35. Cf. footnote 34.
36. Cf. Slotta, 1980, op. cit.,pp. 560-572.
37. Cf. Th. Möhrle, Eisenbeton im Dienste des Bergbaus. In: Technischer Centralanzeiger Kohle und Erz, 16, 1908, pp. 285 ff.
38. Cf. Schönberg, op. cit., p. 317. - W. Groß, 100 Jahre Grube Camphausen 1871-1971. - Slotta, 1980, op.cit., p. 70.
39. On the use of reinforced concrete in frames and winding towers, see F. Kögler, Fördertürme und Fördergerüste in Eisenbeton. In: Glückauf, 57 (1921), pp. 901-906, 929-935 and 957-960. - dto., Neue Fördertürme und Fördergerüste in Eisenbeton. In: Glückauf, 58, 1922, pp. 917-922. - dto., Neuere Fördertürme und Fördergerüste aus Eisenbeton. In: Glückauf, 63, 1927, pp. 185-193.
40. Cf. Slotta, 1980, op. cit., pp. 207-210. - ibid., Bemerkungen zum Verhältnis von "Technik" und "Kunst" am Industrie- und Maschinenbau. In:Die Nützlichen Künste (ed. by T. Buddensieg and H. Rogge), Berlin, 1981, p. 204.
41. Cf. B. u. H. Becher, H.G. Conrad, E.G.Neumann, Zeche Zollern 2 - Aufbruch zur modernen Industriearchitektur und Technik. Munich, 1977 (= Studien zur Kunst des 19. Jahrhunderts, vol. 34).
42. See also various volumes of pictures, e.g., Bernhard and Hilla Becher, Fotografien 1957 - 1975 (ed. by K. Honnef), Bonn, 1975 (= Kunst und Altertum am Rhein - Führer des Rhein. Landesmuseums in Bonn, No. 59). - Special literature is available on specific types of frame designs. Especially the volumes of the journal Zs.f.d.Berg-, Hütten- u.Salinenwesen im preußischen Staate will be a rich source of information.

IRON AS A BUILDING MATERIAL IN THE ARCHITECTURE OF HOUSES IN THE SECOND PART OF THE NINETEENTH CENTURY - INQUIRIES ABOUT THE DEVELOPMENT IN THE USA

Barbara Lipps-Kant

"The age of iron" in American architecture includes the time between 1850 and 1880. The following will attest that this important part of the American art history has been relatively unknown. (1)
Since bridges, conservatories, arcades, exhibition buildings, railway stations and trainsheds were built in Europe much earlier in similar ways, they will not be regarded in this essay. In contrast to Europe in the Americas, beginning first in the U.S., iron as a building material played an important part in the construction of houses after 1850. Elaborately decorated iron fronts characterized the streets in the cities. Warehouses, stores, office buildings, hotels, theaters, libraries, dwellings, townhouses, business buildings, but also factories, granaries, arsenals, ferry houses, light houses etc. had been constructed completely or at least partly from iron. Since the middle of the century iron was available in large amounts and was cast in this country. (2) The technology of the casting was known and reached the same level as in England. Soon the iron foundries offered a large variety of architectural parts. In the second part of the nineteenth century the revival of former styles became important in architecture. With cast iron as a building material these ideas gained special influence. The different patterns came from the Renaissance, the Gothic, the Romanesque, the French Empire and the Moresque architecture etc.. During the seventies and even more the following decade a tendency to accentuate the construction became important. A dramatic change in the facade pattern took place. Not only were the iron parts reduced in size in favour of increased windows, but the decoration was reduced as well. This early functionalism is a predessesor of later ideas in architecture. (3) After 1880 cast iron was less involved as a visible building material, (4) but took a significant part in the construction of houses as well as skyscrapers, where it was used as a material for the frame. Finally, displaced by steel structures, cast iron appeared only in the ornamental architecture.(5)
In 1854 William Fairbairns basic book about iron architecture "On the Application of Cast and Wrought Iron to Building Purposes" was published in New York City after an earlier London edition. (6) Thomas Tredgolds detailed results from his research about the strength and the properties of cast iron and other metals, (7) William V.Picket's "A New System of Architecture, Founded in the Forms of Nature, and Developing the Properties of Metals", (8) and other special literature were discussed amongst American architects.(9) The fashions of building in the old world and especially in England were reviewed regularly in the periodicals of art and architecture.
In 1856 James Bogardus published John W. Thomson's pamphlet "Cast Iron Buildings: Their Construction and Advantages" (10) - a passionate appeal for cast iron and its use in building. During the following years a series of books about iron and, most importantly, about the application of cast iron appeared. (11)
Besides Bogardus' paper however another work published in 1865 is of interest for research. The pattern book "Illustrations of Iron Architecture Made by the Architectural Iron Works of the City of New York", (12) which is equipped with many precious lithographs,

