MAY 18, 1895.

THE AMERICAN ARCHITECT AND BUILDING NEWS

VOL. XLVIII. * REGULAR EDITION * NO. 1012.

ARCHITECTURE

ENGINEERING

DECORATION

211 TREMONT ST.

BOSTON, MASS.

CONSTRUCTION

PRICE 15 CENTS.

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THE AMERICAN ARCHITECT AND BUILDING NEWS.

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Entered at the Post-Office at Boston as second-class matter.

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THE resignation from the Board of Trustees of the Boston Public Library of Mr. S. A. B. Abbott, who has for sixteen years taken a prominent part in the Library affairs, and has been, perhaps, the most active agent in securing appropriations for carrying out the noble building which has just been completed, deserves to be noticed, if only to recall the untiring energy, interest and discrimination with which he has watched over the great work which the citizens entrusted mainly to his guidance. As a rule, the architects of public buildings find themselves misunderstood, thwarted and tormented by the ignorant officials under whose direction they work, from the beginning to the end of their connection with them, and instances of architects who find, at best, anything more than an unwilling and unsympathizing endurance of their ideas are rare, while Mr. Abbott although he kept a strict supervision over the financial part of the undertaking, requiring accurate accounts, and detailed estimates, of everything carried out or proposed, entered with the interest and knowledge of an enlightened amateur into Mr. McKim's plans and tastes. As is well known, the details of the Library, and many features of the interior, are purely Italian. In order to furnish his draughtsmen with an abundance of the best motives, and inspire them with the true Italian spirit, Mr. McKim took his chief assistant on the Library work with him to Italy, and spent several months there, studying the designs which were later to be carried out in Boston, and Mr. Abbott joined them there, studying with them the plans which, in certain ways, he could criticise better than they. It is not too much to say that this cordial coöperation of the architect and the representative of the owners in a work of such importance has borne rich fruit; for without the mutual understanding so arrived at as to what it would be practicable and desirable to do for the Library, the splendid scheme of interior arrangement and design could hardly have been carried out with anything like the completeness which makes it now unique in American architecture; and it is this very completeness, as contrasted with the mangled compromises to which the plans of architects for public buildings are usually reduced in execution, which makes the greatness of the Library. To Mr. Abbott, therefore, who, in his province, did as much as Mr. McKim himself to make the Library possible, the gratitude of all persons who care for art, and, we may add, who care for the honor of Boston, is justly due, and his connection with the building certainly ought to be commemorated in some way in it.

SPEAKING of the Library, it is quite needless to remind any one who reads magazines or newspapers that the building is now being decorated in a manner which lends an extraordinary interest to the work, three of the most noted artists of the century having been employed to paint certain ceilings and walls, while, what is still more curious, only one of the three, Puvis de Chavannes, has a reputation as a painter of mural decoration, one of the others, Mr. Sargent, being known chiefly by his fascinating portraits, and the originality and technical resource with which they are painted; while the third, Mr. Abbey, is famous, particularly, as an illustrator of books, whose clear imagination, directed by a thoughtful and refined mind, has made him one of the best translators of literary into pictorial ideas. The spirit in which these two artists approach their work is characteristic. Mr. Abbey, the idealist, the lover of poetry and romance, sees in his mind a train of pictures, portraying the story of the Holy Grail, the most beautiful, perhaps, of all the mediæval legends. He sees the angel appearing to the child Galahad, the banquet-hall at Camelot with the Siege Perilous, and the vision of the Knights, and the Enchanted Castle; and he tries to convey to the frequenters of the Library the beauty and romance of the story, which he is said to have himself chosen as his subject. To Mr. Sargent, on the other hand, the thought of what he had to do seems to have presented itself, not as a succession of scenes in a story, but as a mass of color, to be distinguished later into symbols, or types, or what not. Of course, Mr. Sargent's work is just as intellectual as Mr. Abbey's, but it appears evidently to have been first a color-conception, differentiated subsequently to tell its story, while Mr. Abbey's was first the story, afterwards clothed with color. In any other case, the results arrived at by the two processes might be identical, but Mr. Sargent is too original for a commonplace development of his scheme, and, beginning with the color proposition, he has emphasized it with a rather startling accentuation of gold and relief-work. As neither Mr. Abbey's nor Mr. Sargent's decoration is finished, or the surroundings fitted to it, nothing can fairly be said of the coloring of either, but those who, like, for example, the editor of the English *Builder*, find the gold on Mr. Sargent's pictures too obtrusive, may comfort themselves with the idea that, if it is so when the decoration is completed, it will assuredly be modified, perhaps in some such way as in the case of the figure of Isis, with her attendant cherubs, which, with its gold and color and flesh-tints shining through the graceful curves of a blue, misty veil, seems to us the most splendid piece of purely decorative painting within our knowledge. What the completed room will be, if the necessary funds are raised for completing it, no one can venture to say, but it would be difficult to imagine a work more interesting to study and watch during its progress.

