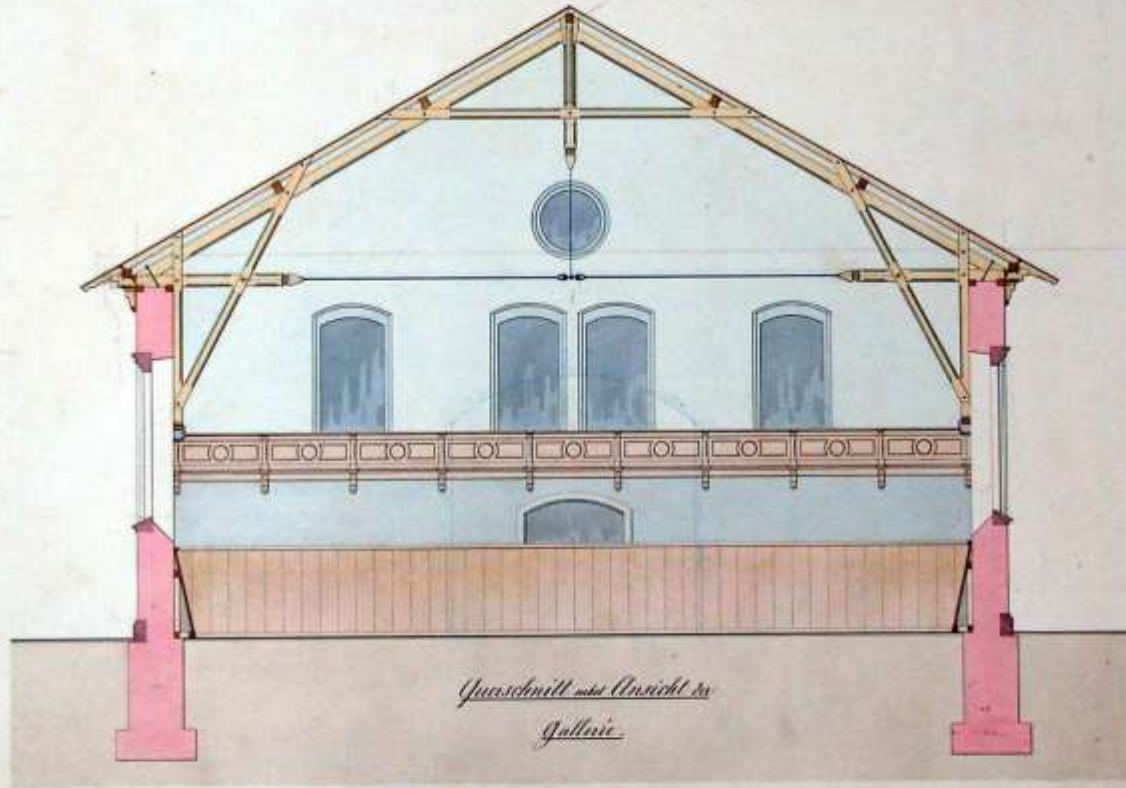
Paris, Gare du Nord (1846), Einsteighalle von Leonce Reynaud (Reynaud 1860)



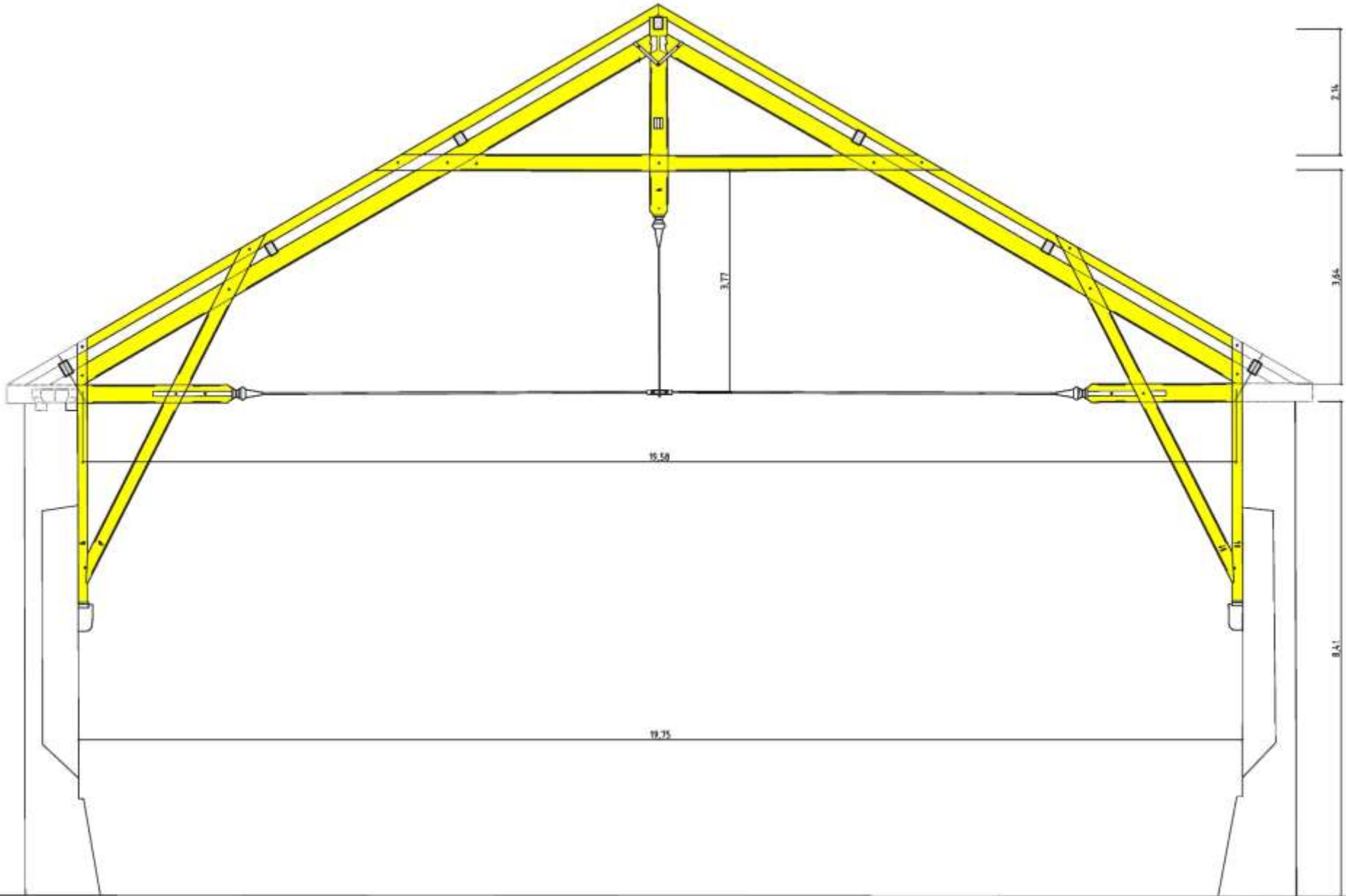
Paris, Gare du Nord (1846), Einsteighalle von Leonce Reynaud (Reynaud 1860)



Paris, Gare du Nord (Leonce Reynaud, 1846-50; zeitgenöss. Modell im Cons. Arts & Métiers, Paris)



C 1123



Aarau, Reithalle (1864)



Aarau, Reithalle (1864)



Aarau, Reithalle (1864)

