ON BUILDING AND ARCHITECTURE.

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Group XVIII.

In no capital of Europe is such an amount of building going on at the present moment as at Vienna. Dwelling-houses of enormous size—some built around two, three, and even four court-yards, and accomodating twenty, thirty, or more, families—are arising; new churches are approaching completion; and, above all, many monumental buildings, whose erection will cost years of labor, are in various stages of construction.

Twenty years ago, beyond the Cathedral of St. Stephen, there was little or nothing imposing or beautiful in the architecture of this city. The streets were narrow, and lined by plain, stuccoed buildings of great height, whose lower stories received so little light that remarkable contrivances were often resorted to, to introduce the same. In the interior city one sees still many windows provided with mirrors, set at an angle of forty-five degrees with the front, to reflect the light from above into the rooms. Within the period mentioned, great changes have been wrought,—the old fortification walls encircling the city have been removed; the great ditch, exterior to these, and having a depth of some sixty feet, has been filled; and the space thus gained, to-

* The Vienna Exposition contained a magnificent collection of architectural material in the shape of models, drawings, engravings, plans, etc.; and, in this display, the Vienna architects were easily first. And this happened both from their propinquity and from the fact, that the enormously rapid growth of the city of late years, has developed the science of building to a remarkable extent. In this Report, it has been deemed better to refer to the actual buildings as examples, rather than to the drawings and illustrations of the same exhibited in the Exposition.—Editor.

gether with a large area beyond, previously used for military purposes, devoted to wide boulevards and squares. These were soon lined with fine structures; and the city acquired a large sum of money from the sale of sites, which it is now devoting to building purposes. The first structure completed with these funds was the beautiful Opera House,—until the completion of the Paris opera building, the finest in the world,—surpassing those of Milan and Naples, if not in size, yet in magnificence and taste. Its cost was not far from five to six million dollars. Within a few steps of this building, a new Academy of the Fine Arts is erecting; while, following the line of boulevards surrounding the interior city, we come to the old parade-ground, on which the foundations of three enormous structures are being placed: first, a new Parliament House, to be built in Grecian style, by Hausen; next, in the centre, the new city hall, or Rathhaus, with a front of four hundred and fifty feet, in modernized Gothic, with a central tower, from the plans of Schmidt, which were accepted from among a large number coming from all parts of the world; and third, the University, by Ferstel, in Roman style. All these buildings are of great size, and will each cost millions,—the Rathhaus perhaps six or seven. The place upon which they stand will be, at their completion, the finest in the world; and will be still further beautified by a new imperial and royal theatre, to be erected in the immediate vicinity.

Passing by these buildings and the Votive Cathedral,—now building for fifteen years, at a great cost,—we turn down the Schotten ring,—a section of the encircling boulevards,—leaving, right and left, palatial dwellings and hotels, and reach the site of the new Exchange, whose massive foundations astonish the gazer, and have alone cost several hundred thousand dollars. At other points on the ring are to be seen the imposing palaces of the arch-dukes and the new Art Museum; while, on the newer neighboring streets, are numberless dwelling-houses, of graceful and ornamental architecture, whose forms are borrowed in general from the Italian Renaissance, abounding in widely projecting cornices and figural decoration. These are mostly of a color very cheering and grateful to the eye,—a creamy ochre,—similar to that of our light sandstones, and apparently of that material.

Closer inspection and observation of the many buildings erecting shows, however, that they are, in reality, built of mastic, which, in some instances, too, is painted. It looks, however, very differently from the mastic on the older buildings; is harder, and presents little tendency to crack or scale away. This arises from various causes, which will be explained further on. Besides the great size of these buildings, —whose fronts are rarely less than one hundred feet long, and whose height is uniform,—an American is struck by the great thickness of the walls; the massive nature of the floors, in which the arch and iron play a prominent part; and the existence of large interior court-yards, which, in many cases, are covered by a glass roof. The great roughness and apparent instability of the masonry produces an unpleasant effect upon one accustomed to the neat brick walls of England and America; but what is apparently carelessness soon proves to be intentional aim on the part of the builder. The bricks are set upon one another with joints an inch thick, and open on the exterior to the depth of an inch, for the purpose of giving a hold to the mastic.

Other points soon noticed are the absence of wooden stairways; instead of which, those of stone alone, or stone in connection with iron, are invariable, and the practice of making all partition-walls of masonry. The generality of these features proves sufficiently that they are the results of building-laws, since their cost is great, and the tendency in building, left to itself, is to secure cheapness rather than durability, or protection from the danger of fire. There is little doubt that such laws—requiring thick walls, stone stairways, etc.—have had an effect upon the material employed for the exterior in Vienna. The great predominance of mastic fronts, and the development of the manufacture of the constituents of this material, reached in Austria, is, without doubt, thus to be in part explained. In order that the final expense of the building may not be too great, the builder economizes where the law permits him, and uses mastic instead of face-brick or stone, seeking, however, to secure as good a mastic as possible,—one that will present a good appearance and prove durable.

The great amount of building undertaken has called for numerous architects, and these were soon at hand; some came from Northern Germany, and brought with them the taste for Gothic art; others were favorers of the French school; but by far the most seem to have drawn their inspiration from study of the Italian works of the fifteenth century.

The close promixity of Venice—to be reached by rail in less than twenty-four hours—attracts crowds of young enthusiasts each winter, who, after study of the famous monuments, are rarely content to return home without a visit to the neighboring cities of Northern Italy,—Padua; Vicenza, the home of Palladio; Brescia, Bergamo, and, finally, Milan, where the famous passage or gallery of Victor Emanuel, by the architect Mengoni, has now nearly reached completion.

Leaving this point, and returning as far as Verona, the favorite home trip is by way of the Brenner pass and Munich, —the latter, fifteen or twenty years ago, the most famous architectural city of Germany, and still possessing numerous structures in ancient Grecian style, fresh and unimpaired by the ravages of time. Vienna has also one master of the Grecian art, whose name is well known upon the continent (Hausen),—the same who has prepared the plans for the Parliament Building referred to above, and has erected many of the public structures of the new Vienna. He, and the other two architects employed in beautifying the old parade-grounds, have the first names in architecture in Vienna. Within a few years, the renowned Semper, formerly connected with the polytechnical school at Zurich, has also taken up his abode here, and is now engaged with the erection of two large museums,—destined also to beautify the ring,—while, in Dresden, the new Royal Theatre, also by him, now well above the ground, has, without doubt, been seen and admired by many Americans who have been abroad within the last year.

The erection of so many public buildings in Vienna, in ornamental style, has affected the architecture of the better dwellings. No one ventures to build a dwelling-house today upon one of the newer streets of Vienna without attention to the requirements of beauty and taste; and the building laws have become so rigid that permission could,

under other conditions, not be obtained for their erection. The use of mastic has rendered this possible without undue expense. Within four to six weeks from the time of completion of the rough brick walls, this coating is applied; the cornices and window-cappings are planed out, and the ornamentation put in place,—to last, perhaps, longer than stone itself.

The Viennese are doing their utmost to make their city the most beautiful in the world; and, though much remains to be accomplished, certainly a wonderful amount has been done within a very short period, and it is already disputing the palm with Paris. The use in the latter city of stone for building purposes, to the almost entire exclusion of brick and terra-cotta,—whose durability is surpassed by no material,—causes indirectly a certain uniformity and plainness in the greater mass of buildings.