THE prediction that we made a few weeks ago, that the decision of the Supreme Court of the United States, in regard to the unconstitutionality of taxation upon incomes derived from rents of real estate, would have an appreciable influence in determining investment toward real property, and, in consequence, of promoting building operations, seems likely to be verified. The Boston *Advertiser*, which is good authority on the subject of real-estate operations in and about Boston, said the other day that the demand for land for improvement had increased within a month or so to an extent which could not be explained by the ordinary spring activity in such business, and it surmised that the decision making rents free from income-tax must have something to do with the change. It is hardly necessary to say that a buying movement in real estate, founded on a substantial inducement of this kind, is a very different thing from a manipulated rise in the stock-market; and it seems likely that for the next two or three years, at least, architects and builders may look forward to something like the steady employment to which they were accustomed before the disastrous season of 1892.

BOSTON is in the midst of one of its periodical panics about narrow streets. Now that the huge Tremont House building is well underway, the plans finished, contracts made, and a large part of the foundation in, it has occurred to some one that it would be desirable to widen Tremont Street at that point. The cost of doing so in any reasonable manner would be several million dollars, but the advocates of the scheme enforce their appeal by pointing to the indisputable fact that the sidewalks are already so crowded, not only on Tremont Street, but on many other streets, that people who are in a hurry to get anywhere have to walk in the gutter, or in the middle of the street. The curious part of these lamentations is that the inference which is always drawn from them is

not that the sidewalks should be widened by taking part of the roadway, but that the buildings should be pulled down to make space on the other side. The consequence of this fashion of looking at the subject is, as we have often pointed out, that no matter how much money the city of Boston may spend in street-widening, the sidewalks are always crowded and uncomfortable, the extra space gained being thrown into the roadway, where it does little good to any one. It is notorious that Boston has a larger proportion of its entire area devoted to streets than any other large city in the United States. It has spent forty million dollars within the last twenty-five years in making its streets wider still, yet its unfortunate inhabitants continue to walk in the gutters, and to contribute still vaster and vaster sums to perpetuate that amazing system under which the roadway is devoted to the rest and refreshment of horses and tired teamsters, to the traffic in "Moxie," peanuts, "ice-cream candy," buttons, toys, and other articles, and, where there is nothing else to occupy it, to dust and loneliness, while the people who pay for all these luxuries crowd and struggle around the margin of this peaceful scene, along a sidewalk which a fat man with an umbrella can effectually blockade.

WHY the Boston sidewalks should, on principle, be laid out one-tenth the width of the street, while those of New York and other cities are made one-eighth, is a mystery which has never been explained, and which derives an additional interest from the fact that the traffic of vehicles in Boston is proportionally very small in comparison with that of New York, while the foot-traffic is very large. As a matter of course, the teamsters, finding the roadways inordinately wide for the traffic through them, draw up their teams at the curbstone wherever they like, and keep them standing there for hours. In School Street, which has very narrow sidewalks, thronged all day long with an elbowing crowd, the roadway is always lined with two rows of stationary vehicles, of all sorts, their horses anchored to the curbstone with weights, while their drivers are shopping in the neighborhood, or slumbering on their boxes. All the wheel-traffic which passes through the street goes comfortably between the rows of anchored teams which line the curbstones, and which ought to be made forthwith to give up the space that they occupy to the foot-passengers who are entitled to it. In Tremont Street itself, the roadway practically comprises nothing but the space between the two or three track railroad in the middle, and the curb-stone, and this is not spacious enough to allow of much anchoring of carriages at the edge, or of increasing the width of the sidewalk, unless the space devoted to the railroad is curtailed, which, with the completion of the Subway, it might well be.

TO show how indifferent the people of Boston are to anything like real street administration, a good illustration may be found in the recent contract by which the principal street-railway company has agreed to keep mail-cars, to the number of not more than five at once, standing in the middle of Water Street, near the Post-office, for the convenience of loading the mails. It is true that the five mail-cars are not much more of an obstruction to traffic than the groups of wagons, often without horses attached, which have for many years occupied this part of the street; yet Water Street is a "congested street," and it is not more than a year or two since an urgent appeal was made to the city authorities to have it widened, just above the Post-office, at a cost of about a million dollars. Many other instances might be given of the recklessness with which "broad avenues," consisting of wastes of paving-stones, visited by an occasional team, and lined with tiny sidewalks, have been made at the taxpayers' expense, without any necessity or advantage to any one, except, possibly, the owners of the abutting land. It is related that when the question of widening Atlantic Avenue, one of the most absurd of these thoroughfares, was under consideration in the City Council, and a day had been appointed for the civic magnates to view the premises, the people who had pecuniary interests at stake hired a vast number of wagons and carts, and set them driving through the streets intended to be widened. The widening was carried through, but Atlantic Avenue has never seen any such traffic since. This was twenty-five or thirty years ago, when the mania for street-widening raged fiercely. Now, after two decades of comparative quiescence, it has broken out again, more virulently than ever, and new schemes for street-widening come up almost every day. Meanwhile, the cart-horses muse by the margin of the huge areas of paving-stones provided for them by the tax-payers, while the tax-payers elbow each other off the same little sidewalks, in the same old way. It seems to us that it is time now to try a different method. Let every street have sidewalks one-eighth its own width, and let teams be restrained by heavy fine, as they are in London, from standing more than three minutes in any street, except at stations provided for the purpose. Boston, with its innumerable triangles and squares and "dodecagons," presents ample facilities for establishing convenient carriage and cart stands, and there is no reason whatever why teams should not wait there, instead of in the space needed for sidewalks. If this were done, and Tremont and Washington Streets relieved of through railway traffic by the Subway, we doubt if any more street-widening would be required for a generation, except, possibly, for making connection between the Subway Station in Haymarket Square, and the Union Station on Causeway Street.