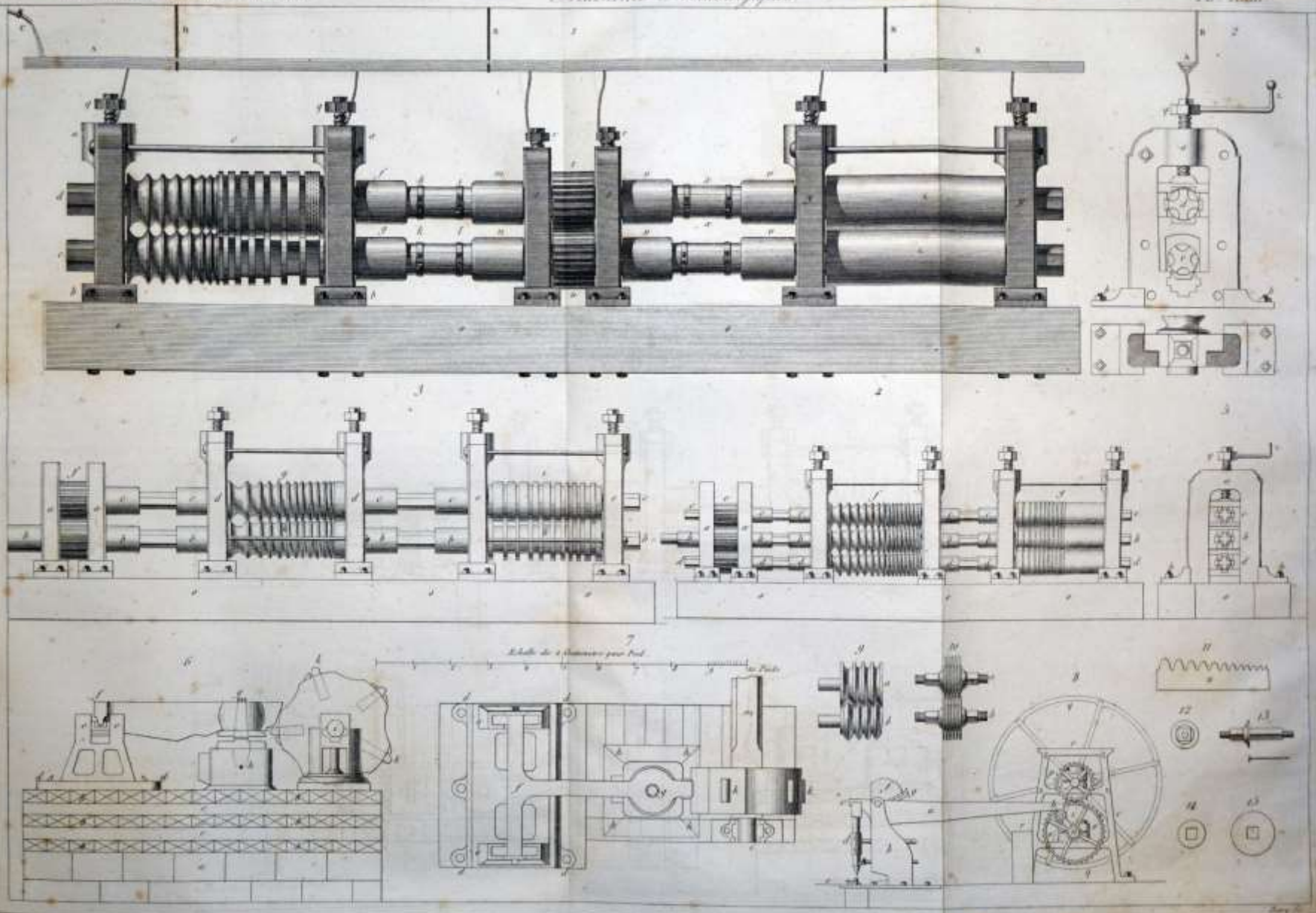
Siegeszug des Schmiedeeisens:
Umformen durch Walzen (ca. 1830–1850)

Stahl (historisch „Schmiedeeisen“ genannt):

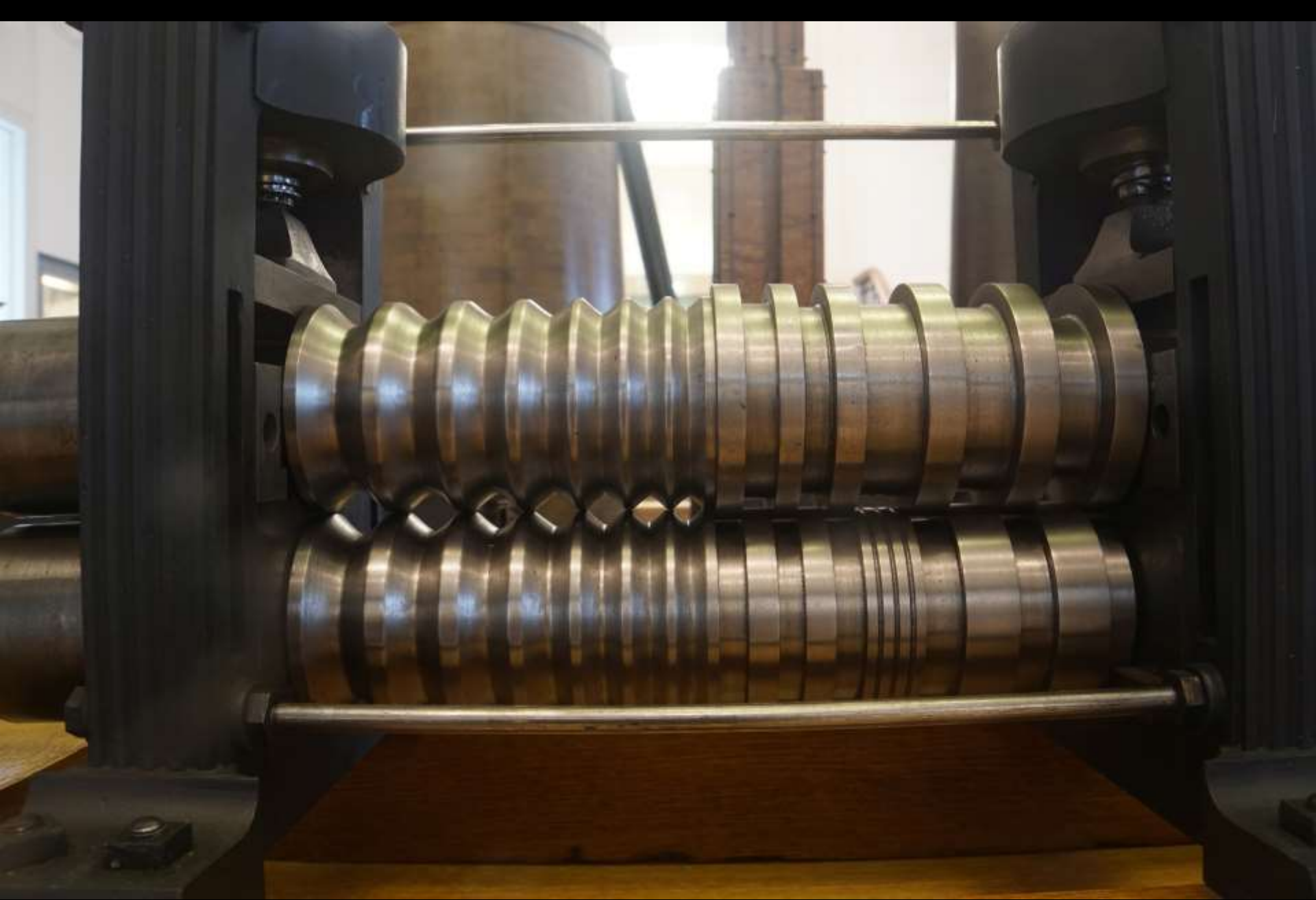
- in rotglühendem Zustand formbar durch Schmieden
- Stabeisen und Blech durch Walzen herstellbar, ab letztes Drittel 18. Jh.
- zäh, auch kalt verformbar
- mechanisches Verhalten ähnlich wie bei Holz, aber viel höhere Zug- und Druckfestigkeit

Formgebung von Stahl: Auswalzen eines Eisenstabs zu einem flachen Profil
(Encyclopédie 1765)

Stahl = Schmiedeeisen

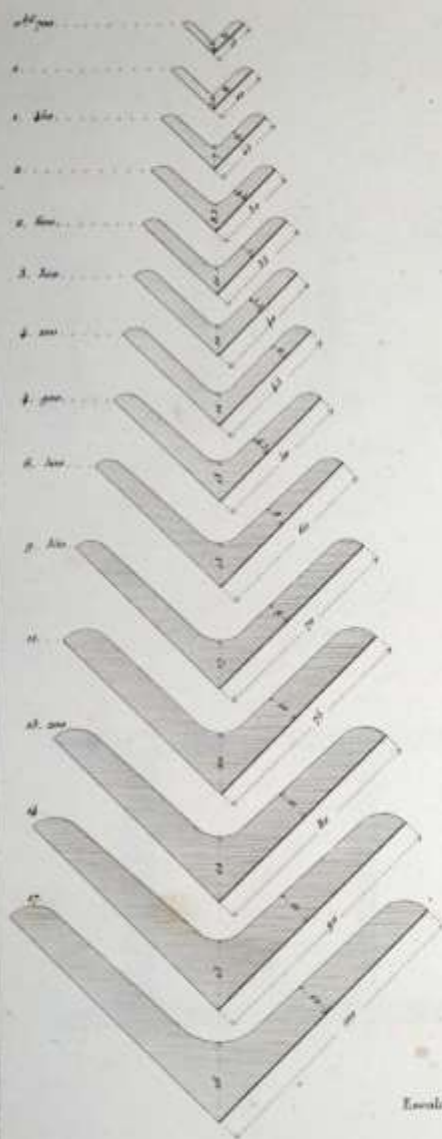


Kaliberwalzen zur Produktion dünner Eisenstäbe
(Flachat 1835)