shows the amount, the richness in decoration and the regional spreading of the iron buildings made by Daniel D. Badgers firm in New York City. James Bogardus (13) and Daniel D. Badger (14) belong to the founders of the American iron architecture and are responsible for its vast development. They explained the new technology with vehemence to the public and were greatly involved in the break-through of cast iron as a visible material for building. Both believed themselves to be the inventors of the first iron structure. (15) This credit cannot be due to them, but because of their inventive ideas with practical realizations these two men take key positions in the American architecture of the second part of the nineteenth century.
Building in iron, characteristic for the age of industrialization, had its beginnings in France and England. Wrought iron had priority in France, while cast iron was given preference in England. During the end of the eighteenth century fundamental knowledge about this material was collected. (16) The properties of iron and other metals were tested in a large series of experiments. (17) These investigations became even more important after the collapse of some iron structures in England and Scotland. These failures were also known in America. (18) Hence iron only made its way into the sector of architecture during the forties of the nineteenth century.
The Miner's Bank in Pottsville, Pennsylvania, from 1828, is considered to be the first example. Cast iron plates covered the facade.(19)
At about 1830 Cyrus Alger (20) from Boston outlined plans for a cast iron townhouse. Daniel D. Badger was familiar with these designs.(21)
In New York City in 1835 iron was used for the first time in the exterior of the Lyceum of Natural History, Broadway near Spring Street. Iron columns in the first story of the facade supported the upper brick walls. (22) The same construction was repeated two years later in the Lorillard Building, Gold Street, New York City. Two rows of columns were introduced into the facade. (23) In 1842 Daniel D.Badger erected his first store front in Washington Street, Boston - a cast iron facade in the ground floor of a multi-story commerce building. (24) A block of three-story houses was constructed in Cincinnati during the summer of 1847. It was said the complete iron fronts for these buildings had been cast already in July, 1847. (25) The casting was most probably done by Gardner Lathrop's Cincinnati Iron Foundry, which had offered "iron building fronts" since 1846. (26)
All these structures were admired sensations at that time, but still, the widely circulating prejudices against the iron could not be eliminated. The break down of the iron architecture as a result of their own weight, the threat of lightning, the suspected melting of the iron parts in case of fire, or the deformation of the architecture owing to seasonal variations of temperature, were all predicted.Only James Bogardus with his unlimited recommendation of iron was able to change the public opinion. In building his own factory completely of iron he presented evidence for the accuracy of his thesis.
On a journey to Europe he had studied the different building types and styles from the antiquity to the romantic period. And in England he had learned the versatile use of iron. As was common practice in the nineteenth century, he wanted to recreate the styles of the past. As early as 1840 on his trip to Italy, having seen the splendor of venetian marble palaces, he felt that cast iron could be an adequate means for the realization of his plans. The Doge Palace in cast iron imitation - an American dream or the typical manner of thinking at that time? Bogardus was so faszinated by the possibility of any moulding of the material, that he was unable to see the disadvantages - which was ecclecticism in the negative sense, a

pretended uniformity and monotony related to the reproduction of the patterns or on the other hand the overloading of facades by too much ornament. After his return to America he became the main defender of the iron architecture. These buildings were easy and quick to erect. There was no dependance upon the seasons. The iron parts had a high capacity of bearing loads. The buildings were highly dissectible. The costs of building were low. The superiority of the iron architecture above all traditional ways of construction - these were Bogardus' recommendations. (27) As a demonstration to prove the correctness of his ideas, in 1847 he designed a building completely made of iron, his own factory. (28)
The same year a cast iron model of the project was exhibited in his workshop. Again this caused discussions. In May 1848 the excavations and the laying of the foundations were started at the corner of Centre and Duane Streets in New York City. Extensive stone foundations were anchored firmly into the ground. Upon these were laid cast iron sills of equal thickness, connected to the ground and together with bolts. From the joints of the sills columns raised, each bolted twice to the sills. The cornice to the next floor was formed by a layer of sills of the same length and width but of greater height. The connection between these and the columns again were bolts. Above it three stories and the attic raised; all were constructed in the same way. The upper part formed an entablature. In the spaces between the columns appeared windows, doors or panels. The frames of the windows, the doors, the divisions between floors, were, in addition to the floors and the roof plates, made out of iron. A coat of paint put on before the mounting protected the iron against oxidation. (29)

With his factory Bogardus had created a model of architecture. Beauty, stableness, durability, fire proof construction, insensitivity to thunderstorms and lightning and economy of the fabrication were greatly admired. (30) At that time the famous structure was well publicized, even in England. (31) Finished in 1849, the building had to be taken down in 1859 during the construction widening Duane Street. The factory was taken into parts and designated to be rebuilt - again a proof of the correctness of Bogardus' ideas. (32) Nevertheless there are some doubts about this reerection of the factory. (33)
In the previously mentioned booklet of 1856, Bogardus presented a vision of his factory. In the engraving only some structural iron parts remain in place though the building is standing and the chimneys are smoking. An impressiv demonstration of stability! In connection with a building material less accepted until than, the factory was a new and by all means revolutionary construction. Its influence on contemporary American architecture we can only speculate. To few of those structures which arose in connection with this future oriented building are preserved. There may have been prototypes for the factory outside of America. For example William Fairbairns steam flour mill, constructed 1839/40 for the Turquish Army in Konstantinopel. (35)
But Bogardus insisted that he built the first all iron structure. In May 1850 he applied for a patent for his invention. (36)
In 1848 Bogardus used some of the parts from his as yet unfinished factory to build the drugstore for John Milhau in 183 Broadway, New York City. The five-story building received a cast iron front. The facade was mounted on the supporting brick wall. The interior sections were made out of wood. (37)
Likewise in 1849, the facades for the Laing Stores from the stock of the unfinished factory were composed. A series of three stores at the corner of Washington and Murray Streets, New York City. The owner was Edgar H. Laing. The iron parts disguised the four-story brick building.