THE first annual meeting of the permanent committee in charge of the American School of Architecture, in Rome, was held Saturday afternoon at the rooms of the Architectural League, in New York. After looking at the competitive drawings for the Roman Scholarship, on exhibition in the room below, the committee proceded to organize, by the adoption of rules and regulations and the election of officers. Mr. R. M. Hunt was made Chairman; Professor Ware, Vice-Chairman; Mr. McKim, Treasurer; and Mr. Boring, Secretary, these four officers constituting an Executive Committee; Mr. C. H. Walker, of Boston, was added to the committee. Professor Hale, of Chicago, chairman of the committee appointed by the Archæological Institute to consider the practicability of furthering in Rome the study of ancient and mediæval antiquities, was present by invitation. He reported that the Council of the Institute had, on the morning of the same day, voted to establish a school in Rome somewhat after the pattern of their School of Classical Studies, at Athens. It was determined that if the Casino del Aurora, now leased by the School of Architecture, proved sufficiently commodious, the two schools shall have a home under the same roof. If, as has been suggested, there is room on the grounds to accommodate, also, students of sculpture and of mural decoration, it would seem as if there were a prospect of establishing upon the Pincian Hill an institution worthy of support from the legion of travellers to whom the name of Rome is a household word.

THE Trustees of the New York Cathedral of St. John have taken the wise course of ordering the foundations of their building to be carried down to the solid rock, many feet below the surface of the hill on which the structure is to stand. The work of excavation has been long and expensive, but the ledge has at last been reached, and the contractors are now levelling it with concrete, to receive the masonry of the foundations. It is hoped that all the substructure will be completed this season, and, another year, visitors will have the pleasure of seeing the building going on above ground.

THE whole scientific world is interested in the new element, argon, discovered by Lord Rayleigh and Mr. Ramsay, in the atmosphere. Although named "argon" from its apparent inertness, the discoverers having been unable to make it enter into any chemical combination, M. Berthelot, to whom a small sample was sent, has been more fortunate. Suspecting that its discoverers might have used too high a temperature in trying to combine it with other substances, he kept it cool, and subjected it, in the presence of other elements, to a silent electric discharge. Nitrogen can in this way be made to unite with benzine and other hydrocarbons, forming compounds which, when decomposed by lime, behave like organic substances, giving off ammonia; and M. Berthelot found that argon was still more susceptible than nitrogen to such electrical influences. By mixing argon and benzine vapor, and exposing them to an electric current, of the sort known as the "silent discharge," he was able to cause the absorption by the benzine of eighty-three per cent of the argon. This reaction produced a yellowish resinous substance, with the peculiarity of being brilliantly fluorescent, and the spectrum of the fluorescence was found to be so similar to that of the aurora borealis as to give reason to suppose that the aurora may be due to the fluorescence of some gaseous argon compound. What other peculiarities the new substance may have, we are not yet informed, but M. Berthelot promises to continue his investigations.

THE SO-CALLED COLONIAL ARCHITECTURE OF THE UNITED STATES.[1] — I.

"Men can with difficulty originate even in a new hemisphere." — EDWARD EGGLESTON.

IT is proposed in this essay to gather together some of the records bearing upon the architecture of the seventeenth and eighteenth centuries, and to arrange these so as to furnish a short, systematic and comprehensive survey of what building activity was exercised within the English provinces of America during those two centuries.

The art of this period, including also the first twenty years of the nineteenth century, is generally called "Colonial." Some object to the term, saying that there is too much variety of style to come under one head, and that, moreover, the best work was executed long after the original Colonies had become Provinces, and even later. But the term has been in use so long, and is so suggestive and comprehensive, that it would be difficult to find one more acceptable. Object as we may to the words "Gothic" and "Colonial," we cannot spare them, for no other words call up in the mind so complete a picture, not only of architecture and of the other arts, but of all the peculiar conditions — social, religious and political — which produced the mediæval ecclesiastical architecture of Europe and the eighteenth-century domestic architecture of America.

In this domestic architecture, there was evolution and growth just as truly as in any other style. If the perfection of Greek art remained unaccountable until the archæological discoveries on the banks of the Nile and the Euphrates, still less would one understand Colonial art without a knowledge of the preceding styles. America owes Europe much, and we shall see that the emigrants left the mother-country with neither empty hands nor empty heads.

THE NEW ENGLAND PROVINCES: DOMESTIC ARCHITECTURE.

The reason for beginning with the New England colonies is not because they are the oldest and furnish a good geographical starting-point, but because in them is more and better material, more thoroughly investigated and recorded. Moreover, the architecture in them, being homogeneous, is more easily classified. By making a classification, the subsequent inquiry farther south will be made easier, for thus a standard or criterion will have been established to which reference can be made.

After the first quarter of the eighteenth century there came to the Colonist a period of comparative peace and prosperity. The Indian was no longer a standing menace, "the stubborn phalanx of forest trees had been gradually beaten back, the disencumbered fields yielded a surplus, and leisure and comfort compensated for hard beginnings." It is only natural to find architecture influenced by this. Almost all good Colonial work is later than 1730.