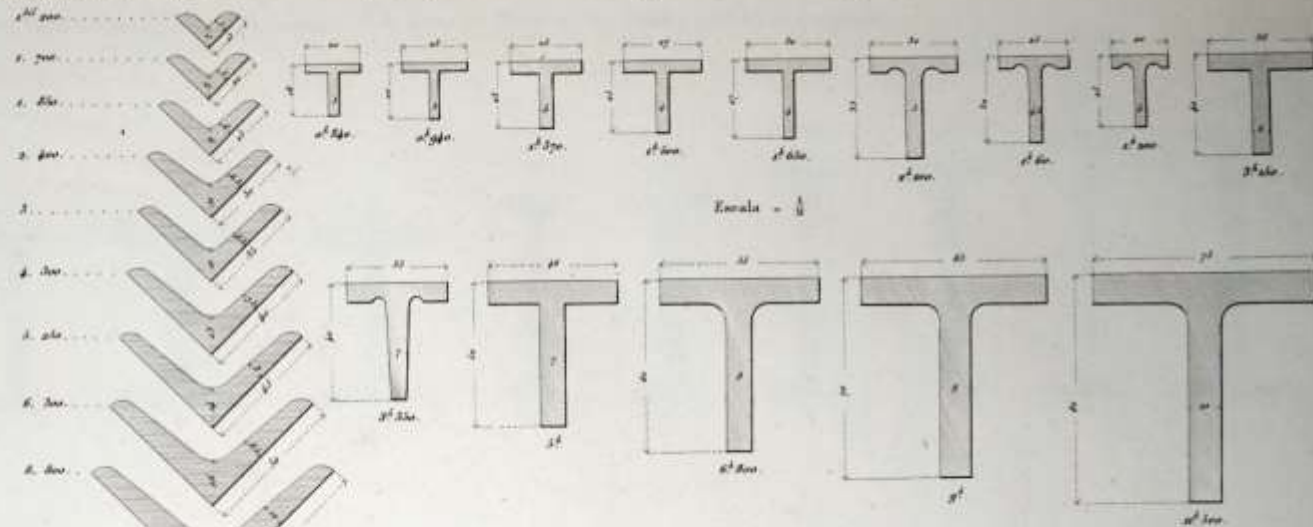


Kaliberwalze, 1840
(zeitgenöss. Modell, Paris, Conservatoire des Arts et Métiers)

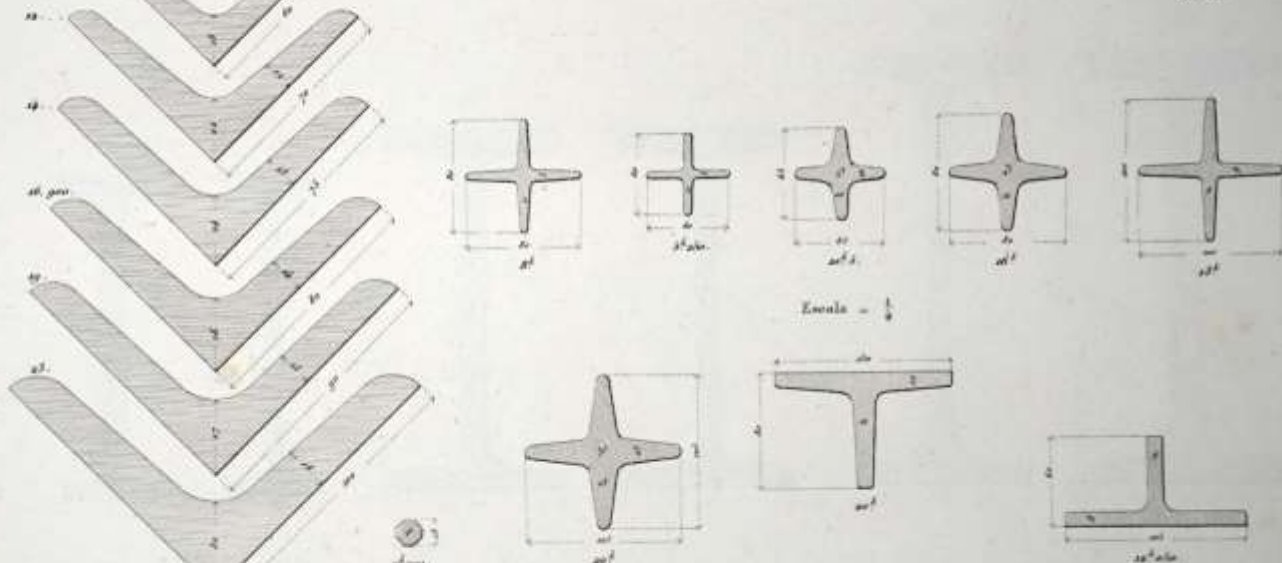
Las dimensiones expresan milímetros, y el peso es dado en kilogramos por m^3 de longitud.



Escala = $\frac{1}{2}$



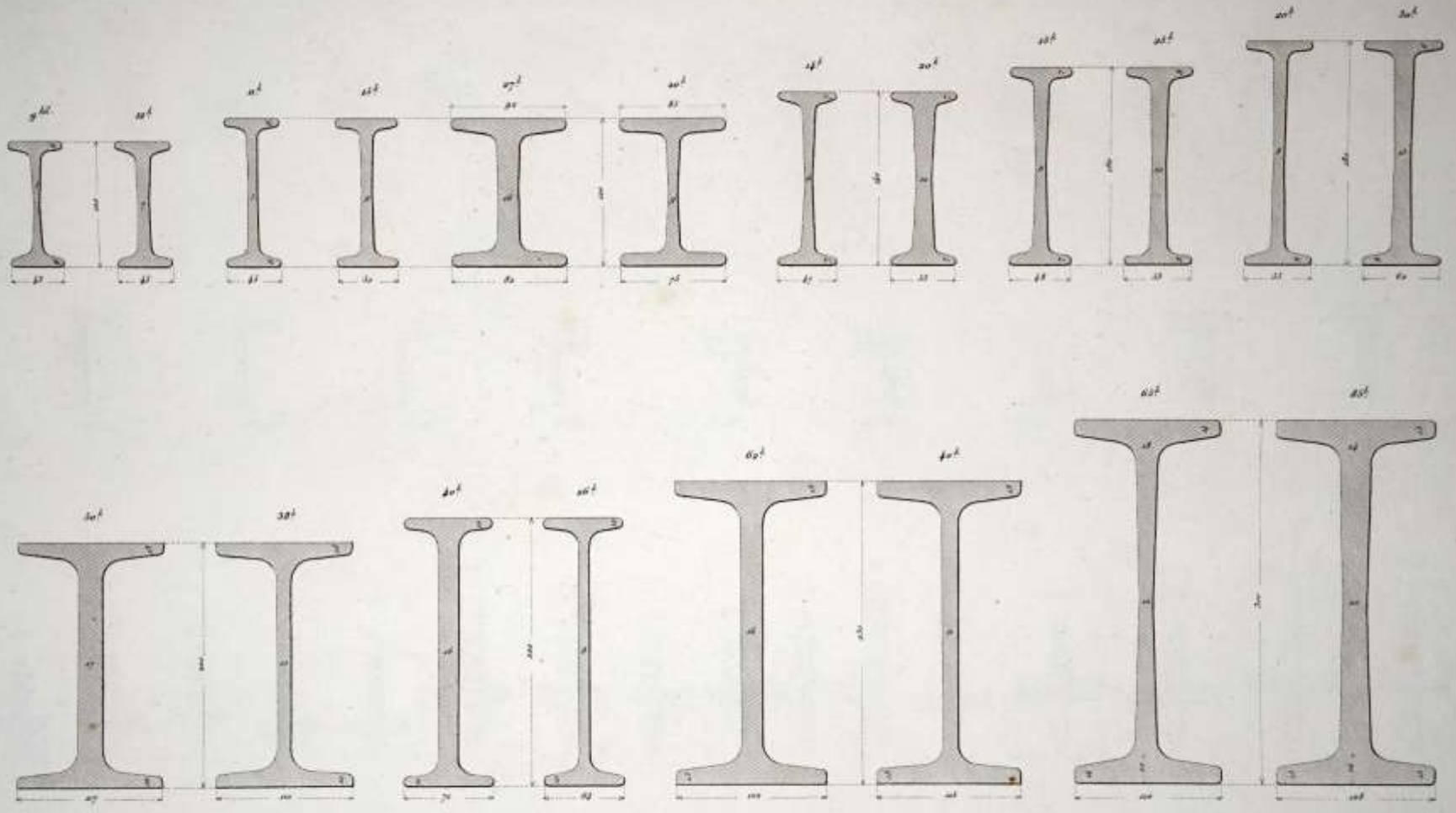
Escala = $\frac{1}{2}$



Escala = $\frac{1}{2}$

Um 1850: Walzen von Profilen (Valdés 1859)

Las dimensiones expresan milímetros, y el peso es dado en kilogramos por m^º de longitud.