Many of the newer streets of Paris, as well as of the other larger cities of France,—as Marseilles and Lyons,—are excessively monotonous and tiresome to the eye. No further attempt seems to have been made in the planning of the fronts than to secure the necessary light for the interior, and the exclusion of the weather. Every window in every house is the same,—and, in general, the interior arrangements are similar; so that the owner of any particular house would find himself equally comfortable in any other in the street. Still more pitiful is the appearance of a larger part of the more respectable portion of London, where proprietors content themselves with plain brick walls, in which rectangular holes are left for windows, and from whose upper portion the roof arises without intervening cornice. The meanness and plainness of these dwellings, miles of which are to be found to-day at the west end of London,—almost invariably the property of men of means,—are, to one who has passed several years upon the continent, most displeasing. In the business portions of the same city a decorative art is widely spread, which, though well represented in America, has, luckily for the Viennese, not made its appearance to an undue extent as yet in their city. I refer to shop and store signs, which cover every available point with their glaring characters, and destroy the little harmony that the architect

has given to the comparatively few handsome buildings there to be found. A writer in one of the Boston papers, after the great fire, advised that decoration should be very scantily applied to the new buildings to be erected, since it would be immediately concealed by signs of stores, banks, etc. Where ornamentation is, as with us, produced by the use of elaborately chiselled granite, this is, without doubt, true. In Vienna, where only the lower stories of buildings are used for business purposes and the upper invariably for dwellings, the matter is different. Here signs are fewer in number, and the growing taste of the people leads them to place them symmetrically upon the fronts, and blend them with the architecture of the building. I have seen many cases where a sign has been made of the same width as a frieze, which, having been left smooth and without decoration, serves admirably as a position for it, and where its protruding nature is rendered less prominent by the shadow thrown by the overhanging cornice.

While in Paris the use of stone has had a direct effect upon the appearance of the streets, through the ensuing absence of ornamentation, which, for ordinary buildings, would, in this material, require too great an outlay of money; in Vienna, on the other hand, the use of mastic in connection with terra-cotta, has played the greatest part in beautifying that city. There are, however, certain indirect effects which arise from the same causes. Where stone is used for the main walls of a building, these need not be as thick as when constructed of brick. For instance: in Paris, at the basement, the front wall of an ordinary dwelling-house may be two feet in thickness, and, at the roof, one foot and a half. In Vienna, such a wall of brick is often two feet and a half to three feet at the roof. Now much, in the way of architectural ornamentation, in order to produce its due effect, must project to a certain extent from this wall, thus giving to the front the light and shade sought for. This is especially true of the upper or main cornice of a building,—that portion which crowns the whole. This is constructed in general by the assistance of stones resting upon the upper surface of the wall, and projecting to the required extent. It is evident that, if these stones project too far, they will topple over into

the street, unless they are counterpoised by a certain weight, or are tied down by irons, built firmly into the interior of the wall. In Paris, to avoid all danger from such causes, these stones are required by law to rest upon the whole width of the wall, and in no case project more than the thickness of this wall at its upper portion. Now, where the wall is but eighteen inches or a foot thick, the cornice can also have no greater projection; and this is insufficient to produce much effect. In Vienna, with thicker walls, wider cornices can be made; and those of three and even four feet projection are frequent. The laws of harmony and taste require that this projection of the main cornice should govern all other projections upon the fronts,—such as of window-cappings, subordinate cornices, etc., all of which are made less than the first. Thus in Paris there is a lack of relief in the general street architecture, which is not found in the newer Vienna. In this connection,—now that the matter of cornices is under consideration,—I wish to call attention to a certain matter connected with the late fire in Boston. Although not present there at that time, I have understood that the large stones forming the cornices of buildings toppled over into the streets at an early period in the conflagration. Before the existence of the present building laws of Vienna, which are recognized as among the best on the continent, such accidents also occurred here, and were occasioned by holding these stones in place on the wall simply by the weight of the roof resting upon them. Upon the burning of the latter, there remained nothing to counterpoise the weight of the projecting portion of these stones, and they necessarily fell. At present, they must be tied in place with irons, which are built into the wall and anchored six to twelve feet below the cornice. Whether these stones fell in Boston from a similar cause to that referred to, or whether the walls, from insufficient thickness, crumbled beneath them, is to me unknown. When a fire occurs in the roof of a Viennese house, the wood simply burns away, without disquieting or affecting the dwellers in the lower stories, and the fire then ceases from want of fuel. I remember, last year, trying to discover a house upon the Ring where the roof had thus been burnt, and found nothing in the exterior appearance of the building to indicate that a

fire had taken place, and should have passed by had it not been for the crowd assembled in the vicinity.

Having called attention to the activity in building, reigning at present in Vienna, and referred to the especial efforts made to beautify the city ; and also given some hints as to the substantial character of the work done, I wish now to discuss these matters more at length. The field here is an especially good one for study, from the fact that so many of the buildings erecting are to be of a monumental character, where no expense or pains are spared to secure durability and preservation from the dangers of fire. The German race is not an inventive one, but is certainly acquisitive. There is little new and good that other nationalities contrive that they do not sooner or later apply to their own purposes ;—thus, all the methods of construction through the use of iron as devised by the French, are, perhaps, to-day more widely used in Vienna than in Paris. A work has been published by a North German, Brandt, upon this subject, and is filled with the most useful drawings made by himself in Paris, London and Berlin, of all varieties of construction in this material. Many of these are, without doubt, known in America, but not as widely as they should be, and this work is well worthy of translation into English and publication at home. The first matter to be looked into would appear to be that of mastic, from its predominant use and excellent character in this city. Unfortunately, no books have been written upon the subject, and what information I have been able to collect upon it has been gained by questioning builders and masons, and in some cases architects, though these latter seem in general to know less of the matter. Whatever the nature of the material may be, it is always desirable to give it a firm hold upon the fronts to which it is applied, and this is here gained by the use of soft, porous bricks, laid with joints open to a depth of an inch from their external surface, and from half an inch to an inch in width. This has been stated above already, but I repeat it here as of particular importance. The mastic keys itself into these crevices exactly as the plaster of a wall or ceiling is held in place by the openings between the laths. The material used in Vienna is of several varieties, but the chief heads under which it can be classified are two : that prepared

by the use of ordinary lime, and that prepared by the use of cement. The latter is considerably dearer, but possesses great advantages. Formerly the first alone was used, and lasted very well when not applied in exposed positions, but where rain and frost could attack it, it showed, after several years, a tendency to crack and blister, though rarely to fall from the wall. Its application here is different from our own. Three mixtures are prepared: the first consists of coarse sand and lime which is thrown upon the walls forcibly from the trowel and allowed to become tolerably dry, the precaution being taken that the bricks be not too dry on its application, since otherwise they absorb the moisture too rapidly from the mortar and cause it to crack; then follows a second mixture of finer sand and lime, which is planed into the required shape, whether of cornice or window capping, by a profile cut in sheet iron and stiffened by a board backing,—this is guided as in stucco-work by strips nailed to the wall. On the second coating becoming nearly dry, an almost liquid mixture of the finest sifted sand and lime is thrown as before upon the wall and again planed out; and finally, corners of moulding, etc., are finished by hand, which presupposes some skill on the part of the workman. It is important that this mastic should nowhere have a greater thickness than one half an inch, and thus, where great projections occur, the rough form of the moulding should be built out with bricks which are broken with the trowel to the required form. For this latter purpose, bricks two feet in length, are burnt in the vicinity of Vienna. The upper surface of such a projection then receives a covering of zinc as a protection against the effects of rain. All the conditions necessary to the production of good mortar are equally applicable to this mastic. The lime and sand must be pure and good; the latter must be sharp, and best from the pit; during its application and setting the mastic must be protected from the influences of the weather, especially of rain. At present, in Vienna, this variety of mastic is going out of use, and the hydraulic variety produced by intermixture of sand and cement is coming into favor; partly on account of its greater durability, partly from the resulting dryness of the walls thus coated, and finally from the greater ease in working. The first variety is now