A brief review of the earlier period possesses, however, both interest and value. The subject can best be discussed under three topics: Log-houses, Military Homes, and Settlers' Cottages.

The log-house, the first and most natural dwelling[2] in a new and thickly-wooded country, was not to the taste of the colonist. Life in it was to him a chrysalid state, from which to emerge, the sooner the better. Roughly squared timbers seemed incompatible with his higher ideals.

Yet the first Doric artisan, when called upon by his fellows to rear a worthy abode for the ancient *xoanon*, did not find it so. Looking about for suggestions, he saw nothing but the low-roofed timber houses of Homer's heroes. But in them his artistic sense perceived great possibilities. In the rough timber ends, he found splendid triglyphs; in the open spaces, sculptured metopes; in the ungainly trunnels, depending guttæ; and in the overhanging rafters, richly raised mutules.

But the colonist, disdaining the material at hand, cast longing glances back to Europe, and, from his earliest efforts to his last, there was a constant and conscious striving to reproduce in this new land his former home, grown doubly dear through long separation. Thus Lowell says of Cambridge, that it looked like an English village badly transplanted.

But many colonists had for a long time no choice but to live in log-houses. This fact they concealed as best they could by covering them with clapboards or shingles, put on with hand-wrought nails. The floor, often at first of stamped clay, was soon superseded by a pavement of rough puncheons. The window-lights were of mica, of oiled paper, or of horn. No glass found its way to the colonies before the year 1700, or thereabouts.

The Military Homes were more important structures. As in the early settlements the prime requisite was protection against the elements, wild beasts and savage men, it was quite common that one or more of the houses should be built especially large and strong, to serve as a refuge and a rallying point, from which the more effectually to repel Indian onslaughts. Many stories and bloody legends still cling with the old moss and lichen to these silent witnesses of a danger-fraught period.

Important among those still standing are: the old brick house of Governor Cradock, built about 1634, at Medford, Mass.; the stuccoed timber house of Governor Bull, in Newport, R. I., built in 1639; and the clapboarded Minot homestead, in Dorchester, Mass., built in 1640. The so-called "Old Stone House," finished in 1640 as a parsonage, at Guilford, Conn., has since been rebuilt upon the original lines. The Red Horse Inn, at Sudbury, Mass., built in 1680, and made famous through Longfellow's "*Tales of a Wayside Inn*," though not known to have served as a fort, resembles the preceding so much as to readily group with them. The poet's words, descriptive of this inn, will be helpful in picturing this class of houses:

> "As ancient is this hostelry
> As any in the land may be,
> Built in the old Colonial day,
> When men lived in a grander way,
> With ampler hospitality;
> A kind of old Hobgoblin Hall,
> Now somewhat fallen to decay,
> With weather stains upon the wall,
> And stairways worn, and craggy doors,
> And creaking and uneven floors,
> And chimneys huge and tiled and tall."

Architecturally, these structures are very simple. Leaving out the Old Stone House, which alone is irregular and picturesque, the main elements are: a rectangular plan, two stories and an attic, a gambrel gable, generally, at each end, a symmetrical disposition of openings and dormers, and an overhang of the second, or of the attic story, for defence.

The Cradock House (Fig. 1), typical in its way, deserves special mention. It is the oldest house standing to-day in New England, and as that delightful Chronicler Drake puts it, "proudly bears its credentials on its weather-beaten face." Though its English owner never saw

Fig. 1. The Cradock House, Medford, Mass. 1634.

Fig. 2. The "Old Manse," Concord, Mass.

it, his "servant" was conscientious in building it well. The design is thought to have been suggested by Cradock's London house. The timber was hewn within a few feet of the site, the bricks were burned on the spot. Iron guards were built into the doorways, and four dangerous-looking loopholes showed that it was a military house first and a trading-post and a home after. Two solid chimneys stand guard, one at each end. Two dormers relieve the long roof expanse of the front. The original windows were small. There is no ornament except a plain band at the second-story level. In the main lines of its composition, it is strikingly like the Hancock House, of Boston, of which a *pseudo replica* was erected at the Columbian Exhibition, at Chicago. It would be interesting to know the arrangement of the rooms, but no plans are accessible. Even if the present partitioning off were known, it would be of little value, owing to probable interior remodelling. Undoubtedly, the planning was simple — a multitude of closets, odd corners, and many staircases are modern conveniences, for even the later Colonial houses, though often elaborate and costly, were seldom comfortable to our way of thinking.

Quite early, another — a cottage — type was evolved, with a long sweeping roof towards the rear, canting off a corner of the ceiling of each story from the attic to the kitchen. This type persisted until quite recently and recurs in hundreds of cottages throughout New

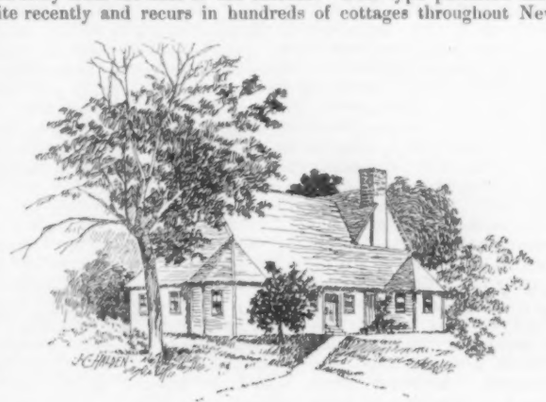


Fig. 3. Avery House, Pequonnock, Conn. 1656.