Escala = $\frac{1}{4}$

gewalzte Profile (bis etwa 300 mm Profilhöhe)
(Valdés 1859)

ATLAS

VON

LXIII Kupfertafeln

ZUR

EISENHÜTTENKUNDE

VON

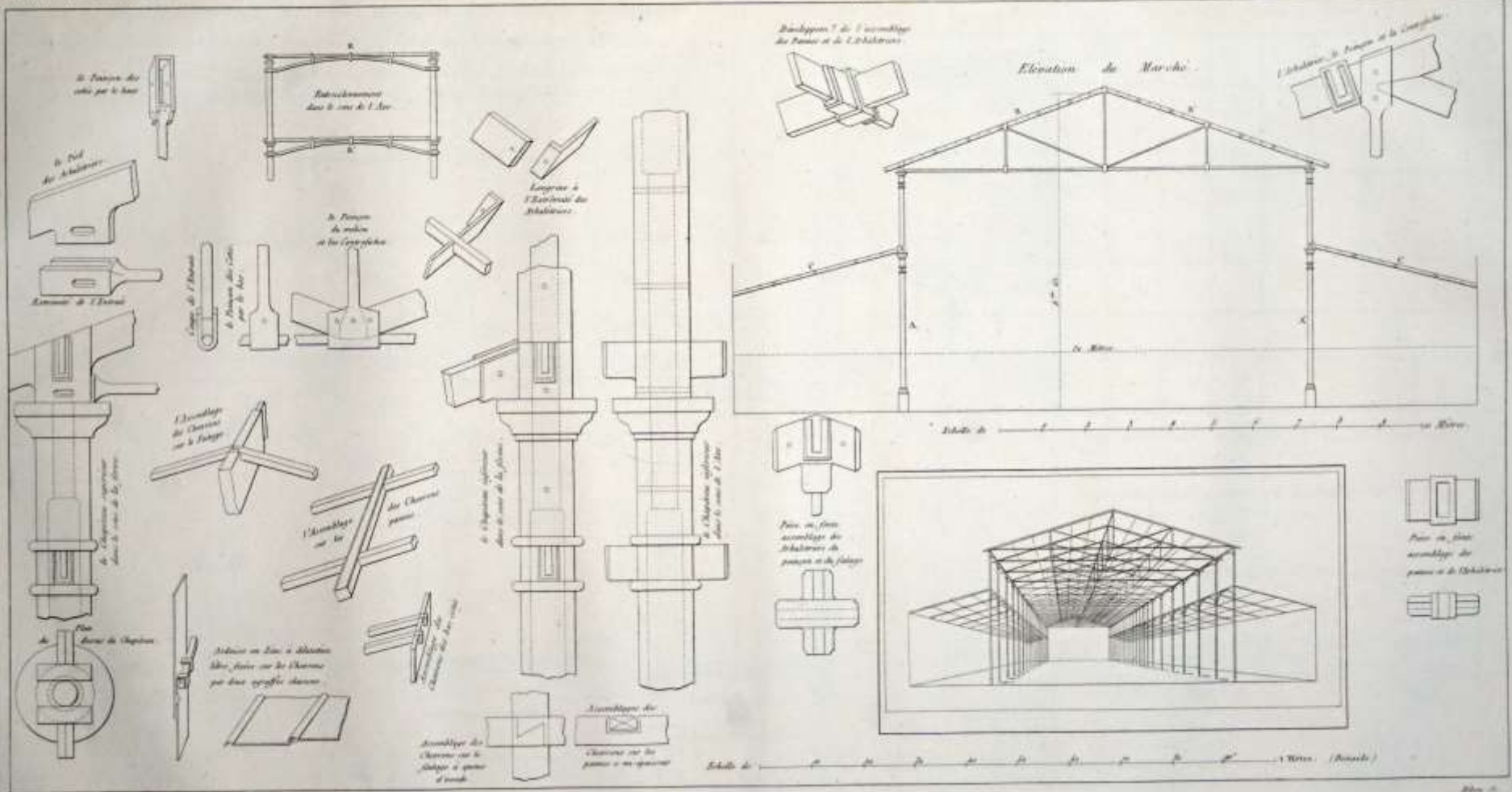
Dr. C. F. B. Karsten.



Berlin bei G. Reimer,
1841.

Eisenhütte um 1840. Antrieb von Gebläsen, Hämmern und Walzen durch Dampfmaschinen
(Karsten 1841)

Bauen mit gewalzten Profilen und Gusseisenstützen



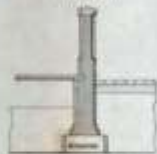
Paris, Marché de la Madeleine (Veugny, 1835): Materialkombination aus schmiedeeisernen Bändern und Gusseisensäulen (Eck 1836)

LONDON AND BIRMINGHAM RAILWAY EUSTON STATION

ELEVATION OF FENCE WALL A



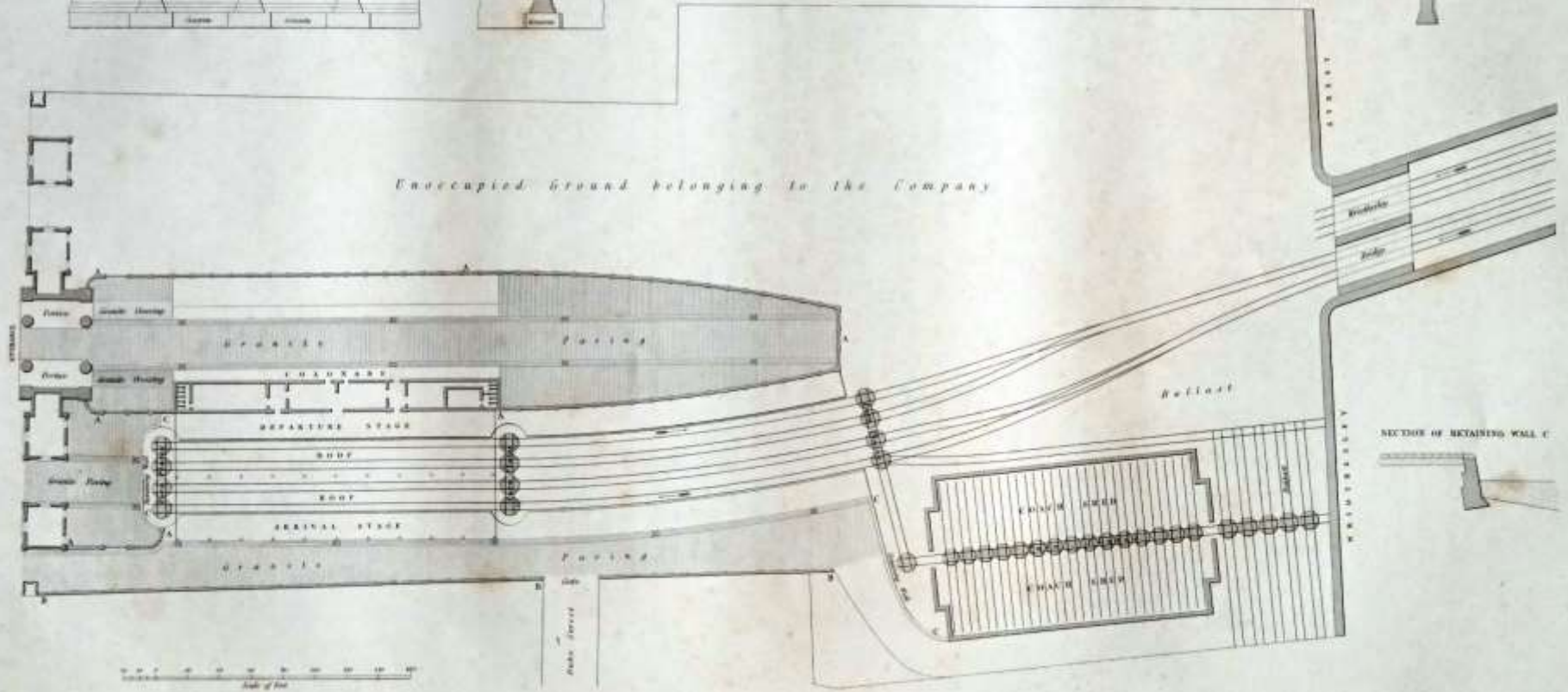
SECTION



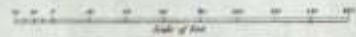
SECTION OF FENCE WALL B



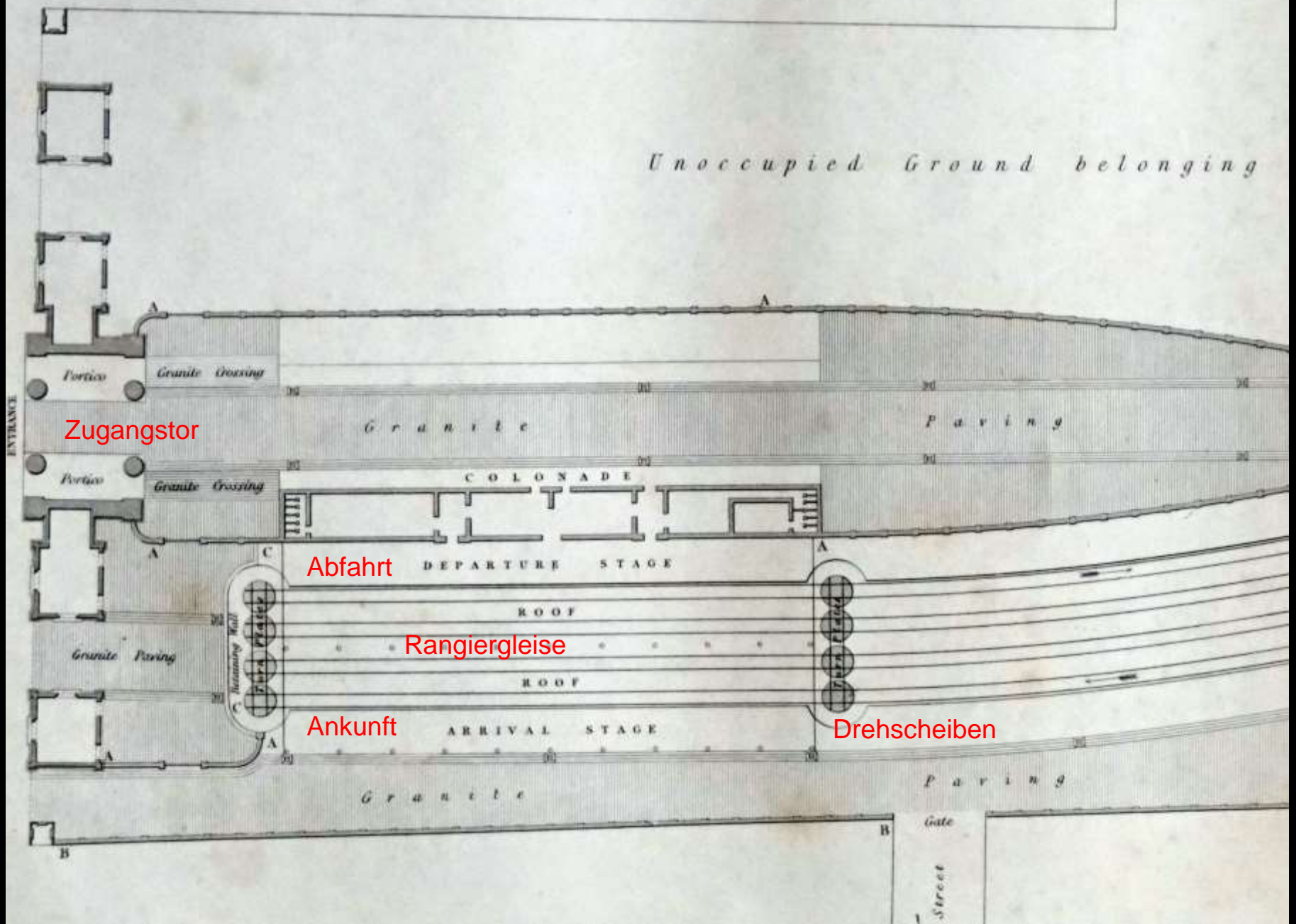
Unoccupied Ground belonging to the Company