This construction with its rounded corner served Bogardus as a study for his own building. The Laing Stores were kept at the original site until 1971. Since the twenties the facades were missing all decorations, hence appearing modernized, as photographs from this period and later show. Today the Laing Stores are considered to be a registered landmark. Their iron fronts were been taken apart in 1971 by the landmark commission and were to be rebuilt on the campus of the Manhattan Community College in New York City. (38)
His factory and the two connected facades had made Bogardus famous to such a degree that there was a major interest in his patented construction also outside of New York. In 1850 he received an order to equip the new Baltimore Sun Building with two fireproof cast iron facades. It is known, that the architect of the Sun, Robert G. Hatfield, had recommended Bogardus and his invention to the owner of the newspaper A.S.Abell. Hatfield also had designed the plans for the iron fronts of the five-story corner building. They are different from Bogardus earlier facades. Whilst those emphasized the plane wall, these show baroque patterns, producing a considerable loosening and an increasing plasticity of the wall. (39)
Numerous conflagrations had devastated large parts of American towns. The wooden houses, a less developed system of fire alarm, and the enormous difficulties in extinguishing fires led to catastrophes. Iron constructions offered protection.
In 1851 Bogardus was asked to build a fire alarm bell tower for the City of New York. This tower was erected in 33rd Street near 9th Avenue that same year in the middle of August as a complete iron structure without walls. From the decagonal ground plan elegant columns raised, joined by slender girders on the level of the capitels. Above again columns and girders etc.. A spiral staircase rose up to the lookout. The middle of the filigreed tower was broken by two platforms, bearing at the upper level the strong fire bell and serving to ring the alarm below. (40) The importance of this first of Bogardus' towers with respect to the succeeding architecture was recognized by T.C. Bannister. (41) The principle of construction is identical to that of the factory in Centre and Duane Streets but includes only the frame. This functional structure became the prototype for the main tower of Bogardus' plan of his exhibition building for the world fair in 1853 in New York City. (42) This plan never was carried out. The fire alarm bell tower at the corner of MacDougal and Spring Streets in New York City, and the lighthouse on the entrance to the harbour of Santo Domingo, Dominican Republic, both erected in 1853, contained the same construction.
During the following years Bogardus created many all iron structures and a remarkable number of iron facades. Some of these are enumerated in his publication from 1856.(43) Two more of his buildings shall be mentioned here: the Harper & Brothers Building in Pearl Street on Franklin Square, and the McCullough Shot Tower in 63-65 Centre Street, New York City.
The Harper printing plant from 1854, conforming to the request of the owners a fireproof iron architecture, was built in the shortest possible time.(44) The designs were made by John B. Corlies and James Bogardus. The interior had cast iron columns, beams, stairs and floors. A magnificent five-story iron facade in the Neo-Baroque style embellished the exterior. Many of the architectural iron parts had been cast from the ancient moulds of the Baltimore Sun Building. These moulds were used because of the shortness of time. The architect R.G.Hatfield agreed with this. The Harper Building has been one of the most famous iron structures - a "statement of the spirit of that time" as Giedeon says.(45) The most modern knowledge about material

and construction was combined with a characteristic fashioning, following the taste of the time for Italian patterns. The splendous front with twenty window axis had been painted in a bright colour. The building, which unfortunately was destroyed, can be seen on old prints and engravings. One receives the impression of a precious marbe palace situated in the midst of modest lower houses.

The following year Bogardus constructed the McCullough Shot Tower in Centre Street. This tower seemed not to be important enough to be mentioned in the pamphlet of 1856. By order of the McCullough Shot and Lead Company rose a tower for the manufacture of small shot and bullets.(46)
Towers of this type existed in the middle of the nineteenth century in Baltimore, Philadelphia, St. Louis, Lead Mines/ now Austinville and New York. In general they were about 70 meter high and built in massive brick construction. In the interior melted lead was poured through a sieve from the upper level. The lead drops hardened in falling down and were caught up in a water basin. The Phoenix Shot Tower in Baltimore from 1828, today a registered landmark, gives evidence of the old tradition of shot manufacture. (47)
James Bogardus' New York project had no well known plans to refer to. The ground in Centre Street was humid and soft. This fact and the small size of the building lot excluded a traditional heavy brick structure. Instead a light cast iron frame was chosen for the octogonal tower. Horizontal and vertical iron parts supported the light brick walls like a skeleton. This visible exterior iron frame is a logical outcome of his factory architecture from 1849. In the McCullough Shot Tower a undisguised constructive iron frame is to be seen for the first time. With that Bogardus was a fore-runner for modern architecture.
In the fifties of the last century iron as a building material gained more and more significance. Iron fronts became fashionable. The manufacture of cast iron parts no longer was limited to a small number of foundries. A large series of iron works had been founded. Long established foundries adapted their production to the new needs. It would be interesting to compare the patterns of the particular firms in the different regions. Then one could make exact statements about the adoption and the spreading of the different architectural styles, about the taste of that time and about the standards of casting. The preeminence of New York in the manufacture of cast iron buildings could possibly be proven. For some time New York City's superiority in both - quality and quantity of iron architecture - has been presumed.
Bogardus, one of the pioneers of iron buildings, soon found himself in a situation of competition. Many other firms suddenly offered iron architecture as well. Daniel D. Badgers Architectural Iron Works, situated in front of Bogardus' factory in Centre Street, became extraordinarily successful. Badgers connections with leading architects in the design and production of new architectural parts turned out to be beneficial. The offerings of the Architectural Iron Works, such as shown in the pattern book of 1865, were various. Iron architecture in many different styles was introduced. Cast iron as an inexpensive building material, painted in bright colours, made possible the erection of splendid buildings. A dream of white marble palaces became apparently reality. T.C.Bannister calls cast iron one of those characteristic substitutes, symbol for "the nineteenth century's yearning for low cost haute couture".(48) No other material guaranteed the availability of different architectural styles to that extent.