England. Such were the childhood homes of the Presidents Adams (Fig. 4). It was just such an humble dwelling, in Easthampton, Long Island, whose fond memories re-echoed in the heart of John Howard Payne, and produced the song of "Home, sweet Home."

The doorways only are remarkable. There is usually on each

[1] Graduating thesis of Mr. O. Z. Cewin, School of Mines, Columbia College.

[2] [Mr. C. W. Ernst has recently discovered satisfactory evidence that the very first work of the settlers was to set up saw-mills that they might get out the lumber in the sizes and shapes which they were wont to handle at home. — EDS.]

side of the door a Classic pilaster, with a moulded capital, supporting a plain cornice with a pediment. Even this simple feature is often omitted.

To this period belong the historic Witch House, in Salem, and the home of Paul Revere, in Boston, neither of which groups readily with any of the above.

Fig. 4. John Quincy Adams's House.

The peace and commercial prosperity, which set in about 1730, stimulated building activity. The shrewder merchants, having amassed considerable fortunes by traffic in slaves, lumber, fish, tea and English stuffs, set themselves to the pleasing task of spending their gains in the best manner. What better could they do than to erect commodious houses? Some professional men and some landed proprietors, too, had become wealthy, and vied with these merchants in their building enterprises. The ordinary material was wood, that is, houses were constructed of an open framework of timber and covered with clapboards, or sometimes with shingles. Brick was rarely employed, except in the larger towns.

Many, especially the earlier houses, seem to have been suggested by Governor Cradock's military home, or by others similar. By degrees the gambrel roof was eliminated. First, the hipped or the mansard roof came into vogue, from about 1760 to 1790. This was in turn superseded by the flat deck, towards the close of the century. Of course, examples of each overlap, the gambrel type being specially persistent; but the general tendency will be clearly shown, in an appended chronological table.

It is strange that the evolution of so bold a feature as the gambrel roof has not been traced. The oldest examples show it used with a

Fig. 5. The Vassall-Craigie-Longfellow House, Cambridge, Mass. 1837.

confidence bred of familiarity. This roof, though the oldest, is the most graceful and pleasing, avoiding the box-like effect and hard lines of the other two. Of this type, the following are quite remarkable: the Pepperell mansion, at Kittery, Maine, begun about 1720, and confiscated after the Revolution with its thirty miles of property; the Hancock mansion, at Boston, begun in 1737; the birthplace of General Putnam, at Danvers, Mass., built partly in 1650 and partly in 1744; and the often illustrated "King" Hooper House, also at Danvers, which was, in many things, a copy in wood of the Hancock house. The Hancock house, now a memory only, though one of the oldest, was one of the best. It was a stone building, so solidly erected as to require blasting when torn down. Thomas Hancock began it in 1737. Having become immensely wealthy, for those days, through skilful trading, he felt that Boston was getting too crowded for him. Just outside its limits he found a fine hill overlooking the bay. Here he staked out his house, fifty-six feet wide. When completed, he improved the grounds with walks and gardens. The entrance in the middle of the front was protected by a balcony, opening from the wide hallway of the second story. On the sides were two large windows in each story. Three dormers lighted the attic. A modillion cornice, returning on itself at the ends, marked the transition from the wall to the roof. A balustrade of neat spindles surrounded entirely the upper and flatter slope — a connecting chain from chimney to chimney, justified only by the happy way in which it crowned the whole. The corners and openings were trimmed with white stone quoins. The details were refined and the ornament sparing, but appropriate. Altogether, it was a roomy, well-designed and dignified house, exactly suited to be the mansion of the first gentleman of the Commonwealth, and through him and his illustrious nephew, John Hancock, to extend its stately hospitality to the greatest men of the day. It lacked many important features. Thus there were no spacious verandas, no two-storied pilasters, and no gable over the front entrance.

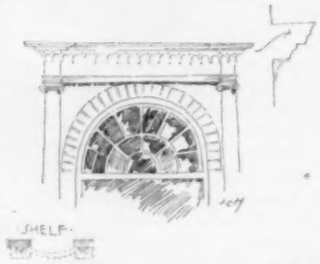


Fig. 6. A Door-head, Portsmouth, N. H.

The second, or mansard type, is more Classic, presenting on all sides a predominance of horizontal lines. But the elements of the design are virtually the same. The roof balustrade is usually, as it should be, placed around the flat deck on top. Sometimes it occurs at the base of the slope.

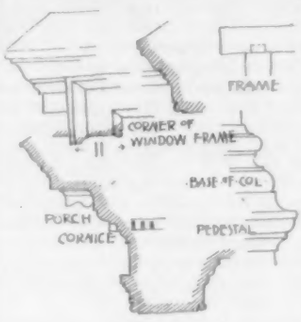


Fig. 7.