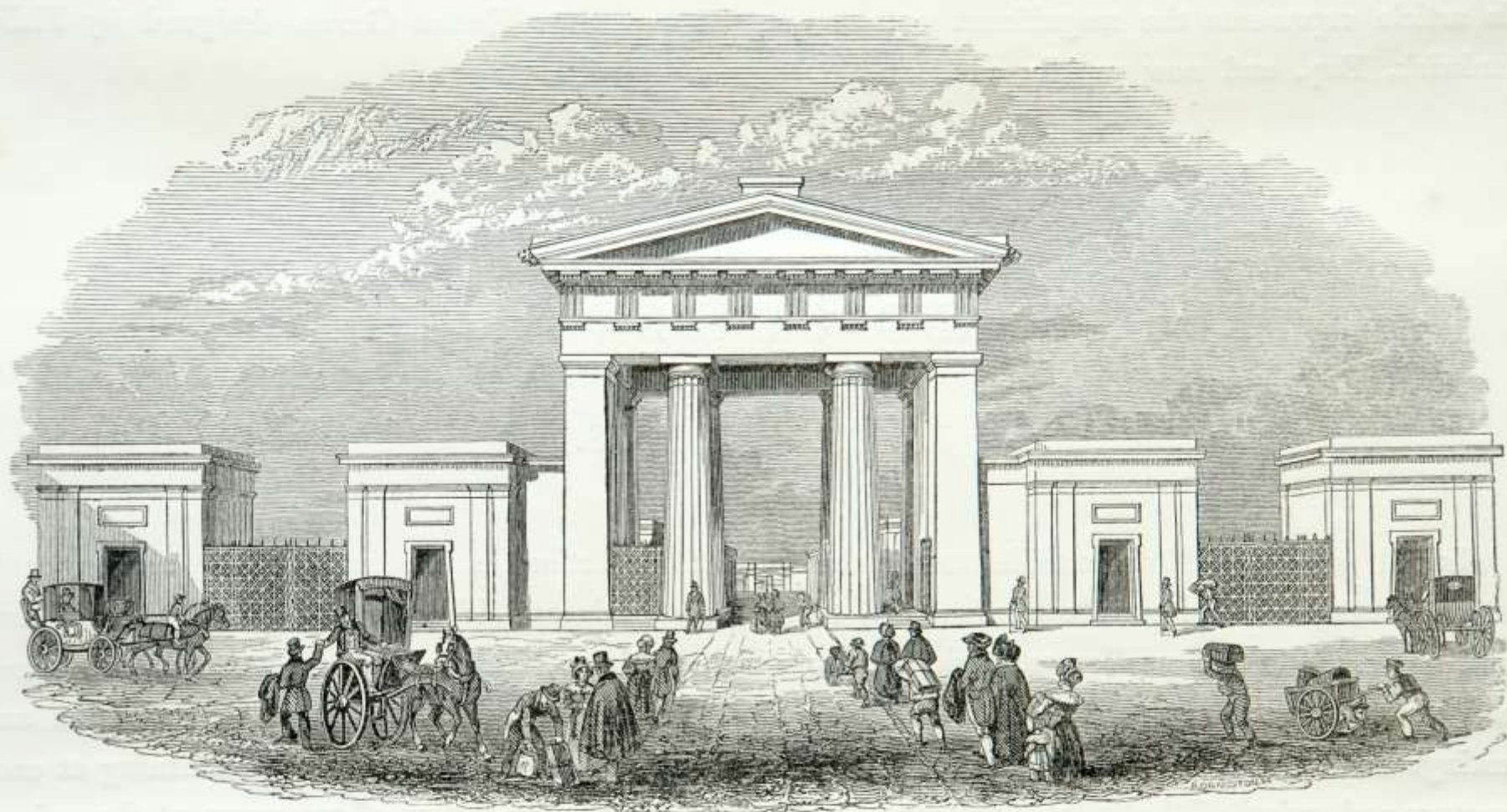
SECTION OF RETAINING WALL C



London-Birmingham (1838), Euston Station, Gesamtanlage (Simms 1838)



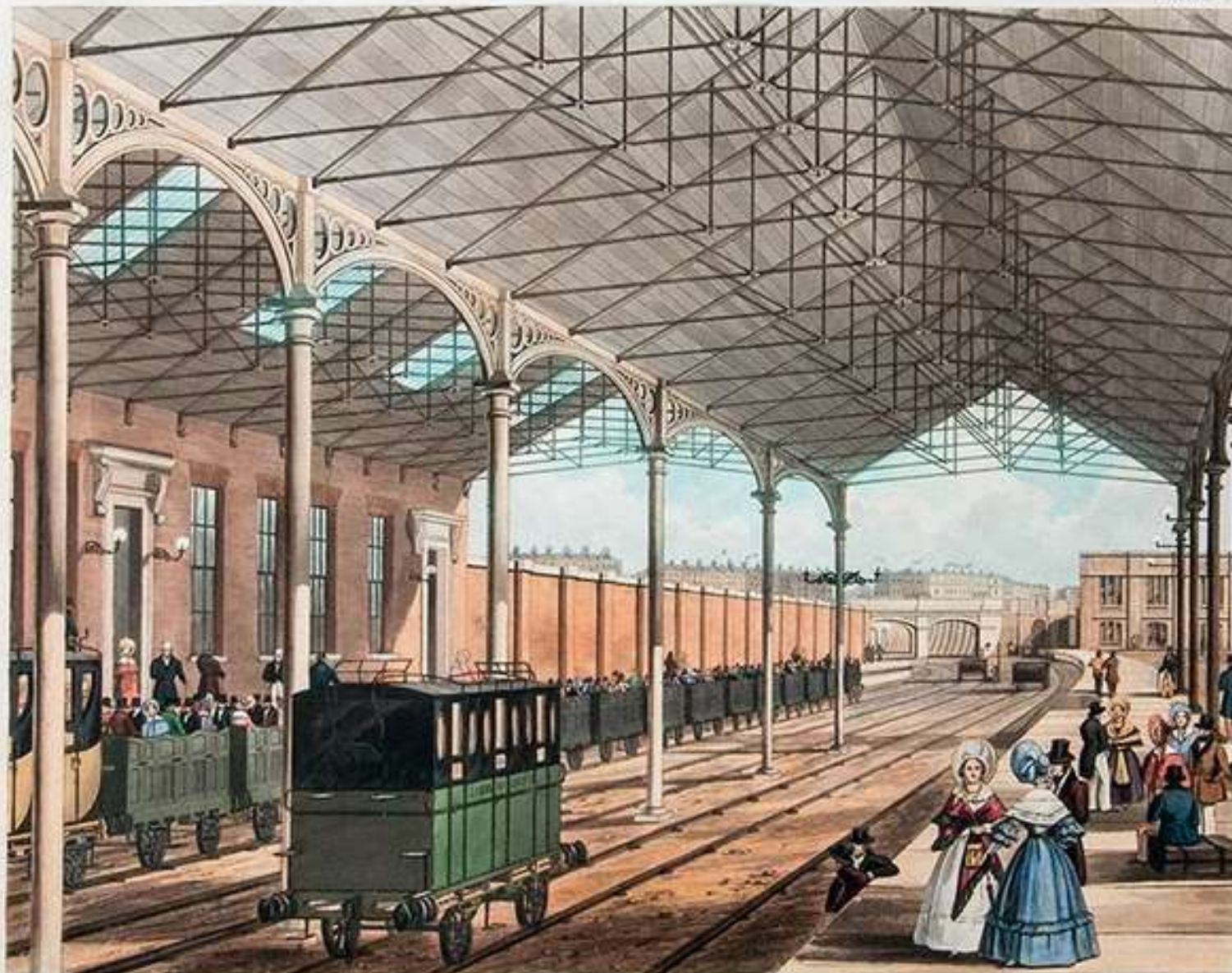
London-Birmingham (1838), Euston Station, Gesamtanlage und Funktionalität des Kopfbahnhofes (Simms 1838)



ENTRANCE TO THE STATION AT THE LONDON TERMINUS.