used principally in sheltered positions, as for court-yards covered with glass, for the portions of walls directly sheltered by cornices, etc. Hydraulic cement is best known to us at home under the names of Portland and Roman cement, and the best varieties have been supposed to come from England. At the International Exposition at Vienna, varieties have been exhibited by the Germans and Austrians, which, however, are quite equal to the best English, and are considerably cheaper. The Portland cement is prepared from a limestone with which clay and silica are mixed previous to burning. The Roman cement is obtained directly from a limestone containing the same materials naturally. The proportions are important, and upon them depend the excellence of the cement and its power of hardening under water. The variety employed, principally in Vienna, is manufactured in Kufstein, in Tyrol. United with broken stone in small pieces, *béton* is prepared from it, which is here applied to many uses, among others the construction of foundation walls in moist places, as an underlayer for asphalt pavement, manufacture of artificial stone, etc. The basin for a large fountain has just been completed in Vienna entirely of this substance. The foundations, commenced at a depth of some sixteen feet below the surface of the soil, were prepared of a mixture of three parts of gravel and one part of Kufsteiner cement, and upon these the bed of the basin was laid with a thickness of one foot. The parapet, after being brought roughly into form with the same material, received a coating of a mixture of one part of cement and two parts of clean sand. The mouldings were then planed out and a final coating of one part of cement and one part of fine sand was applied, planed into form and finally polished with a variety of Bohemian stone, which appears to be a soft sandstone containing mica. In conducting this work the whole was kept constantly moist to prevent the appearance of cracks. The workmen employed were all Italians; and these have the reputation in Vienna of thoroughly understanding all applications of cement, and beyond this, of great faithfulness and industry. As masons in general they are unsurpassed, and doubtless, those who are now engaged in street-sweeping in New York, could be much more profitably employed in this labor. The use of cement, as mastic for buildings, is con-

ducted under similar conditions to those described. The exact proportion of sand to be added to the cement cannot be fixed for all varieties, but is always dependent on the quality of the latter. In some cases in Vienna I have understood that the cement is applied without intermixture of sand at all. It must be worked into form immediately upon application, which must ensue directly upon mixing with water. The latter must be used unsparingly, and the whole kept thoroughly wet for several days to prevent the appearance of cracks. It is not, as the ordinary lime mastic, applied in three layers, but all at once, the other conditions being, however, the same as those described in connection with that substance.

The best varieties of cement for mastic are those which set slowly, but the proportions vary for different climates, and can be best determined by experiment. In Vienna the Kufsteiner cement costs about 75 cents per hundred-weight and the labor of application as mastic varies from 30 cents to 75 cents per square yard, according to the nature of the work. Many of the more elaborately ornamental features of fronts, which cannot be directly prepared by the workmen with his ordinary tools, or which require a certain amount of artistic skill, such as consoles or brackets, key-stones, fretwork, etc., are cast in cement and afterwards attached in position with irons, and, if hollow, filled with cement. These, of course, have no weight to support, but are purely decorative. Better and more durable than cement for such purposes is terra-cotta, which is now widely used in Vienna, and is only prevented from supplanting the cement castings by its greater cost. The color of these mastic fronts is that of light sandstone, and is very pleasing to the eye; only when a deposit of saltpetre appears from the brick wall beneath is it customary to paint them. Very pleasing decoration of smooth surfaces of mastic is also produced by the Italian art of Sgrafitto painting. The finest modern specimens of this are to be seen in the passage Victor Emanuel, in Milan. The process is the following: With the mastic is mixed hard coal and charcoal dust, also Frankfort black, previous to its application. After setting it receives a thin coating of slack lime and water, which while still moist is scraped away by a pointed steel instrument, in such a manner

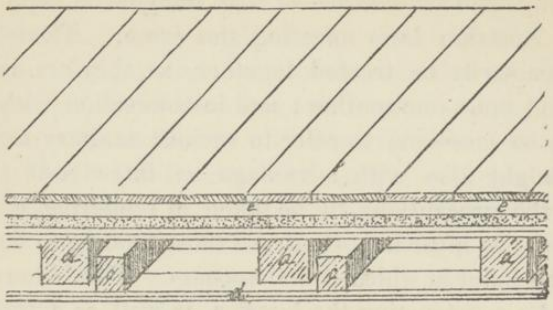
as to produce the drawing in white, with black shading and background, or in black upon a white background. This method of treatment is more satisfactory to those minds which find a sham and pretence in the imitation of stone-work by mastic.

Terra-cotta, as before said, is very extensively employed in Vienna, and many large works are now in operation in the vicinity of the city, where statues, mouldings, columns, capitals, fountains, and in fact all varieties of decoration for exterior and interior purposes, are prepared. This material has been known from the earliest times in history, but has occasionally gone out of use for long periods. The ancient Greeks manufactured vases for ornamental and practical purposes from it. Before them it was employed by the Egyptians, and after them by the Etruscans and Romans. In Pompeii large earthen vessels, capable of containing several hogsheads each, have been excavated, while in Rome, one of still more colossal size has recently been discovered; pieces of frieze and cornice in good preservation have also came down to us from these times. In the fourteenth and fifteenth centuries its use was again revived in Northern Italy, and the hospital at Milan, and above all, the court-yards of the Certosa, near Pavia, are resplendent with the material in most gorgeous hues, to be still seen in unimpaired condition. In England, terra-cotta is manufactured to-day of great hardness and durability, and it is well known that that employed in the Parliament Houses in London is lasting much better than the stone by its side. At the Exposition in Vienna, the finest exhibition of terra-cotta has been made by Austria; the design of all ornamental objects of the substance is marked by taste, and their color,—a light, creamy hue, almost identical with that of the cement mastic described above,—is very pleasing to the eye. It is not so hardly burned as the English varieties, but stands frost well, and is sold at a very low price. Life-size statues, of careful workmanship, as durable and well finished as marble, can be had for ten to fifteen dollars each. The most celebrated factory here is the Wienerberger, within a half an hour's ride of Vienna. Here some four thousand workman are employed in the manufacture of bricks, form-bricks, tiles, terra-cotta objects, etc.; and for the purpose of burning, the ring furnace

is alone used. This, I believe, is already known in America. Its essential features consist in the feeding of the fires from above, and in a strong draught produced by a tall chimney. It is said to occasion a great saving of fuel, estimated at as high a rate as three-quarters of that required for the old methods of burning; but the bricks do not seem as hardly burned as our own. Among the conspicuous Austrian structures at the International Exhibition was a triumphal archway, erected of the products of this factory. Under its shelter were exposed various models of furnaces,—terra-cotta objects, such as vases, brackets, etc., of very exquisite design,—and many varieties of brick. The bricks used generally for building purposes in Vienna are slightly less than $12 \times 6 \times 3$ inches, the full size being made up by the joints; others are to be seen here eighteen inches and two feet in length, used, as previously described, for cornices, window-cappings, etc., in connection with mastic; others used for similar purposes have one edge bevelled to avoid the necessity on the part of the workmen of chipping them with the trowel. In addition are hollow bricks used in the construction of fire-proof floors, fire-bricks, perhaps six inches square and two inches thick, used in paving cattle stalls; wedge-shaped bricks for arches and vaults; and hollow conical bricks, in shape much like a small flower-pot closed at both ends. Some of the latter have been employed in the construction of the dome which surmounts the centre of this triumphal arch. Nearly all of these varieties are, I believe, if not novel in America, still limited in their use there. While here upon the continent generally, and especialy in Austria, the arch and vault play a prominent part in every house, in America only our most important public buildings are constructed with them. In Vienna the law requires that the cellars shall be, with few exceptions, vaulted throughout, while in the basement story, the ceiling is in general supported upon iron girders or beams upon which are sprung vaults of hollow brick. These measures are taken in part to secure the solidity of the building and in part as a precaution against fire. A valuable and costly work upon the subject of terra-cotta and form-bricks, containing numerous colored illustrations, by Gruner, appeared some years ago in London, and is recommended to all especially interested in the subject.