The Vassall mansion (Fig. 5), built in 1759, at Cambridge, Mass., and since 1837 the home of Longfellow, is a splendid example of this class. The large Oliver house, at Dorchester, Mass., built in 1740, the birthplace of Edward Everett, is also a worthy structure, in spite of its steep box-like roof and lack of verandas. The Quincy mansion, Quincy, Mass., built in 1770, is quite remarkable with its attic rising like a clerestory above the outside walls. Many other prominent examples could be quoted.

The flat-roofed houses, forming the third class, are less interesting. The details are more correct, and there is a tendency to formalism. Many of these are three stories in height. In Boston, they were often four stories high and of brick. There is in this type, a meagreness about the details. The porches are small and bare, the columns few and slender. Evidently, the original inspiration had begun to fail, and there was a striving for new effects.

The birthplace and home of Lowell, known as "Elmwood," at Cambridge, is as fine and typical an example of this class as is Longfellow's of the preceding. "Elmwood" is three stories high, the upper story, however, more like a mezzanine. It stands charmingly among high trees planted by the poet's father.

Naturally enough, few names of designers have been handed down. It is, therefore, a pleasure to record that William Spratz, a Hessian soldier, was the architect of the Deming house, at Litchfield, Conn., built in 1790. It has a low mansard roof, with a balustrade just over the cornice. The middle portion slightly projecting and finished with a pediment, has, in the second story, a fine Palladian window, very similar to one found in a brick house at Annapolis, Md. [See Fig. 56.] The details are very correct and elegant, as though designed with "*Vignola*" in the hand. The general effect is pleasing, except that the cornice lacks a frieze, which gives it the appearance of having sunk into the wall.

The mere fact that Spratz was a soldier throws some light upon the status of the architectural profession. The provinces possessed

Fig. 8. Hood, Ayrault House, Newport, R. I. 1739.

but few educated architects. Most houses were the result of collaboration of owner and village carpenter. The one furnished the general plan and ideas; the other worked out the details. Thus Dr.

Ayrault, in 1739, specified in his contract, still existing, that the builders were to provide a hood over the entrance, and to support the same on carved brackets (Fig. 8). Such notices, and some accidentally preserved books on the Orders, by Swan, Pain, Langley and others, indicate that the Colonial mechanic was more than a mere skilful tool. He spent much time in devising practical methods for executing in wood Classic features and details originally designed for stone construction. Many characteristics, such as a tendency to increase the proportional height of the columns (Fig. 6), and details like the one illustrated in Figure 7, may be traced to such efforts.

(To be continued.)

SOUND IN ITS RELATION TO BUILDINGS.[1]

IT is now nearly thirty-five years since a paper was laid before the Institute on the subject of acoustics in connection with architecture by Professor T. Roger Smith [*F.*], followed in the next year by the publication of his excellent treatise on the "*Acoustics of Public Buildings.*" This work is now unfortunately "out of print," and difficult to obtain. Mr. H. H. Statham [*F.*], in 1873, contributed a very valuable paper on "Architecture practically considered in reference to Music."[2] During the past session this subject was broached at one of the meetings of your Science Committee, and the writer was deputed to consider the question of acoustics for discussion at one of the Sessional Meetings. Little apology is needed for the introduction of so important a matter; but one is certainly needed for the author, who is merely an architect, not a physicist, and perhaps, therefore, not fully competent to deal with the science of acoustics in its abstruse bearings. Without professing to put before you any new views on the treatment of this complicated science, I shall endeavor to pass in review some of the principal later writings of others, scattered as they are through many scientific treatises and technical journals.

The inherent difficulties of the subject are great, and they are by no means lessened, but amplified, by the strange divergence of opinion at times expressed upon one and the same point; one observer pronouncing a building to be good for sound, while another condemns it. This may, in part, be attributed to different uses to which the building is subject. "To put it simply," says the Rev. Compton Reade, speaking of churches, "just as that concert-room which is best for voices is worst for instruments, and *vice versa*, so the church most suited for oratory is least suited for harmonic effects." But, conversely, other writers contend that "there is no instance of an apartment where music is heard to advantage where a speaker does not find himself free from restraint, oppression, or a necessity for exhaustive exertion. Therefore, our problem is plainly to build our apartment, whatever it is intended for, as if it were a music-room, and we are safe."[3]

One finds a flat wall a source of echo and annoyance, and promptly proceeds to build a curved one as a remedy, perhaps only to find that he has plunged into a worse difficulty by focussing and concentrating the sound into one or more points in his building. Another pleads for the use of wood as the cure-all for every acoustic defect; while yet another utterly condemns its use, and would depend entirely upon plaster surfaces and smooth hard floors and the like. Each case must be considered on its merits, and the individual use to which each building is to be put carefully weighed, before a suitable result can be arrived at. An American writer says he "can see no excuse for building an apartment so that its acoustic properties are not as much a matter of course, as keeping out the weather." But while even the greatest scientific authorities on matters acoustic are not agreed upon some of the problems which are more or less contemptuously dismissed as one of those things "which every schoolboy knows" by architectural writers, and while the strangest variance is expressed by the latter in their views as to the application of scientific laws to buildings, success can hardly be assured.

To take a well-worn theme, that of the Whispering Gallery at St. Paul's Cathedral, as an example, Ganot, in his "*Treatise on Physics*," attributes the peculiarity to *reflection* of sound from point to point until it reaches the ear. Tyndall also deals with it as an echo or repetition; the late Astronomer Royal attributed it to reflection from the surface of the dome overheard; while Lord Rayleigh says the sound "seems to creep round the gallery horizontally." Professor T. Roger Smith, following Saunders, says the sound is conducted round the walls; but whether by vibration of the latter or by the air is not stated.