LONDON AND BIRMINGHAM RAILWAY.

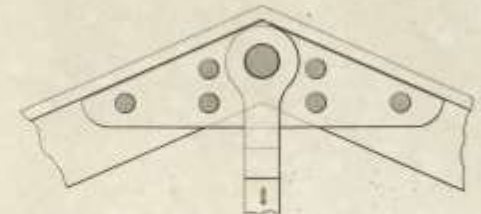
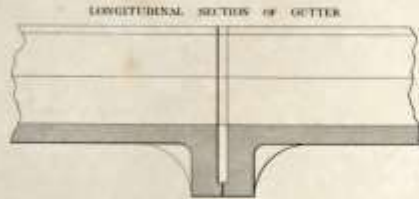
London-Birmingham (1838), Euston Station, Zugang zum Abfahrtshof
(Simms 1838)



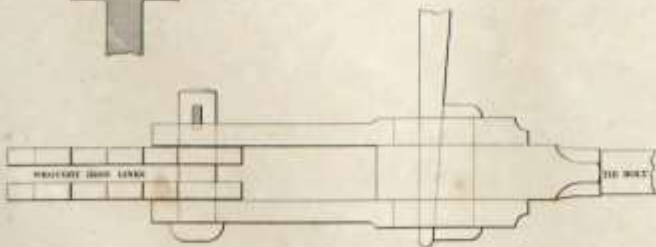
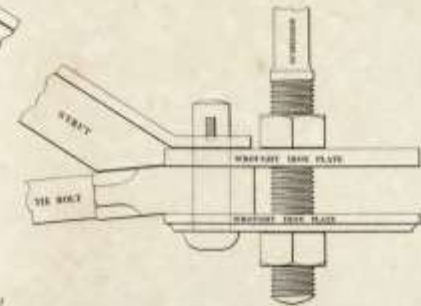
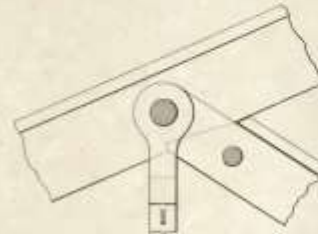
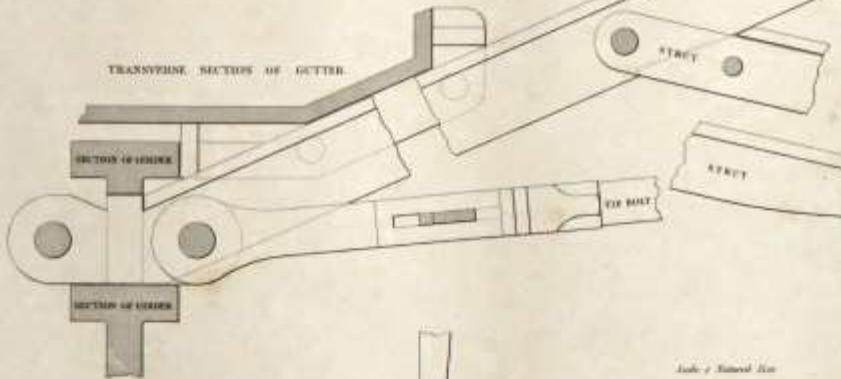
THE STATION AT EUSTON SQUARE

London, London-Birmingham Railway, Euston Station (1836). Gusseisensäulen und Schmiedeeisendach (Aquatinta-Radierung von Talbot Bury, 1837)

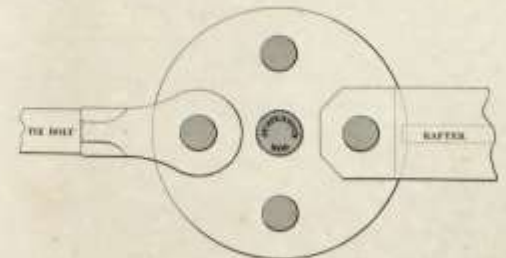
LONDON AND BIRMINGHAM RAILWAY
PASSENGER ROOF, EUSTON STATION



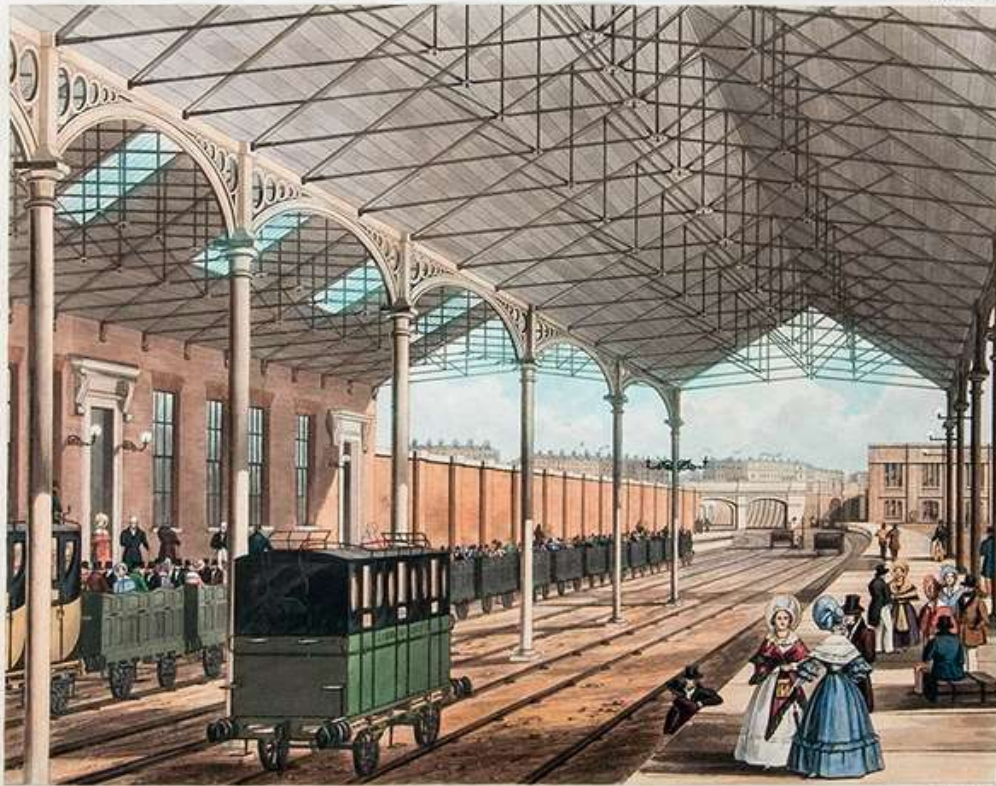
TRANSVERSE SECTION OF GUTTER



Scale of Vertical Size



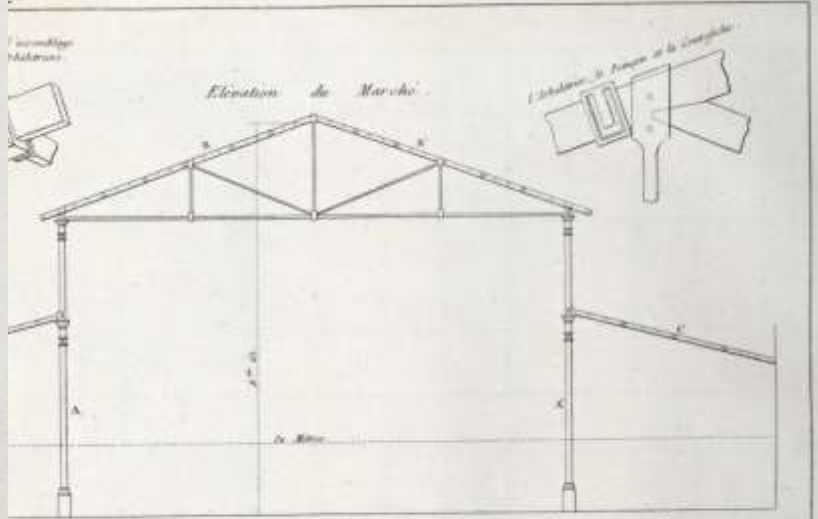
London, London-Birmingham Railway, Euston Station (1837). Eine der ersten Dachkonstruktionen aus gewalzten Profilen. Gelenkig ausgebildete Anschlüsse mit Bolzen (Simms 1838)