As a reminder of the nineteenth century, the "cast iron palace" from E.V.Haughwout is still standing at the north-east corner of Broadway and Broome street in New York City. A coat of nearly black paint, representing the taste of our century, gives the building an unaccessible and dark touch. John P. Gaynor designed the patterns for the fronts of the five-story corner building in 1857. They were cast the same year at Badgers firm. The magnificent Neo-Renaissance architecture with its corinthian columns, roman arch windows, cornices and heavy entablature calls venetian models. Originally the iron parts were painted white. The Haughwout Store was famous for its elegant goods and distinguished clients. Therefore an Italian palazzo seemed to be a suitable building type. The store was published as an outstanding design in the pattern book of the Architectural Iron Works in a colour lithograph. (49) During the following decade this palace type of Italian provenance appeared in the architecture of stores and warehouses. Those palaces originated in many towns. The plasticity of their well balanced iron facades was generally admired.(50)

The pluralism of styles as well as the different possibilities of combining the iron parts produced an astonishing variety of iron architecture. This can be seen even today in some streets of the SoHo district in New York City. As already shown in Bogardus' constructions the use of a module system was common. Badgers firm alone was represented in 1865 in New York with 551 buildings or iron fronts.(51) Brooklyn is listed with 28 buildings: one of them a gigantic grain storage house, built for the United States Warehousing Company from plans by George H. Johnson. (52) Badgers production reached several thousands. By ship or railroad his iron parts came to all big cities on the East coast, to the South - Atlanta, Charleston, St. Louis, New Orleans etc., to the West coast - San Francisco, to Canada, Cuba, Brazil, even to Alexandria in Egypt. (53)
Iron as a building material was not only preferred in the construction of factories, shops, stores, warehouses and office buildings but also for dwellings and town houses (54), for hotels (55), for theaters (56), for libraries (57), and for bank buildings. Thanks to James Bogardus and Daniel D. Badger the iron architecture quickly gained recognition. The fashion to disguise houses with prefabricated cast iron parts went so far as to treat some of the older buildings as well. The large supply of cast iron products spurred the founding of an abundance of iron works. Besides the factories of Badger and Bogardus, New York City and Brooklyn had 39 other firms manufacturing parts for iron architecture. The reaction to this in the other states proceeded in a similar impetous way. A temporary stagnation was perceptible only in the South during the Civil War.
New York City is the town with the highest amount of constructed iron architecture. And here preservation of these buildings is also the furthest developed. Besides New York, St. Louis had a remarkable number of cast iron buildings. Along the missisippi the first iron fronts were built from 1849/50 on - modest constructions with pilars or columns and large windows. (59) None of these old and at that time numerous shopfronts and office buildings survived. St. Louis was then the big trade center for the West. In 1849 a conflagration destroyed parts of the old town. Warehouses, stores and office buildings were required. Cast iron - fire proof and at hand in prefabricated parts - gained preference as a material for rebuilding the town. Many of the structures were erected without plans from architects but only by the iron works. Siegfried Giedeon has a quite realistic view in saying: "The owners of these foundries, unlike James Bogardus, had no Italian

travels behind them and no desire to inaugurate a Renaissance revival in cast iron." (60) A second boom succeeded after the Civil War. Again cast iron predominated. The buildings of this second period, ornated to more extend than the earlier ones, contributed to the splendour of the Riverfront. From the approximately 500 iron buildings of this worldwide famous site only one, the Old Spaghetti Factory, is preserved. (61) This six-story building from the late seventies at the corner of First and Morgan Streets shows a rich cast iron facade with pillars and an elaborate entablature. The iron parts are painted and give the impression of sandstone. Some constructive parts in the interior are made of iron too.
In the second part of the nineteenth century iron architecture dominated in most of the cities in the United States. But neither in Baltimore, Boston, Philadelphia, Chicago, Pittsburgh or San Francisco can essential works be seen today. What was not destroyed by fire, earthquake or concepts of townplanning before 1910, became a victim of modernizing in our time. Besides New York, where in 1973 all 126 blocks of SoHo had been declared as a historic district - this is the area with most of the old iron houses - there are only a few places where iron architecture is still preserved.
The Skidmore Area in Portland, Oregon, is one of them. Along the Wilamette River before 1892 180 out of 200 brick buildings had facades, inner supports or decorative parts in cast iron. Twenty of these buildings are left. (62) In contrast to structures in Baltimore or New York City Portland's iron fronts seem to have less plasticity. The characteristic pillar formations form single houses or whole blocks in an uniform way. The same design is applied many times. The Portland iron architecture, even if mentioned only at that time in enthusiastic terms, gives an impression of a certain monotony. But this statement is made by looking through old pictures.
Central City in Colorado, an old mining town, is another example of preserved iron architecture in a confined area. In the center on two streets cast iron fronts from 1874/75 can be seen. In 1874 only the Operahouse survived a conflagration. Immediately after this catastrophe the miners started with the reconstruction. To prevent a similar calamity in the future, they constructed fireproof buildings using stone and iron instead of the wooden houses. Rich cast iron fronts, colourfully painted in the manner of the West, presented shops, restaurants, the saloon, the prison and the sheriff's office as important buildings of the, at that time, rich goldmining town.Some of the houses are dated 1874 in the gables. Nothing is published about the iron architecture in Central City so far. The iron parts are supposed to have come from foundries in St. Louis. (63)