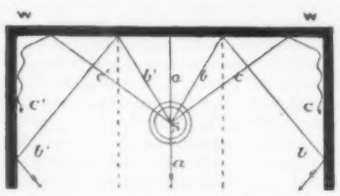
It is only by a patient accumulation of facts that scientific truths can be established, and no cursory dismissal of a subject, on the ground of its having been already well discussed, should be tolerated. The probable existence, for instance, of such a constituent of our atmosphere as *Argon* was not even suspected till quite recently. I do not propose to deal with the purely physical aspect of the science, but to consider it from the architect's point-of-view entirely, and it is with a view to raise some practical discussion on a difficult subject that I venture to bring that of acoustics before you.

Form of Buildings. — We come, then, first to the consideration of the form which a building should assume to ensure acoustical success, and we find that the greatest diversity of opinion has been expressed upon this most difficult and important part of the subject.

Plan. — It will probably conduce to clearness of treatment if I describe buildings, so far as their form or design is concerned in regard to acoustics, much in the way that the problem would present itself to the mind of an architect in evolving his ideas, dealing first with the plan. As the limits of distance to which an average speaker can be heard are about 90 feet in the direction to which he speaks, 75 feet on each side, 30 feet to the rear, and 45 feet vertically, authors have endeavored to group buildings into classes — those, first, which fall within the range of voice, and in which, therefore, sound proceeds from the speaker to the listener by direct radiation; and, secondly, those which exceed the above dimensions, and in which the sound must be conducted, assisted and reinforced by the design, construction and materials. Guillemin, in his "*Physical Forces*,"[4] "divides rooms into three classes: first, the concert-room, where the orchestra or speaker is placed, or should be placed, in the sound focus, and where everything is subordinate to the auditor; second, the theatre, where there are two sound foci — one for the orchestra and one for the actors; and third, the hall for deliberative assemblies."

But little importance can be attached, apparently, to these somewhat arbitrary divisions, as many buildings without the slightest obstacle between speaker and hearer, and under one roof, are decidedly bad for sound — giving rise, in some instances, to confusing reflections, and consequent echoes, and in others to great decay of sound through the dispersal of the sound rays upward in the large open roofs required to cover single spans of wide dimensions.

Simplicity of plan is not of necessity good for acoustics, as it has been so often shown that square rooms are defective; indeed, flat surfaces are condemned by most authorities on the subject, as reflections take place in the right angles of such apartments, at the floor, walls and ceilings. A figure is given in the report of a lecture by Mr. W. Fletcher Barrett,[5] which illustrates this. Let *S* be the speaker, near the flat wall *W W;* the sound diverging in all directions strikes the wall at every angle. Consider the rays *a, b, c;* the first reaches *W W* perpendicular to its surface, and is reflected back in the direction of the arrow; *b* strikes the wall at an angle and is reflected; *c* reaches the wall at an angle approaching 30°, and is not regularly reflected, but is propagated as a roller (in the manner demonstrated by the late Scott Russell in his researches on waves). The nearer the speaker is to the flat wall the greater is the obliquity of the incident ray, and more rays are therefore abstracted from the volume of sound. In such cases, therefore, it has been found of advantage to cant off the angles of the rooms, or to curve the ends, or to place the speaker near the corner of the room, so that he addresses the audience diagonally, much as we do in the meeting-room of the Institute. By curving the ends of the room the incident rays strike the wall at a less oblique angle, and are then reflected forward — in the case of a parabola as a series of parallel rays.



If rectangular rooms are adopted, some authors consider they are improved if one dimension is longer than the other. The late Dr. Brewer[6] said: "The best form for the interior of such rooms is that their length be about *two-thirds* greater than their breadth, in order that the sounds reflected from the side walls may mingle with the voice and strengthen it." As sound-waves are propagated in spherical layers from their point of origin, it has often been imagined and urged that curved forms are the best to adopt for acoustic reasons, and many opinions have been expressed both for and against this view.

Of buildings having a circular plan we have already noticed the well-known bad example of St. Paul's Cathedral; but it must be borne in mind in connection with it that the effect is in great part due to the close proximity of the speakers to the walls. Another effect would, no doubt, be produced if the speaker were situated in the centre of the circle, or near it. Tyndall records that at the London Colosseum, "a circular building 130 feet in diameter, Mr. Wheatstone found a word pronounced to be repeated a great many times. A single exclamation appeared like a peal of laughter, while the tearing of a piece of paper was like the patter of hail." So, again, at the Dublin Rotunda a speaker said: "It appears as if some one were in front soaking up my words with a sponge as soon as the syllables had left my mouth."[7] The Pantheon at Rome is also stated to produce some very singular effects of resonance, due partly to the dome and partly to the circular plan. Radau[8] mentions that in the circular concert-room of the Fine Arts Society in Berlin, where the walls are broken by a large number of deep embrasures, this inconvenience is not met with. Closely allied to