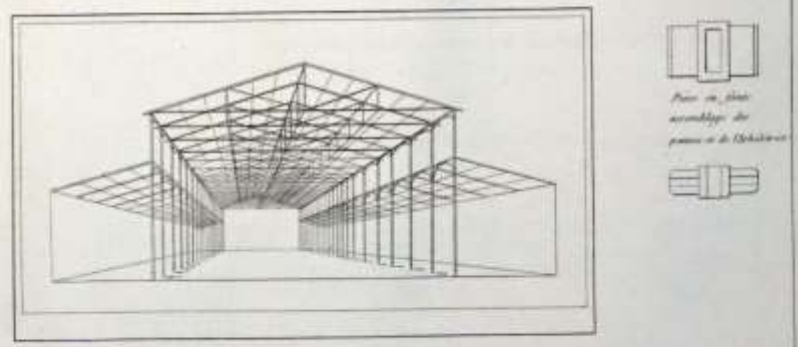
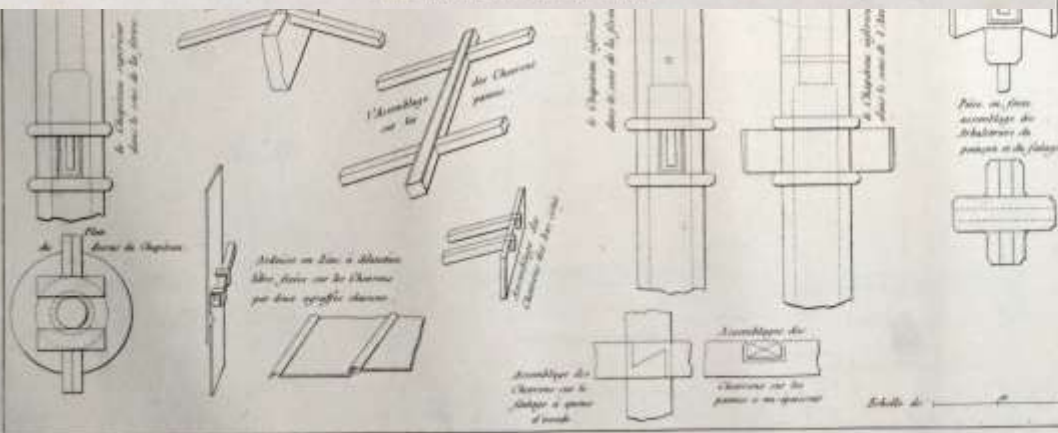
THE STATION AT EUSTON SQUARE

ny ané Architecte.]

Pl. 50.



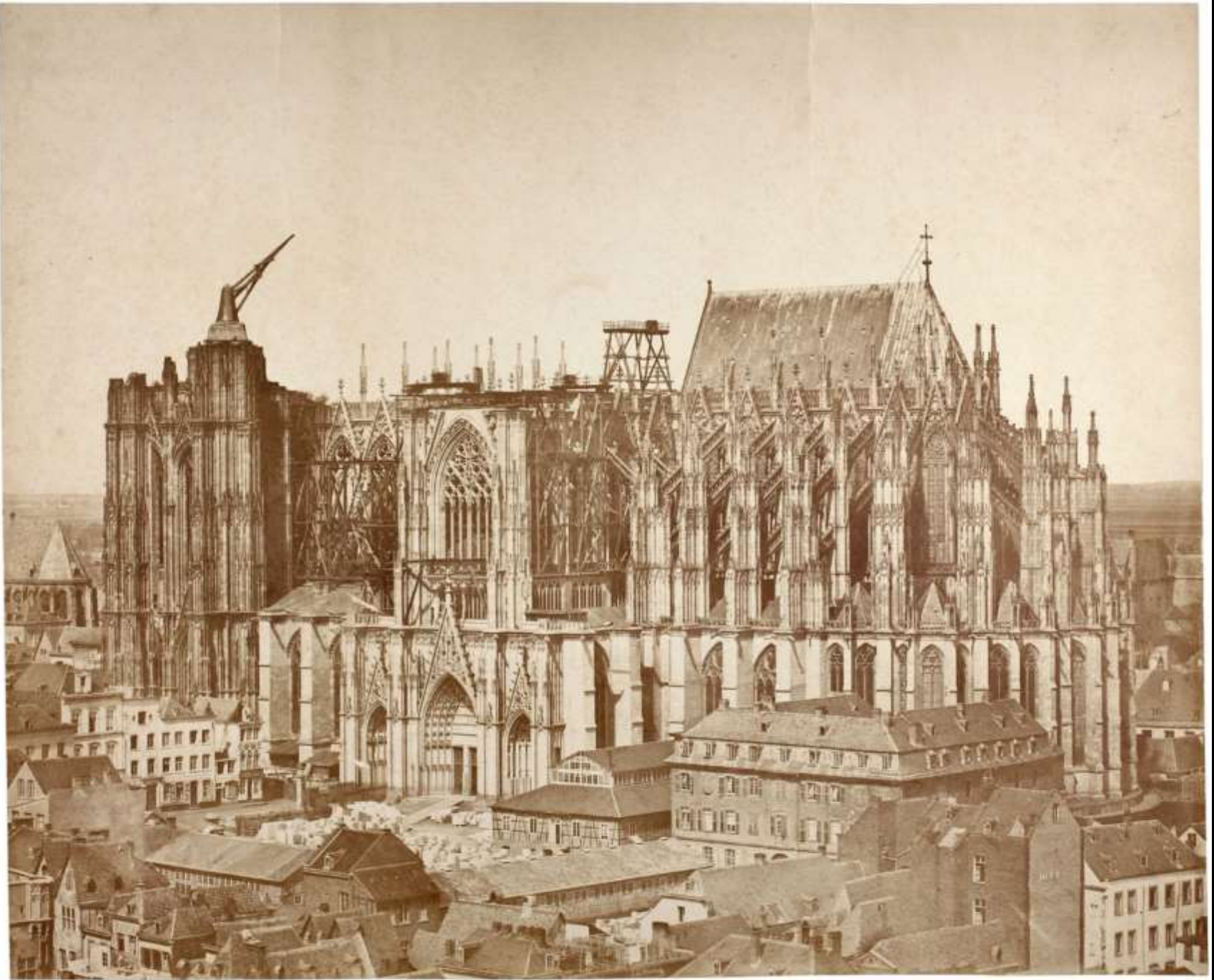
Elevation de Marche



Ferronnerie par M^r Gomet.

Marché de la Madeleine, Paris, und Euston Station, London, im Vergleich

Eisenbau und (Neu-)Gotik



Weiterbau und Vollendung des Kölner Doms (1842–80) – wichtigstes Monument der Neugotik

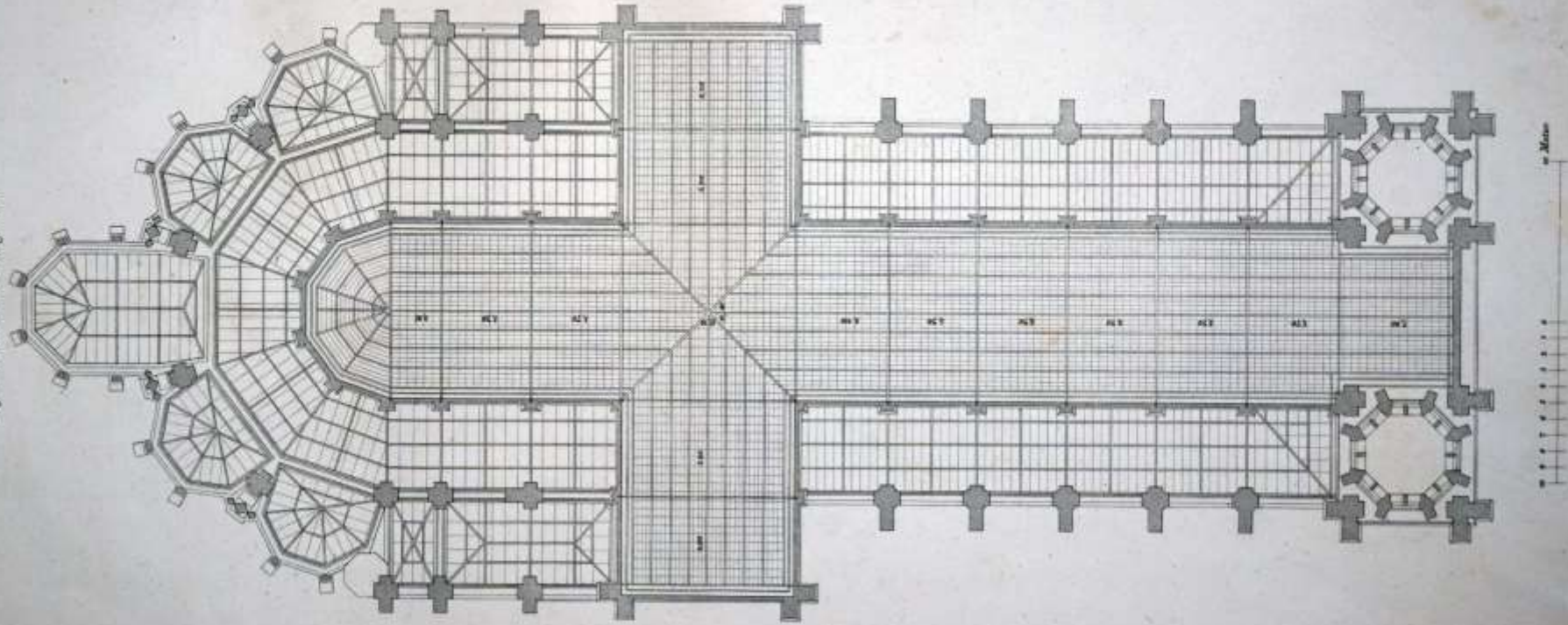


Paris, Sainte-Clotilde (Franz Christian Gau 1846-57)