Cast iron, as shown above, took not only an important place in the construction and decoration of exteriors but was also a firm component in the interior, used constructively and ornamentally. Primarily in factories and stores, where large halls were needed, pillars or columns and beams were iron. The majority of these iron parts were painted white.
The reading-room of the Peabody Institute Library in Baltimore is one of the few examples of a complete inner iron structure. It was built in 1878 from plans of Nathaniel H. Morrison and Edmund G. Lind. (64) The main library hall, a large tall room with skylight, is bordered by five stories of open galleries containing the bookshelves. Heavy pillars support the galleries, which are connected by stairs. The iron parts are painted in a light grey. Bits of goldpaint can be found in the ornaments. On the occasion of the 100th birthday of the library J. Dorsey described the interior as "a combination of functional statement and sheer drama". (65)

Besides being used as a visible material for construction, iron did appear as support inside of walls. Hereupon a final statement shall be given. The cupola of the State Capitol in Washington is considered to be the most important early example. The original wooden constructions turned out to be of less carrying capacity than expected and had to be replaced in 1855 by cast iron ribs resting on an octogonal base. (66)
The eighties of the nineteenth century became decisive for the use of iron as a constructive material inside of walls. The invention of the elevater made skyscrapers less problematic. Everywhere in the cities more space was needed. Banks and insurance companies were the first to ask for higher buildings. Certainly these early skyscrapers were not very inviting with their heavy stone walls and little windows. William LeBaron Jenney used iron for the first time in 1885. When the Home Life Insurance Company in Chicago asked him for a plan for an office building, he proposed a supporting iron structure for the ten-story building. Cast iron was the expected material for this. But during the construction steel beams and supports were offered by the Carnegie Phipps Steel Company. So he changed the material. The Home Insurance Building in Chicago is the first skyscraper built in the modern way. The construction dates back to the McCullough Shot Tower from Bogardus. LeBaron Jenney had seen and studied this tower in New York City. Like there the walls are supported by a carrying frame. A pioneer structure, astonishing in the simplicity of the construction! (67)
Louis Sullivan accomplished the final step into the architecture of the twentieth century with his Schlesinger & Mayer Store, later known as Carson, Pirie & Scott, in Chicago. (68) It was planned in 1895 and the following years and built from 1899 till 1904. Sullivan followed LeBaron Jenney's principles of construction but created a more functional architecture. The narrow partitions besides the large windows give the effect of lattice, an expression of the inner supporting steel frame. Cast iron as a material for ornamentation is used on the outside of the two lower exhibition floors, in the lobby and in the salesrooms. As a typical material of the nineteenth century it had to give place to steel and concrete. However, this must be stated in conclusion, without the American cast iron architecture and their far developed technology, modern building would not have been possible.