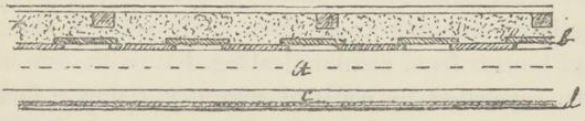
I now pass to a matter of especial interest to Bostonians, and, in fact, to Americans in general, and one which can nowhere be better studied than in Vienna. I refer to the methods of building which have for their object the insurance of stability and avoidance of the danger of fire, with the various Austrian laws affecting the same. These subjects must necessarily be treated together, as they are intimately dependent upon one another; and in connection with them it will also be necessary to refer to various sanitary regulations which might also with advantage be introduced at home. Among the precautions to be taken in rendering a building fire-proof, the most important are those tending to confine the fire to the point at which it first appears. This is here accomplished by constructing the interior as well as exterior walls of masonry, making the floors and ceilings as far as possible fire-proof; completely isolating the woodwork of the roof from the remainder of the building, and avoiding the use of wood or other combustible matter generally in staircases and the skylights opening upon them. To prevent the roofs of adjacent houses from communicating fire with one another, they are separated by walls of masonry rising a foot above their upper surface and are in all cases covered with slate, tiles, metal or other uninflammable substance. To prevent the burning roof from falling through into the lower stories, the floor of the attic is made both incombustible and of great strength. The fire-proof floors here employed are of several varieties and materials. A wooden floor is rendered incombustible by a filling of dry mortar, gravel or sand, supported by a rough boarding placed either upon or between the rafters. The depth of this layer is generally six to eight inches, and upon its upper surface comes the flooring, nailed to joists, which are buried in the filling. I have never heard of a case where a fire in Vienna has penetrated through this filling to the beams or rafters below. If fire breaks out in the room below, the plaster of the ceiling is sufficient to protect the beams, since there are no partition-walls of wood to strengthen the flames, and the burning of doors and windows, with their casing, together with the furniture, is insufficient to destroy it. In case of rooms used for the storage of large quantities of combustible matter, there are especial laws

requiring brick ceilings. The construction common in the better class of houses in Vienna, where the depth of the room is twenty-four feet generally, is shown in the accompanying drawing.



Section across beams.

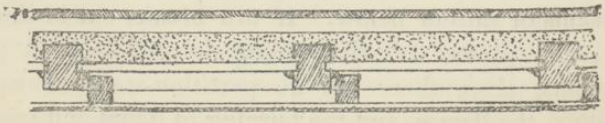
Beams of nine-inch by six-inch timber, separated by intervals of not more than three feet, rest parallel to each other, with at



. Section parallel to beams.

a main beams. *b* boarding. *c* smaller beams supporting ceiling. *d* stucco, etc. *e* joists.

least six inches of their ends upon the walls. Upon these a boarding is laid to receive the filling referred to. In this filling are buried joists at right angles to the main beams, and upon these the flooring is finally nailed. The laths or reeds to receive the plaster of the ceiling may be nailed directly to the lower surfaces of the beams, or, as is more customary, to smaller beams placed between the first and slightly lower. In this way the ceiling is secured from vibration, which is especially desirable when much stucco-work is employed.

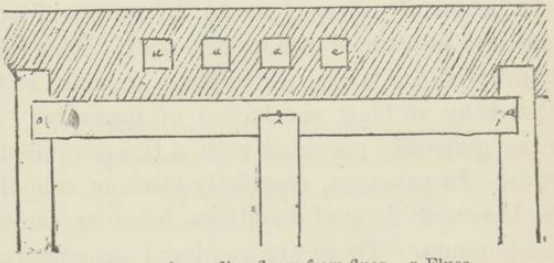


Fire-proof floor with filling and separate support for ceiling, and boarding between the beams.

The whole thickness of this construction is eighteen inches, which includes a parquet flooring. At the risk of making

these details still more minute, and taking it for granted that great interest is felt at home in these matters, I will state further that as regard the walls upon which the beams rest, the exterior one is of such thickness that it can generally be diminished six inches at each story at the point where these rest, thus giving them a free support, and diminishing the danger of injury to the wall by the vibration of the floors; where it is impossible to make the middle wall of such thickness as to admit of a diminution of six inches on each side in every story, the ends of the beams, before being built in, are covered with zinc to prevent the corrosive effect of the wet mortar upon the wood. These matters are not connected with fire, but I mention them here incidentally as of value and perhaps not generally known at home.

A building-law of Vienna requires that all woodwork should be separated from the interior surface of flues by a thickness of at least six inches of brick. It further insists, that in the interior of the flue, an earthen pipe shall be inserted in every story, extending at least from the ceiling to the surface of the flooring above. Flues occur frequently here in the middle



Manner of guarding floors from flues. *a* Flues.

wall, which supports the ends of the beams for floors, and often several flues occur side by side, so that the end of one of the beams might lie directly upon their opening, if all are supported directly by the wall. To avoid this, a simple contrivance is employed, known, without doubt, in America, and easily understood from inspection of the accompanying drawing. Upon the two adjacent beams a cross-timber is supported, which receives, at its middle point, the end of the beam in question. The flues are in general six inches in diameter, and the wall necessarily at least eighteen inches

thick, in order to allow six inches of masonry upon each side of the opening. The object of carrying the flues up through the middle wall is to cause as much heat as possible to be retained in the building, and to avoid the protrusion of the chimney into the interior, which would result if it were placed in the side-walls, which are generally of lesser thickness. Whether the neglect of these precautions has anything to do with the constant fires which we hear of at home, as resulting from defective flues, I am unable to say.

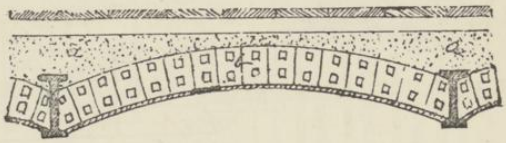
Another form of construction in wood, common in the attic, and often occurring also in the basement floors, consists in laying half or whole trees side by side, and pinning them firmly together. Upon these comes a filling and flooring, as above described, for the basement; and, for the attic, a filling and tile pavement. In all these floors, greater solidity is gained, if the ends of the beams rest upon a timber running the entire length of the wall, thus diffusing their weight more uniformly upon the masonry. This is, of course, especially applicable to the case where the wall is diminished six inches in thickness at the point where it takes up the beams.

Another practice, here worthy of note, is the union of the ends of the beams of adjacent rooms, by means of irons passing through the interior of the middle wall. This adds much to the stability of the floors, while these remain, at the same time, isolated by at least six inches of masonry. Further, kitchens are generally provided with a tile pavement as well as the attics. In passages, especially those of school-houses, and in the basement floor of dwellings, *béton* or cement floors are not uncommon. These are rendered ornamental by the insertion of small bits of stone into the mass before setting, forming regular patterns, and the whole is eventually polished.

These two forms of fire-proof floors are the most common in Vienna, where wood is used. It remains now to speak of iron and masonry, alone or in connection with one another. Where transverse strains occur, wrought-iron is made use of, and only in a few of the cases where there is a pressure in the direction of the length to withstand, is cast-iron considered admissible. Where beams of moderate length are used, rail-road iron is often applied here; but for greater lengths, double T or I girders are necessary. In cases where greater

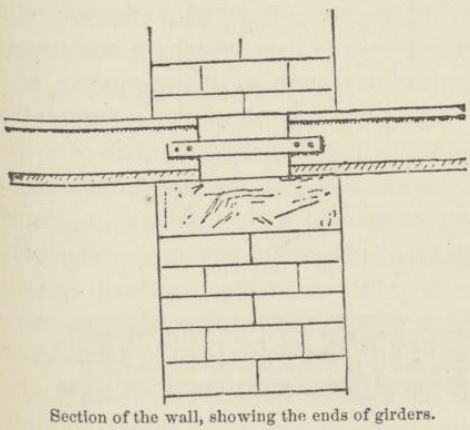
strength is required, beams are rivetted together from bar and angle iron. These forms are all well known in America, but are not in general use there for the construction of floors.

The first variety of floor I shall describe, is that most common on the continent, and, without doubt, known in special cases at home. Girders are laid parallel, from wall to wall, at intervals of about six feet, and upon them flat segmental vaults of hollow brick are sprung. Where additional security



Section across vaults and girders. *a* Filling. *b* Hollow bricks.