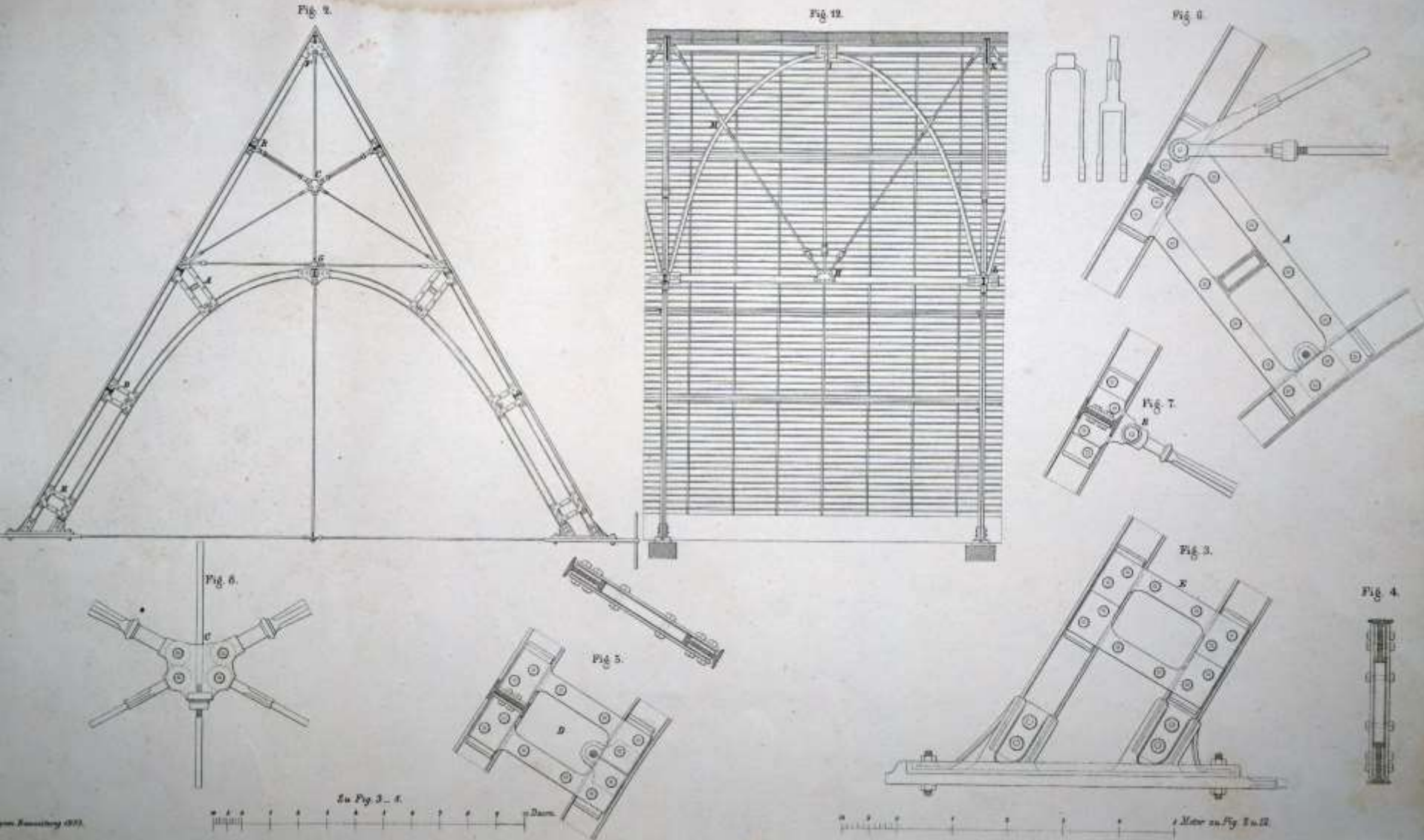


Paris, Sainte-Clotilde (Franz Christian Gau 1846-57)

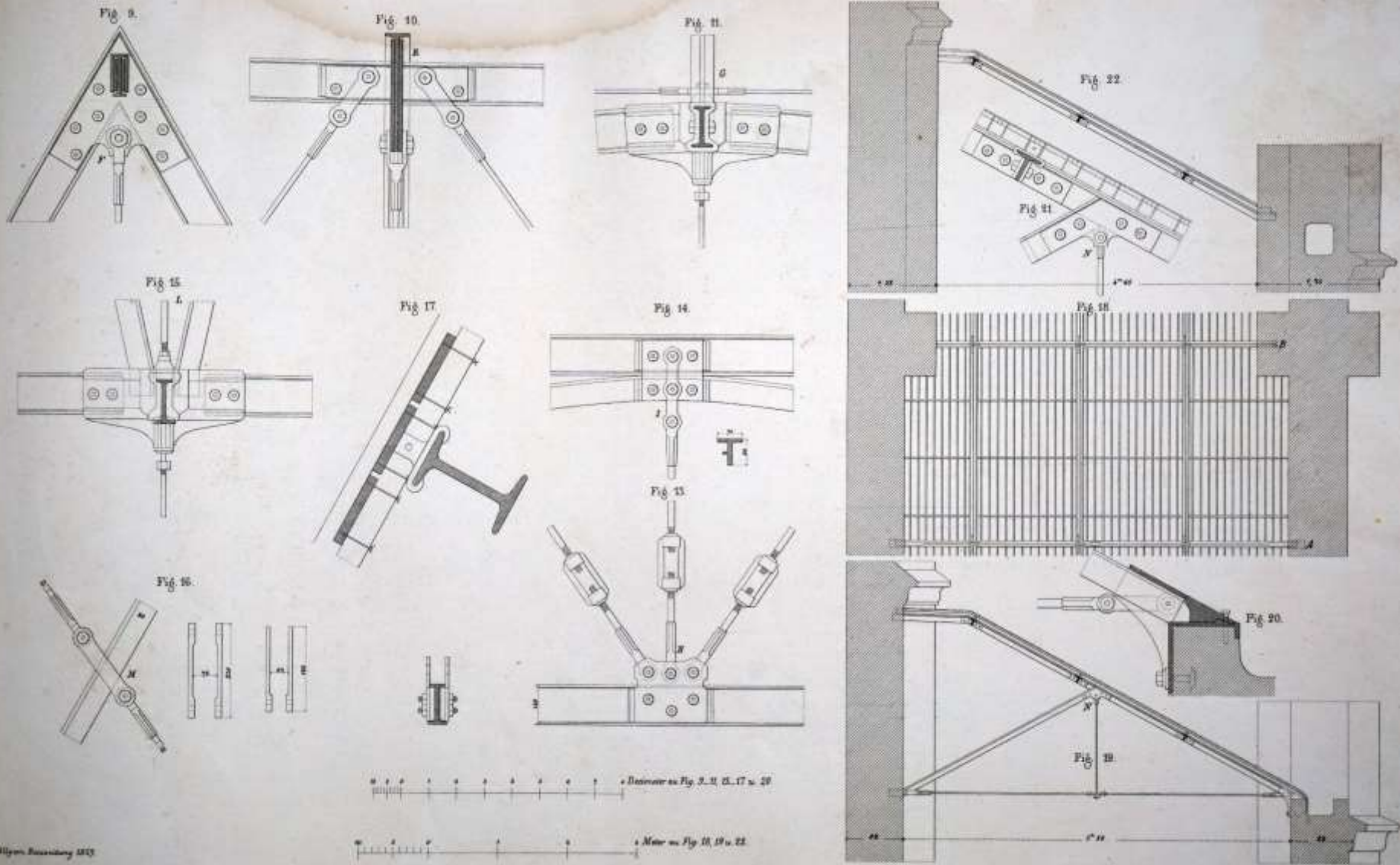
Fig. 1 Grundriss der Dachgehölze



Paris, Sainte-Clotilde (Franz Christian Gau 1846-57)
Dachwerk (Allgemeine Bauzeitung 1859)



Paris, Sainte-Clotilde (Franz Christian Gau 1846-57)
Dachwerk (Allgemeine Bauzeitung 1859)



Paris, Sainte-Clotilde (Franz Christian Gau 1846-57)
Dachwerk (Allgemeine Bauzeitung 1859)



Paris, Sainte-Clotilde (Franz Christian Gau 1846-57)



Paris, Sainte-Clotilde (Franz Christian Gau 1846-57)



Paris, Sainte-Clotilde (Franz Christian Gau 1846-57). Gewalzte I-Profile



Paris, Sainte-Clotilde (Franz Christian Gau 1846-57). Anschlüsse mit Sechskantschrauben