Notes

1. The history of the American iron architecture has not been written yet. Proofs of this development, which is typically American, become rare.
   Literature about iron architecture in the USA: Siegfried Giedeon: Space, Time and Architecture. Cambridge, Mass.,1941. - John Gloag, Derek Bridgewater: A History of Cast Iron in Architecture. London, 1948. - Turpin C. Bannister: The First Iron Framed Buildings. Architectural Review, Vol.107 (April,1950), pp. 231-246. - Henry Russell Hitchcock: Early Cast Iron Facades. Architectural Review, Vol. 109 (February, 1951), pp. 113-115. - W. Knight Sturges:Cast Iron in New York. Architectural Review, Vol.114 (October, 1953), pp. 232-237. - Turpin C. Bannister: Bogardus revisited. Journal of the Society of Architectural Historians, Vol. 15 (December,1956), pp. 12-22; Vol. 16 (March, 1957),pp.11-19. - Carl W. Condit: American Building. Chicago, 1968. - Sidney Fiske Kimball:American Architecture. New York, 1970. - W.Knight Sturges (Introduction): The Origins of Cast Iron Architecture in America. New York,1970. - Henry Russell Hitchcock: Architecture: Nineteenth and Twentieth Centuries. Baltimore, 1971. - Margot Gayle: Cast Iron Architecture in New York. New York, 1974. - William John Hawkins: The Grand Era of Cast Iron Architecture in Portland. Portland, Oregon, 1976.
2. In 1648 the first American iron works were founded on the Saugus, Massachusetts, and were maintained by experts and iron workers from England. In the beginnings seven tons of iron were produced per week. Leander J. Bishop: A History of American Manufactures from 1608 to 1860. Philadelphia, 1861.
3. This architecture was not conformable to ideas in the 19th century. There is no revival of the past. Functional facades characterized parts of the Riverfront in St. Louis, which is destroyed today.The Gantt Building in 219-221 Chestnut Street, St. Louis, a five-story office building, with its cast iron front from 1877, is an example for this functional building type. - S. Giedeon, op.cit.n.1, fig. 113.
4. After 1880 the number of new designs for facades diminished. But in the catalogues from iron works and foundries cast iron architecture was still offered later. To my knowledge the latest complete cast iron front was built in 1904; the facade of the Little Singer Building, 561-563 Broadway, New York City. The twelve-story office building with L-shaped ground plan,constructed for the Singer Sewing Machine Company, can be seen today. Ernest Flagg designed the Art Nouveau facade. - M. Gayle, op.cit.n.1,fig. p. 149.
5. After the socalled "Ferromania" there was a return to conventional building materials as are sandstone, granite, marble or brick,following the ideas from Ruskin. - T.C.Bannister, 1956, op.cit.n.1,p. 12. - John Ruskin: The Seven Lamps of Architecture. New York,ca. 1885.
6. William Fairbairn: On the Application of Cast and Wrought Iron to Building Purposes. London, New York, 1854.
7. Thomas Tredgold: Practical Essay on the Strength of Cast Iron and other Metals. London, 1822. - In 1842 the fourth edition of the late Thomas Tredgolds essay was published in London. This edition, enlarged and with footnotes by Eaton Hodgkinson, had a decisive importance for the use of cast iron as a building material.
8. William V. Picket: A New System of Architecture, Founded on the Forms of Nature, and Developing the Properties of Metals.London, ca. 1843.
9. Iron as a building material had been discussed largely in connection with the construction of bridges and railroads. - Report of the Commissioners Appointed to Inquire into the Application of Iron to Railway Structures. (Parliamentary Blue Book). London, 1849. - Edwin Clark: The Britannia and Conway Tubular Bridges. London, 1850.
10. John W. Thomson: Cast Iron Buildings: Their Construction and Advantages by James Bogardus Architect in Iron. New York, 1856. The volume from W. Knight Sturges (Introd.): The Origins of Cast Iron Architecture in America. New York, 1970, contains a reprint of this pamphlet.
11. Frederick Overman: The Manufacture of Iron in all its various Branches. Philadelphia, 1856. - Frederick Overman: A Treatise on Metallurgy. New York, 1864. - William Pole: Iron as a Material of Construction. London, New York, 1872. - N.E.Spretson: A Practical Treatise on Casting and Founding. London, New York, 1878. - A publication of the American government shall be mentioned as well:

Reports of Experiments on the Strength and other Properties of Metals for Cannon. 1856. - A great influence had the following books from England: Robert Mallet: On the Physical Principles Involved in the Construction of Artillery. London, 1856. - Experiments at the Royal Arsenal, Woolwich, on Cast Iron for the Manufacture of Cannon. Parliamentary Paper, 1858, No.492. - William Fairbairn: Useful Information for Engineers. London, 1860. - William Fairbairn: Iron; its History, Properties, and Processes of Manufacture. Edinburgh, 1861.