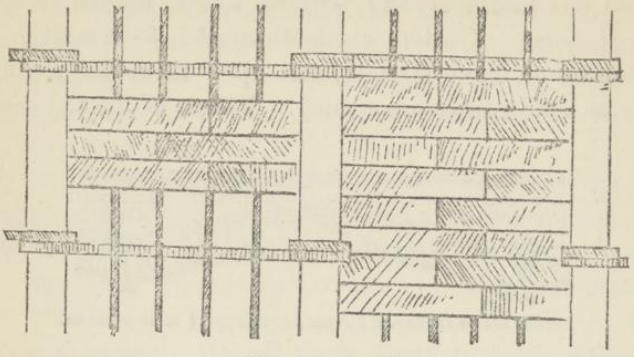
is desired, the ends of these girders are anchored fast in the walls, or where adjacent rooms occur, having this form of floor, the girders may be tied together through the middle wall. In some cases, the thrust of the vaults is taken up by rods of iron tying the girders to one another transversely. To prevent the protrusion of these rods, it is becoming usual, in England, to pass them through the interior of the bricks, which requires them to be slightly curved, but not sufficiently so to produce any undue pressure. The lower surface of the vaults receives a coating of plaster, and is, in Vienna, generally decorated with frescoes, as may be seen in many of the new coffee-houses. Above, the vaults are covered with a filling, upon which come the joists and flooring, as before described. This form of floor is more thoroughly fire-proof than either of the others, and is required by law in Vienna, in most cases, in the basement story of buildings. To secure the greatest solidity, a stone is built



Section of the wall, showing the ends of girders.

into the walls to receive the end of each girder, and distributes its weight over several bricks.

A second form of floor, employed where it is desirable to



View from above.[1]

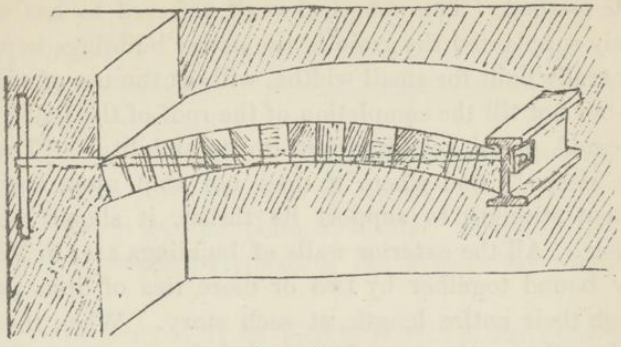
save room, occurs in several buildings in Vienna, but not so generally as the last. Girders are employed as before, but support, in this case, cross-pieces of iron, which, in their turn, receive rods of the same material parallel to the girders, and placed between them. The resulting network is bound together with wire, and hollow bricks are laid upon it in cement. The whole thickness of this construction is about nine inches.

For fire-proof passages connected with stairways, or built on the sides of court-yards, it is customary to lay a girder

Cross-section through girders.

parallel to the wall, with its ends supported by the two adjacent walls alone. It is then tied firmly to the first by several iron rods, and a segmental vault is sprung from girder to wall, as before described, of hollow brick. Such passages are very substantial, if properly made; but are otherwise excessively dangerous. From insufficient strength in the tie-rods, an accident of the most distressing nature occurred a year ago here. Some heavy weights thrown violently upon such a passage connected with a stairway, tore the ties

asunder, and the whole mass of brick-work fell, carrying stairs and passages with it, from the fourth story to the cellar,



Austrian arched passage.

while fourteen workmen were killed. However, there are but few houses in the newer part of the city where these passages do not occur, and ordinary care proves sufficient to prevent such disasters.

Vaulting of masonry alone was formerly common in Austria in all stories of buildings, but is now confined, in most cases, to the cellars, having been supplanted elsewhere by the extended use of iron. The ordinary cylindrical vault is employed occasionally, but the tendency seems to be to transfer the weight of the superstructure to special points or pillars, rather than to continuous walls, after the principles of the Gothic architecture. In this way the same stability is secured, with a less expenditure of material; and German writers contend that the necessities of building are thus met in the most rational manner. A passage, for instance, is to be built and covered by masonry alone. Instead of erecting two walls of uniform thickness, and joining them above by a cylindrical vault, a row of pillars is built, having, in special cases, the width of the passage for their distance apart in the row. Each pillar is then connected by a strong arch of several superposed layers of brick with the one opposite it, and the one on each side of it. In this way the length of the passage is divided into squares, and each of these is covered by a light vault of spherical form, supported by four of the arches described. The spaces left between the pillars in row, are

then built up with a light brick wall, which has nothing but its own weight to support. The amount of material thus employed is much less than that required by the first mentioned method. The spherical vault referred to has almost entirely supplanted the groin in the newer buildings here, and is generally built for small widths, without the use of scaffolding; but not till the completion of the roof of the building, as rain could prove very injurious to its stability. "The arch never sleeps"; and where it does not abut upon a wall of sufficient strength to support its thrust, it should be tied together. All the exterior walls of buildings are, in Vienna, firmly bound together by two or more ties of iron passing through their entire length, at each story. When these are built into the masonry, and protected from contact with the air, they are not affected by rust. At the demolition of a house at least fifty years old, I have seen such ties taken out in perfect condition.

Before proceeding to the description of fire-proof stairways, one of which, at least, is required in every building in Vienna, I will give a translation of the more important building-laws here in force, as they contain much information on this subject, and will assist in making the preceding portion of this article more intelligible.

1. When the position of a building is such as to make it desirable, as a precaution against fire, the ground floor must be vaulted. In the attic, and in the first story, when the ground floor is not vaulted, the floors must be massive (as described), and a layer of dry mortar, sand or other incombustible matter, must separate the beams from the planking.

2. Stables and hay-lofts must have a fire-proof ceiling.

3. Rooms for storing fuel must be, in general, located in the cellar, and built of masonry. When they are in sheds of but one story, they must, in addition, have a fire-proof roof.

4. In every building fire-proof stairways must communicate from the attic to the cellar, and with every dwelling, by means of fire-proof passages. (This implies, that the vestibule should be also fire-proof; and it is, in fact, invariably vaulted, and has a flooring of stone or *béton*.) In buildings of great extent, there must be several such stairways, sufficient to

enable all persons dwelling in them to pass readily out of doors.

5. When a stairway is lighted by means of a skylight, the frame of the latter must be constructed entirely of iron, and rest, on all sides, on masonry rising above the roof.

6. All stairways and passages connected with them must have a fire-proof railing.

7. Woodwork must be removed from the interior surface of all flues by a thickness of at least six inches of masonry. The masonry of the chimneys must be plastered on the exterior, from the pavement of the attic to the highest point of the roof.

8. Each story shall be provided with at least one separate flue, passing, without communication with any other, to its exit at the roof. Where the beams of the floors rest upon the walls containing flues, an earthen pipe shall be inserted into the latter, having, for its length at least, the thickness of the whole floor; and for its thickness, at least one inch. Every flue must have, at its commencement in the lower story, and also in the attic, a side opening, closed by two iron doors, closely shutting, and provided with a lock. Where several flues lie side by side, they shall be closed still further by an iron bar and padlock, extending over the openings of all. All woodwork in the vicinity of these doors must be covered with sheet-iron.

9. All roofs must be covered with tiles, slate, metal or some other fire-proof material. The woodwork of the roof must at no point be nearer than six inches to the pavement of the attic. Iron roof-frames must rest upon masonry alone; wooden cornices are forbidden.

10. The attic roof must be covered with tiles, cement or other fire-proof material. An iron door, hung in an iron frame, must communicate alone from the main stairway with the attic. At least once, in every ninety feet of its length, the attic must be subdivided by a brick wall running across its width and rising nine inches above the roof. (This is generally covered above with zinc.) The compartments ensuing shall communicate with each other only by means of iron doors hung in iron frames. No dwelling-rooms are permitted in the attics of buildings.

11. Every house shall be provided with a wall at least six inches thick, separating it from its neighbor,—for the two houses thus ensues a wall of twelve inches.

The thickness of walls must be regulated by the weight they have to support and the material of which they are composed; also by the height of the stories and the construction of the floors and ceilings.