12. (Daniel D.Badger): Illustrations of Iron Architecture Made by the Architectural Iron Works of the City of New York. New York,1865. - The Volume from W. Knight Sturges (Introd.): The Origins of Cast Iron Architecture in America. New York, 1970, contains a reprint of this book.
13. James Bogardus (1800-1874), invented a number of machines,awarded prizes, owned many patents, one of the founders of iron architecture in America. 1836-39 London, 1839/40 journey to the continent, private studies of French and Italien architecture, 1840 return to New York, workshop in 40 Eldridge Street, N.Y.C.. B. offered his "eccentric sugar mill", 1844 larger workshop in 87 Eldridge Street, B. sold cast iron parts, which had been cast for him in other foundries, in 1849 new factory at the corner of Centre and Duane Streets in New York, trading with "Cast iron houses". B.created many cast iron buildings and facades in New York City and other towns of the U.S. and in foreign countries. A catalogue of his works has not been written yet. - Dictionary of American Biography, Carl W. Mitman "James Bogardus", - T.C. Bannister, 1956 and 1957, op.cit.n.1.
14. Daniel D. Badger (1806 - ?), apprentice in the iron trade, 1829: B. opened his own workshop in Boston, production of cast iron parts for buildings, B. contacted Cyrus Alger, the head of the South Boston Iron Works, in 1842 B. created his first cast iron shop front in Washington Street, Boston. 1843: B. bought from A.L. Johnson in Baltimore a patent for the manufacture of rolling iron shutters. In 1846 B. moved his factory from Boston to New York City. His new factory was in 44-46, Duane Street. Manufacture of cast iron fronts and iron rolling shutters. All his products gained great interest. A second factory was founded in East 14th Street in 1855. Since 1856 B.'s firm was registered as "Architectural Iron Works of New York". For nearly two decades this firm was one of the leading iron manufacturers of the country. From B.'s factory iron architecture was sent to clients in the U.S. and many other countries. - Illustrations of Iron Architecture, op. cit.n.12. - T.C. Bannister, 1956, op.cit.n.1,pp.14-17.
15. Bogardus believed himself to be the inventor of the first all iron building. He refered to his factory, which was completed in 1849. - J.W. Thomson, op.cit.n.10,p. 3.
    Badger refered to the one-story shop front in Boston from 1842. - Illustrations of Iron Architecture, op.cit. n.12, p.3.
16. For the first time cast iron as a building material was used for a bridge construction. 1779: Severn Bridge near Coalbrookdale, cast iron structure.
    In England cast iron columns and beams appeared in the architecture of factorys during the last decade of the 18th century. 1792/93: Calico Mill in Derby; 1796: Flax Spinning Mill of Benyon, Bage and Marshall in Shrewsbury; 1797: Strutt Mill in Belper.Also in churches cast iron was used. 1770/72: St.Ann's Church in Liverpool - cast iron columns supported the galleries; 1790/92: St. Chad in Shrewsbury - cast iron columns supported the gallery; 1784: St. Mary Magdalen in London - the new organ gallery was supported by cast iron columns.
17. Thomas Tredgold, Eaton Hodgkinson, op.cit.n.7. - W. Fairbairn, op.cit.n.6.
18. In America iron was discussed with vehemence. One asked even for the prohibition of this building material. Those, who were against the iron, described the threatening dangers of iron structures: the collapse of iron buildings, the attraction of lightning, not being fire proof etc.. The suppositions for these arguments were wrong. Only the knowledge of nearly unlimited reserves of wood and other building material allowed this discussion to be led that persistently and aloud.
19. John Havilland from Philadelphia was the architect. He had wanted for the facade of the brick building a stone mantling first. Instead of stone cast iron plates were used. They were painted in stone imitation. The local Greenwood Foundry supplied the iron plates. When Havilland decided to use this uncommon building material, earlier European prototypes might have been in his mind. - T.C. Bannister, 1956, op.cit.n.1, p. 15 f. - John Havilland: An Improved and Enlarged Edition of Biddle's Young Carpenter's Assistant. Philadelphia, 1833. Pl. 60.
20. Cyprus Alger was an iron enthusiast. He was the leader of the South Boston Iron Works. He knew Daniel D. Badger.
21. Illustrations of Iron Architecture, op.cit.n.12, p.4.
22. C.W. Condit, op.cit.n.1, p. 81. - The architect was Alexander Jackson Davis. Similar constructions existed earlier in France. - François Thiollet: Serrurerie de Fonte et de Fer récemment éxécutées. Paris 1832.
23. C.W. Condit, ibidem.
24. T.C. Bannister, 1956, op.cit.n.1, p. 14.
25. It is not known, which buildings had been concerned. - T.C.Bannister, ibidem. - Quoted is the Cincinnati Daily Commercial from July, 27, 1847, vol.8, no.97, p.2.
26. Robinson and Jones' Cincinnati Directory for 1846, p.509.
27. J.W. Thomson, op.cit.n.10,p.7.
28. The factory from 1848/49 was Bogardus' workshop and office. The building was situated in front of Badgers firm. Thomsons booklet contained a view of the factory, an engraving by S. Beck. The legend said: "This plate represents the Factory of James Bogardus, inventor and patentee of Cast Iron Buildings. It is situated at the corner of Centre and Duane Streets, New York, and it is the the first cast iron house ever erected." - J.W. Thomson, op.cit. n.10, fig. 1. - C.W. Condit, op.cit.n.1, p. 82 ff.
29. J.W. Thomson, op.cit.n.10, p.6.
30. Ibidem.
31. The Illustrated London News published a description and a woodcut of the factory on April 12, 1851. - T.C. Bannister, 1956,op.cit. n.1, p. 14.
32. The dissection of the factory was of common interest. In November, 1859, a report was published by the New York Sun and a few days later in the Architects' and Mechanics' Journal, I, (November, 1859), p.47. - There are no hints given about a reerection of the factory.
33. T.C. Bannister considered, that the cast iron parts could have been melted and reused later. - T.C. Bannister, 1956, op.cit.n.1, p.14.
34. J.W. Thomson, op.cit.n. 10, fig. 2.