The following rules are to be observed:—

(a.) The principal outer walls, as well as all interior walls, at the point where they contain flues, must be at least eighteen inches thick. The principal walls of the upper story must be at least two feet thick, if the depth of the rooms is more than twenty feet. The main walls may have the same thickness in two successive stories. In buildings of three stories, the main walls must, at the ground, be at least two feet thick; in buildings of four stories, at least two and one-half feet thick. Those portions of the main walls which do not support floors can be made eighteen inches thick for all stories.

(b.) Where the ceilings are vaulted and rest on iron girders, in case the latter are not more than twenty feet long, the walls supporting them need only be eighteen inches thick for all stories; where they are of greater length, the walls must be two feet thick.

(c.) The foundation walls must, in all cases, be six inches thicker than those of the lower story.

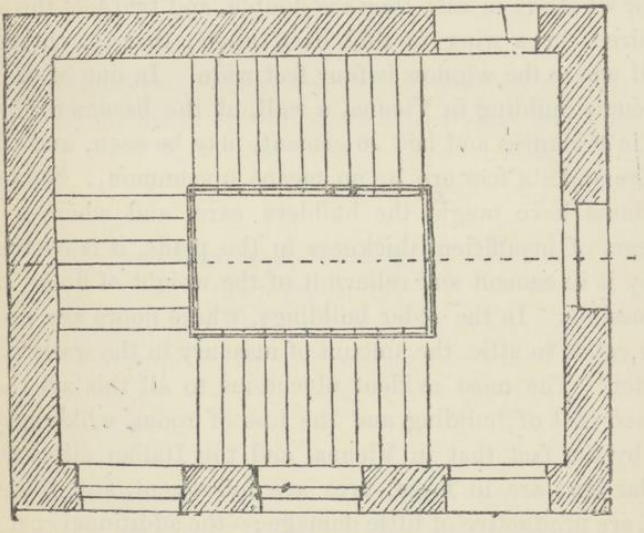
(d.) In light walls, the walls must be in all cases eighteen inches thick where they support ceilings or bound rooms used for dwelling purposes. In other cases they need be only twelve inches thick.

(e.) Walls supporting massive floorings of half or whole trees (as described) must be two feet thick, and the trees must rest for six inches at their ends upon the same.

The thickness of walls, as seen by the above extracts from the laws, is fixed in no case at more than three feet, which would occur in foundations where the basement wall had two and a half feet. The Austrian foot is about one-half inch

longer than the English, and the thicknesses fixed are in all cases multiples of the length, breadth and thickness of the bricks. The tendency is, however, in the better buildings, to build walls of still greater strength, and for a variety of reasons. These admit, as before mentioned, of greater projection of cornices; they are good non-conductors of temperature, and remain in good condition even after extensive fires. The large size of rooms in the newer houses, having in general a depth of twenty-four feet, and a height of twelve to eighteen feet, and the great size of the windows, call also for an additional strength of masonry. The latter do not, as with us, slide up and down, but fold back in two wings on hinges, and generally towards the interior, thus enabling the whole window opening to be uncovered, while by our method one-half of it must always remain closed. To prevent the projection of these wings into the interior of the rooms on opening, the walls must be at least three feet thick, of which six inches represent the distance the window is set back from the front, six inches the interval between the exterior and interior windows in case they are double, and two feet the space required for a wing to fold back upon; that is, three feet in all where the window is four feet wide. In one of the new museums building in Vienna, a wall, at the basement twelve feet in thickness and laid in cement, may be seen, and others of five and six feet are by no means uncommon. Numerous accidents have taught the builders care, and where a wall appears of insufficient thickness in the plans, it is customary to lay it in cement and relieve it of the weight of floors as far as possible. In the older buildings, where floors are vaulted from cellar to attic, the amount of masonry in the walls is still greater. The most evident objections to all this are the increased cost of building and the loss of room, which may be met by the fact that in Vienna, and the Italian cities where similar laws are in force, fires are infrequent, and if occurring, are productive of little damage;—the additional cost may thus be looked upon as a good investment of capital. If such regulations cannot be introduced in general in America, something might be done to insure the safety of human life, in theatres and hotels especially, by requiring the construction of substantial and fire-proof stairways and passages.

In most of the dwelling-houses and other buildings of Vienna, the stairway forms one of the most important architectural features of the interior. It is of stone usually, although of late the French constructions, with the use of wrought-iron, are coming somewhat into vogue. Where the flights are direct, without curve, the breadth of the steps must be at least four feet clear for buildings more than two stories high. The favorite form of stairway is that in which each step is built at one end alone, some ten inches into the wall, and is not otherwise supported. Good limestone is chiefly employed for this purpose, and stands very well when not subjected to violent shocks from heavy weights. In one of the new large hotels, where the steps are some twelve feet long, these are supported by double T girders, passing under each end and resting upon stone columns. Where the necessary space is at hand, a three-armed stairway is generally built in dwelling-houses, in each corner of which a square resting-place occurs, formed by a single stone built on two of its

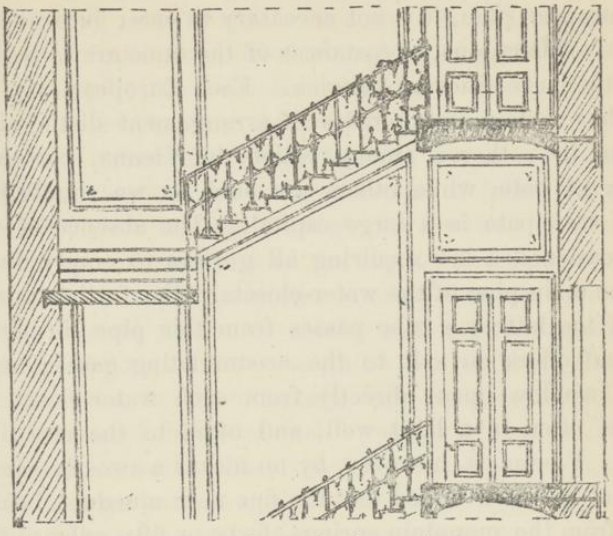


Plan of staircase in a Vienna house.

sides into the adjacent walls. There is a case in Vienna of artificial stone being applied to this purpose and standing very well for several years;—its width and breadth are about

six feet, its thickness six inches, and its composition Kufsteiner cement and sand.

I lived on one occasion for several months in a new house in Vienna, where a stairway of the form referred to exists.



Section of same, showing one story.

It is remarkably easy of ascent, and has plenty of light and air, provided by windows opening onto a large court. It is inclosed, with passage, by four walls, bounding a rectangle of eighteen feet in width by twenty-two feet in depth; on three sides of this, three flights of steps, each six feet in width, are supported at one end only; on the fourth side is a vaulted passage of the same width, running across from wall to wall, and communicating with three dwellings. In each of the two opposite corners are resting-places, six feet square, and in the centre of the whole is an open space measuring six feet by ten feet. The breadth of each step is thirteen inches, and its height six inches. By law, these dimensions cannot be less in the first case than eleven inches, nor more in the second than six inches. In the case of spiral stairways, or those ascending in any curve, the breadth of the steps at the distance of eighteen inches from the walls must be at least eleven inches, and at the smaller end at least five inches. All these stairways are provided with a metallic or stone railing. If

such stairways already exist in a house, others of wood are also permitted, but their width cannot be made less than three and one-half feet, and in their other dimensions they must conform with the laws already quoted.

As regards the general arrangement of dwelling-houses on the European plan, it is not necessary to enter into any very minute explanations, as instances of the same are to be found in all the large cities of America. Each European city, however, has certain peculiarities of arrangement distinguishing it from the others; among which, in Vienna, certain are worthy of note, while others are such as we should by no means anticipate in a large capital. The absence of water has occasioned a law requiring all gutters to empty directly into the main-pipe of the water-closets. For further purification of the latter, a tube passes from this pipe through the roof and offers an exit to the accumulating gases; beyond this a window opens directly from each water-closet upon the air, often in a light well, and often to the rear of the house. Vienna is, however, by no means a sweetly-smelling city, but it is now hoped that the fine new aqueduct, bringing water from the mountain springs, forty or fifty miles distant, will do away with this evil. The direct communication of each water-closet with the exterior air, is a point which we unfortunately do not generally regard. In Berlin I have also noticed a great neglect of this precaution, the privy being there frequently placed in a corner of the kitchen, while with us, any point where room is at hand, is thought sufficient. How often do we place it in the interior of the house, and furnish it with light by means of a window opening into a bedroom! In buildings of great extent, interior court-yards are frequent here, and furnish light and air to subordinate rooms, passages frequently also to water-closets. Where these are of great size, at least sixty or seventy feet square, and the sun can shine into them several hours a day, the better apartments are also located upon them, and are thus secured from the noise and dust of the street; this being especially the case in large schools and university buildings where lecture-rooms are frequently so placed. Another advantage is the privacy thus gained. Smaller court-yards, measuring perhaps thirty by forty feet, are often covered by

a glass roof, supported by an iron frame and provided with a monitor-top for ventilation. The newer hotels of Vienna and Paris, as for instance the Grand Hotel of the latter city, have such covered courts. Where two buildings have their courts adjacent, it is customary to carry the wall between them up to a height of only fifteen or twenty feet. The perspective view gained from the vestibule into the court is often made very pleasing by the presence of a statue or fountain in the latter. Frequently, too, the wall just referred to, is painted decoratively with architectural features which are sometimes so contrived as to give an appearance of increased depth. I remember once looking through the doorway of a modern Italian palace in the heart of the city of Brescia, and seeing to my astonishment beyond the court, an extensive range of meadow, beyond which lay a lake and villa with park. In the foreground was a fountain, and a row of arcades on each side terminating in a garden pavilion. On entering the vestibule I discovered that here was a remarkable combination of the real and unreal. The court was sown with grass, and several trees grew at irregular intervals at the sides. Upon a wall rising at the rear, the grass and trees were painted in diminishing perspective, while the arcades were only for a short extent real; their continuation and the garden pavilions being also painted as the remainder of the picture, with the exception of the fountain in the foreground. The main entrances of houses in Vienna, are, with few exceptions, eight to ten feet wide, and provided with a driveway, on each side of which is a narrow footway raised several inches above the former. The height of the buildings is fixed at four stories, in addition to which a half-story or mezzanine is allowed, separating the ground floor from the first story. Mansard roofs are almost unknown, from the fact that dwellings not being permitted in the attics, they could serve no purpose but that of ornamentation.

Thus far little has been said in this article in regard to the International Exhibition, since most of the buildings there are of a temporary nature, and, beyond their picturesque appearance, present little of interest. The central rotunda, however, is a remarkable structure, and, with the emperor's pavilion and a few other buildings, will be spared on the

general demolition following the close of the Exhibition. It is composed entirely of iron, is circular in form, and covers, with its roof, the largest area as yet built over without the use of interior columns or pillars. Its essential features are thirty-two iron columns, placed at equal intervals in a circle, upon foundations of *béton*, and which support as many iron beams radiating towards the centre of the circle. A ring, also of iron, connects the tops of the columns and takes up the thrust of the roof, formed of iron plates riveted to these beams. The roof is of conical form, and supports a large and a small lantern. The diameter of the circle is one hundred and eight metres, and the height of the whole eighty-four metres. Exterior to the columns is a brick wall supporting an iron roof and inclosing the whole. The emperor's pavilion is chiefly remarkable from the magnificence of the interior decorations, but has been lost to most of the visitors at the Exhibition, from the difficulty of obtaining entrance. Beyond these, an Austrian building, composed entirely of concrete, is worthy of note. The roof is vaulted of this material, and is above flat and surrounded by a balustrade. It serves the purpose of a terrace, and is reached by a stairway of concrete alone, and supported entirely by a single arch. It is claimed in Vienna that such buildings can be erected at a less cost than those of brick; but the difference appears slight, since the walls must be made somewhat thicker of concrete, and, where it is used in such masses, great care must be taken to prevent its cracking, and, consequently, crumbling. The experiment is an old one; and, at the Exhibition in Paris in 1867, various laborers' cottages were built of the material without seeming to meet with general favor. The English exhibitors have erected, at the present Exhibition, several cottages of corrugated iron nailed to a wooden frame. These have the merit of cheapness, but are of little value in excluding heat or cold. During the hottest part of the summer it was excessively uncomfortable in their interior, and, moreover, in one or two cases where they have taken fire, elsewhere, they have burned like tinder. Wood in connection with iron, for building purposes, is, in fact, more dangerous than wood alone. When the latter has reached a glowing heat, everything in its vicinity that is at

all combustible is instantly inflamed. This is well understood in Austria, as is shown by the building-laws quoted above, which require the separation of these two substances. Where danger of fire might arise from falling sparks,—as in many cases of railroad buildings,—of course a sheet-iron casing has its value; but in general, where fire is liable to occur within, its use, to any great extent, seems inadmissible.

Among the plans to be seen at the Exhibition, my attention was especially directed to those of the new national library at Paris, whose description was appended. I translate a few of the principal particulars. This building is capable of containing (2,000,000) two million books and manuscripts. Its walls are all of masonry, while the floors, roofs, doors and windows are all of iron. To avoid the necessity of steps and ladders, all books can be readily reached by numerous iron balconies, separated from one another by intervals of about six and a half feet, while the carpenters' work is, in general, replaced by iron throughout the building. The roof is covered by glazed tiles, supported upon iron trusswork, and, at various portions of the same, terraces, affording access to large reservoirs, constantly filled with water, offer additional protection in case of fire. In the large reading-room, containing seats for four hundred and fifty persons, several iron columns, of very small diameter, help to support the roof. These are here in place; but, where there is a large quantity of combustible matter in the vicinity, such supports are always dangerous. As the Boston fire showed, they bend immediately upon becoming red hot, and let everything borne by them fall in general destruction; granite proved little better,—cracking and falling rapidly to powder when attacked by the flames. For magazines and store-rooms,—especially those containing combustible matter, and where a small loss of room is comparatively unimportant,—brick, it would seem, might be used for pillars where these are necessary. Certainly, no other material has shown itself so valuable in case of fire.

Better than the Exhibition, as a field for study, is the city of Vienna itself; and I cannot do better than describe its finest building throughout, before closing this Report. For its beauty, the solidity of its construction, its security against

fire, and its excellent arrangements for ventilation and heating, the Vienna Opera-house could well serve as a model for the world. Less imposing and costly than the similar building now completing in Paris, it is nevertheless admired by all visitors, and is acknowledged by the French as its rival in convenience and taste. It was completed in 1868 from the funds gained by the sale of land acquired by filling the ancient military ditch and levelling the walls, and cost not far from six million dollars. The area upon which it stands has an extent of eleven thousand square metres, of which eight thousand are occupied by the building itself. Its form is symmetrical, and the whole stands free, open on all sides to the view. The front upon the opera ring,—a section of the new boulevards surrounding the interior city,—presents two superposed arcades, containing five arches each, the lower being entrances to the main vestibule, which is reached from this point by crossing the *porte-cochère*, or at the ends directly from the sidewalk; the upper arches open upon a loggia, which is richly decorated with frescoes, and is, in the evening, brilliantly illuminated. From the centre of the vestibule ascends the main stairway, which, with its vaulted passages, covered with frescoes of light and graceful form and harmonious colors, forms perhaps the most beautiful portion of the interior. This communicates with the private boxes alone, which occupy such a large portion of the galleries of all European theatres. To the right and left are smaller stairways,—like the main one, of course, all of stone, —which lead to the seats in the upper galleries. Following the central line of the building, are next—the parquet and the front and rear stage. The latter, with their adjoining rooms, receive light from two court-yards measuring thirty-three by eleven metres, and covered with glass. These are situated symmetrically to the right and left of the central line, and descend below the level of the street to give light to the rooms below the stage. In the middle of each side of the building is a wing, advancing some twenty-five metres, bounding an end of the courts mentioned, and containing stairways for the emperor and arch-dukes. At the rear of the building are two similar wings, connected with the first by arcades, and behind them a row of shops,—these bound-