35. Fairbairn's mill was a three-story iron structure made of cast and wrought iron. The iron parts had been prefabricated in London. A reconstruction was given by Bannister. - T.C. Bannister, 1956, op.cit.n.1, p. 15, fig. 5. - Samuel Smiles: Industrial Biography, Ironworkers and Toolmakers. London, 1863. p. 330. - William Fairbairn: Treatise on Mills and Millwork. London, 1865. pp.252-254.
36. Patent no. 7337 from May 7, 1850: "Construction of the Frame,Roof, and Floor of Iron Buildings.".
37. In 1848 the four-story brick building was heightened. And, within only three days, the cast iron front was built. The prefabricated iron parts for the architecture were provided from the stock of the Bogardus factory. The drugstore has been demolished after 1900. - T.C. Bannister, 1956, op.cit.n.1, pp.12-14, fig. 2.
38. On February 5, 1849, the raise of the building was started. Edgar H. Laing ordered fire proof facades from Bogardus' factory. Within only two month the whole construction of the stores was completed. 150 tons of iron were needed for the casting of the facades. Four different foundries provided the iron parts: the West Point Foundry, Burden's Foundry, William L. Millar's Foundry and the Novelty Works of Stillman, Allen & Co.. - T.C. Bannister, 1956, op.cit.n.1, p. 13, fig. 3. - H.R. Hitchcock, 1971, op.cit.n.1, p. 235. - M. Gayle, op.cit.n.1, p. 10.
39. In 1851, from January through September, the Sun Building in Baltimore was erected. Parts of the iron facades were cast in the foundry of Hayward. Bartlett & Co. in Baltimore. - T.C.Bannister,1956, op.cit. n. 1, p. 16, fig. 7.
40. Lowell M. Limpus: History of the New York Fire Department. New York, 1940. - T.C. Bannister, 1957, op.cit.n.1, pp.11-14,fig.13.
41. Ibidem.
42. Benjamin Silliman, C.R. Goodrich: The World of Science, Art and Industry. New York, 1854. - T.C. Bannister, 1957, op.cit.n.1, p. 11f, fig. 11.
43. J.W. Thomson, op.cit.n.10, p. 16.
44. The predessesor of this building had been destroyed by fire. - J.W. Thomson, op.cit.n.10, fig. 4. - T.C. Bannister, 1956,op.cit. n.1, p.16, fig. 8. - Ada Louise Huxtable: Harper and Brothers Building - 1854, New York, N.Y.. 1957.
45. S. Giedeon, op.cit. n.1, p. 195. (Quoted is the 3rd edition, Cambridge Mass., 1965).
46. T.C. Bannister, 1957, op.cit.n.1, p. 13, fig. 15.
47. Writers' Programm: Maryland, a Guide to the Old Line State. New York, 1940, p. 228 f.
48. T.C. Bannister, 1956, op.cit.n.1, p. 16.
49. Illustrations of Iron Architecture, op.cit.n.12, pl.III. Colour lithograph by Savony, Major & Knapp, New York. - The Haughwout Store was the building with the first elevator, a construction from Elisha Gravis Otis. - T.C. Bannister, 1956, op.cit.n.1, p.17 f. - M. Gayle, op.cit.n.1, p. VIII, p.161 f. - Nikolaus Pevsner: A History of Building Types. London, 1976, pp.216f,276.
50. William J.Fryer Jr.: Iron Store Fronts. The Architectural Review and American Builder's Journal, Vol.I(April,1869),pp.620-622.
51. Illustrations of Iron Architecture, op.cit.n.12, pp.24-33.
52. Ibidem, pl. 60-62.
53. Ibidem, pp. 23-35.
54. Ibidem, pl.14. Five-story cast iron front for a dwelling house.

55. Old Gilsey Hotel, 1200 Broadway, New York City, built in 1869, style of the second French Empire. Iron architecture from designs of the architect Stephen D. Hatch. - M. Gayle, op.cit.n.1,pp.166-169.The Palace Hotel in San Francisco was built in 1874. The designs for the cast iron fronts and the building itself came from John P. Gaynor in New York City. - W.J. Hawkins, op.cit.n.1,p.14 f.
56. New Market Theater, Portland, Oregon. Building in the style of Neo-Renaissance from 1872/73. Architects: A.P. Ankeny and Andrew J. Watson. Cast iron front in the Victorian style. - J.W.Hawkins,op. cit. n.1, pp.66-70.
57. Washington D.C., new Library of Congress in the State Capitol, cast iron construction of the interior. In 1852 Janes, Beebe & Co. from New York City - Bogardus neighbours in Centre Street - were the winners in a competition for the manufacture of the iron parts. - J.T. Frary: They Built the Capitol. Richmont, 1940. - T.C. Bannister, 1956, op.cit.n.1, p. 16 f.
Baltimore, Peabody Institute Library, built in 1878, designs from Morrison and Lind. Cast iron construction of the reading room.
58. Ladd & Tilton Bank, Portland, Oregon. Cast iron facades in the style of Neo-Renaissance with Venetian provenance. Architect: John Nestor. Built in 1868. - J.W. Hawkins, op.cit.n.1,pp.44-47.
59. This early building type was represented in 109-111 North First Street, St.Louis. - S. Giedeon, op.cit.n.1, pp.200, 299, fig.179. (Quoted is the 3rd edition, Cambridge, Mass.,1965).
60. Ibidem, p.198.
61. The Old Spaghetti Factory was built in 1875. The cast iron front covers that side of the brick building, which goes to the river.
62. W.J. Hawkins, op.cit. n.1.
63. The history of Central City: Perry Eberhart: Guide to the Colorado Ghost Towns and Mining Camps. 4th enl. edition. Chicago. 1968. pp. 19-30.
64. N. Pevsner, op.cit.n.49, p.104 f. John Dorsey: Mr. Peabody's Library. Baltimore, 1978.
65. J. Dorsey, ibidem, p.2.
66. The iron parts were manufactured by Janes, Beebe & Co, New York City. 4454 tons of iron were needed. - J.T. Frary, op.cit.n.57.
67. Thomas E. Tallmadge: Architecture in Old Chicago. Chicago, 1941. pp. 193-197. - Frank A. Randall: History of the Development of Building Construction in Chicago. Urbana, 1949. pp.13, 88 f. - Carl W. Condit: The Rise of the Skyscraper. Chicago, 1952. pp. 112-113. - T.C. Bannister, 1957, op.cit.n.1, pp.14-16. - H.R. Hitchcock, 1971, op.cit.n.1,p. 242. - Perry Duis: Chicago:Creating New Traditions. Chicago, 1976, p. 27.
68. Morris Ketchum: Shops and Stores. New York, 1948. p.6. - P.Duis, op.cit.n.67, pp.2o-22. - Hugh Morrison: Louis Sullivan: Prophet of Modern Architecture. New York, 1935. - Louis Sullivan: Autobiography of an Idea. New York, 1956. - Carl W. Condit: The Chicago School of Architecture. Chicago, 1964.