ing the fourth side of the courts. In these wings are staircases for the actors and actresses, and in one of the courts are six steam-boilers, connected with the engines for heating and ventilation, and here placed to avoid the injurious results of an explosion. At the rear of the building is a central entrance to the rear stage, and to its right and left are situated magazines. At the height of the third gallery, which corresponds with the second story externally, a ceiling of iron and brick covers the main stairway, and above it is located a buffet or restaurant. In the upper stories of the four wings are wardrobes, rooms for scene painting, etc., to which purpose the room over the rear stage is also devoted. The ceilings of these rooms are all fire-proof, and, of course, all walls in the interior of the building are of masonry. Right and left from the stage are nine stories of vaulted passages, in whose floors are water-pipes, supplied by reservoirs in the attic, and furnished at short intervals with cocks, reached by small iron doors in the walls. These can throw powerful streams upon the stage in case of fire. A steam-engine, of eight horse-power, pumps water into the reservoir and moves the stage machinery. It is located in the cellar, under one of the wings. The auditorium accommodates in all three thousand persons, including six hundred standing places in the fourth gallery and the rear of the parquet. The breadth of the stage is 29 metres and its depth 24.6 metres. The opening covered by the curtain is 11.4 metres high, and 14.2 metres wide. The depth of the rear stage is 19.9 metres. The exterior of the building is covered by a layer of stone upon brick, and, though tastefully treated architecturally, is, in general, simple in design. The central portion of the building is covered by a semi-circular roof of iron, to which is hung the stage machinery and the fire-proof ceilings over the stage and the auditorium,—the latter of which is decorated with paintings by the first native artists. A wire curtain can separate the stage from the audience in case of fire. The ventilation of the opera-house is conducted by means of steam-pumps, which force in the fresh air through a multitude of small openings dispersed about the floor of the parquet, the boxes and the galleries, thus occasioning no perceptible draughts. The heated gases pass away by an opening, four

metres in diameter, above the central chandelier of the auditorium. A steam-engine, of twelve horse-power, situated in the cellar below the main vestibule, sets a fan some three metres in diameter in revolution, which can force one hundred and twenty thousand cubic metres of air per hour into the rooms above. The cellar, which is more than seven metres in height, acts as a reservoir for the air, which is drawn in through various channels, and has here in summer the opportunity to cool. It then passes upwards by several openings into the upper rooms, or, in winter, can be first led through a chamber heated by steam-pipes. The system is on the largest scale ever as yet applied. Below the auditorium is situated the inspection-room, from which all the machinery is regulated. Here the temperature is observed, the position of the valves, the steam pressure, etc., while speaking-tubes and electrical wires communicate with all parts of the building.

Further information in regard to this building can be obtained from various works published in Vienna; among them the "Technical Guide,"—also translated into French,—which appeared at the commencement of the Exhibition; also the work of A. Folsch,—"Fires in Theatres and their Protection against the Same," and others.

The subject of ventilation, especially of that of schools, theatres, public buildings, etc., is still being investigated abroad, and every year finds some advance in the methods employed. In Glasgow a university building, recently completed, is provided with a tower of great height, in which a steam-fan sucks in the air from the summit and diffuses it through the building. In this way a pure atmosphere is secured which does not exist in the lower strata of the air of this great manufacturing town. This is introduced through numerous small openings, placed under the seats in the lecture-rooms and at the lower parts of the walls, while the exit of the bad air above is assisted by an additional engine. In the new Exchange building of Vienna, extensive provision is being made for thorough ventilation, and below the cellar, channels of great size, connecting with exterior openings, twelve to fifteen feet square, furnish the requisite fresh air. Some of the simpler contrivances in coffee-houses and dwell-

ings, in this city, are also worthy of note. Openings are very often made in the upper portions of the walls connecting with the chimneys, and in these a gas-flame assists the draught. These are sufficient to carry off a large portion of the smoke and vitiated air, but unless some provision is made for introducing fresh air at various points, this is sure to make its entrance by the cracks of the doors and windows, thus causing disagreeable and often dangerous draughts.

One method of obviating these is, to pass pipes connecting with the external air through the stoves, or fireplaces, used for heating the rooms, in which way a draught is produced and the current is warmed. The practical result is immediately evident in the cessation of the cold currents from the cracks of the doors and windows. These particulars, and many others of interest, are contained in a little work by Ludwig Degen, architect of the city of Munich, on the subject of ventilation. As regards the applicability of the methods of building described in this Report, in a country like America, where labor and material are dear, it can only be said that they would effectually prevent the recurrence of the great fires which have proved so destructive there. It is very doubtful whether our government is sufficiently powerful to establish the regulations cited as prevalent in Vienna; but certainly a description of what other nations are doing (as the result of the experience of centuries) is of value, and will impart the information on the basis of which the necessity of such restrictive laws can alone be properly appreciated. A step can be taken in the right direction by the proper construction of government buildings, and by the application of the necessary restrictions to theatres, hotels, school-houses, and other buildings where fires could be productive of great loss of life. Beyond this, men of wealth and patriotism could set a good example by the erection of private edifices of the sort described, which would have the additional advantage of helping to check the spread of the flames, in the same manner that the Boston Post-office has already once done.

I have been repeatedly assured that it is impossible to induce the people at home to build fire-proof buildings,

unless they be convinced that these are as cheap as those at present erected there. Now this is, of course, impossible to prove, for it is not true; but when it is generally understood that, in building houses with thin walls and pitch-pine floors a crime is committed against the public, it is natural to suppose that good citizens will cease from and discountenance such building, and that laws can finally be passed forbidding it. At the same time the expenses may, in many ways, be lessened. While a bricklayer in New York and Philadelphia (whose skill consists in making all the joints of a constant width, never varying by the thickness of paper) receives five dollars a day, the Italians, who are renowned in Europe as the first masons of the world; who, with inferior material, can construct a wall not only strong but handsome, and thoroughly understand all the jointing of vaults and arches, earn seventy-five cents a day. The ring-furnace, before referred to, produces bricks of inferior quality, but excellently adapted to the application of mastic, and at a greatly reduced price. With these, the thick walls necessary to sustain vaulting could be built at a low cost, which could be still further reduced by the importation of Italian workmen. The cheap terra-cotta could be imported from abroad at first, at reduced rates of duty, which is certainly as advantageous as importing our marble in wrought forms from Carrara, and other parts of Italy, as is now frequent.

I have heard it often said that we do not need to build fire-proof buildings, as those erected would form but a small percentage of all buildings standing and dating from other periods; but that we need care and an excellent fire department, and various other things, all of which are perfectly true, with the exception that we certainly also require as many fire-proof buildings as we can have. These points are all-important, and should all receive their proper consideration. The lesson is a hard one, but must be sooner or later learned, and those that profit by it earliest will profit the most. An objection to the Viennese methods of building has also been brought forward by those claiming that, in Paris, London, and other capitals, wood is used more generally than in Vienna, and that these cities are secure from

fires. The matter is entirely a relative one. Fires are less frequent and extensive in all European cities, except, perhaps, Constantinople, than in America, for the reason that there is more masonry and less wood in their buildings than in ours. At the same time, fires are less frequent in Vienna than in other European cities, for the same reason. As I write, the news of the destruction of the French Opera-house has arrived, and I feel little doubt that the Communists would have found much more difficulty in destroying Vienna than they did in their work in Paris after the Franco-German war.

In closing here, let me say that the attempt has been made in this Report to convey as much information on the various subjects treated as possible, and, at the same time, to make it of interest to the general reader. The latter end has been, at times, sacrificed to the former, as must naturally be the case when technical matters are treated of. The writer, however, trusts that those who have had the patience to read it to the close will have found matter for reflection, and will be convinced of the importance of some changes, at least, in our manner of building at home.

NELSON L. DERBY.

VIENNA, 1873.