[1] A paper by H. W. Burrows [A. R. I. B. A.], read at the General Meeting of the Royal Institute of British Architects, Monday, March 25, 1895, and published in the *Journal* of the Institute.
[2] "*Transactions*," 1873, p. 71.
[3] A. F. Oakey, in Van Nostrand's *Engineering Magazine* (1881), vol. xxv., p. 234.
[4] *Building News*, vol. xxxii. (1877), p. 427.
[5] *The Builder*, vol. xxvii. (1869), p. 402.
[6] "*Sound and its Phenomena*" (1854), p. 314.
[7] *The Builder*, vol. xxvii. (1869), p. 403.
[8] "*Wonders of Acoustics*," p. 109.

the circular plan we find many polygonal buildings giving varied results. Among those which have been noted are the following:

The Westminster Chapter-house, octagonal on plan, the sides each about 24 feet, with its well-known central clustered columns and vaulted roof, is stated by Saunders and others to be bad, acoustically. So, again, with the octagonal vestibule, the "Hall of Secrets" in the Paris Observatory — Brewer shows that reflections take place from one side to the other, producing a regular "whispering gallery." On the other hand, the old Surrey Chapel, Blackfriars, is quoted by Saunders as a very successful building for its purpose. It is a sixteen-sided room, with a gallery above, and below which are windows, the whole being covered by a hemispherical roof, with a lantern light.

With the examples here noted it will be observed that the breaking up of the wall-surface by "deep embrasures," as in the concert-room of the Fine Arts Society in Berlin, already mentioned, and by the gallery at the Surrey Chapel, successful buildings apparently resulted from the adoption of a plan which may be looked upon as normally defective.

Departing from the circular and polygonal types of plan, other modifications have been tried, and notably, perhaps, the oval or ellipse, as exemplified by the Albert Hall, London. Nearly every writer has condemned this building for its acoustic properties, or rather, for the lack of them. It was pointed out by many before the building was begun that failure would in all probability result, as the reflections from such a form were known to be concentrated in the foci of the ellipse; and this, together with its vast size, form and material of roofing, have alike combined to produce a great failure from an acoustic point-of-view. The amphitheatres of the ancients were not trammelled with the same restrictions that beset us: the only covering needed was the *velarium* to keep off the sun's rays, and in such buildings it can even to-day be shown that the seats were so disposed that the actor's voice proceeded directly to all the auditors. Radau says: "Even in the ruins of such theatres we can see that this end was generally obtained. Every word spoken in the arena can be heard at the farthest seats. The theatre of Hadrian's Villa at Tivoli, the Circus of Murviedro, and the Amphitheatre at Nîmes are remarkable in this respect."

The amphitheatrical type of plan has often been adopted for lecture theatres, and it certainly possesses many and distinct advantages, so far as the seating capabilities are concerned, and in many instances has proved successful from an acoustic point-of-view; but there are notable exceptions, among which may be mentioned, chiefly defective from an excessive sonorousness, the semicircular room of the Fine Arts School at Paris, which is described by Radau[1] as being beautifully decorated, but miserable in this respect, as are also the great Amphitheatres of Physics and Chemistry in the Jardin des Plantes, and the Amphitheatre of Physics in the College of France. Efforts have been made in each case to remedy the defects, but with little success. One of the examples often quoted as a successful application of this type of plan is the Lecture Theatre at the Royal Institution, plans and sections of which are given in Prof. T. Roger Smith's work. At the University College, Gower Street, in the Botanical and Mathematical Lecture Theatres, both of which are arranged on this plan, with a quadrangular recess behind the speaker, I have noticed a distinct echo when the rooms are only partially filled by an audience, the speaker's voice beating on one's ear in a confusing manner: the effect is more noticeable in the lower room. This echo in semicircular buildings is, no doubt, in great part due to the speaker being placed in the focus of the curve, as I have observed at Gower Street that when speakers address the audience from either the right or left of the lecturer, the echo is not as perceptible, and is in many cases entirely lost.

Closely allied to the above types of plan we may next consider those in which the end is more or less curved, and the sides produced somewhat in the manner of the plan of a basilica. The objection to the concentration of sound in one focus is to a great extent lost by this arrangement, as the sound-waves, not being produced in the centre of curvature, are in part conducted by the walls before striking the curve. The London County Council Chamber, described by its architect, Mr. Blashill, before the Institute, and figured in the *Journal*,[2] is an example of this method of planning, and is considered to be acoustically successful. Radau mentions that Chladni proposed a plan to terminate rectangular halls with a parabola, as found in some ancient basilicas, and suggests that the arrangement might be completed by giving a parabolic form to the roof over the platform. The objection to all such arrangements is that, although sound is undoubtedly conveyed by a parabola in a series of parallel rays, all sound originating in the body of the hall may be concentrated in the focus of the parabola, so that great difficulties present themselves in dealing with any curved surface of that nature.

Among other buildings planned as elongated rectangles with rounded ends which are successful acoustically may be mentioned the Cincinnati Music Hall,[3] the Concert-hall at Leipsic,[4] and the Queen's Hall, Langham Place.[5] In the last-named plan the truncated trumpet-shaped orchestra is a noticeable feature, as in nearly all other examples I have noticed the curve at the back of the orchestra is concave, parabolic, semicircular in outline, or a compound curve not easily definable.

The horseshoe type of plan has been adopted in a large number of theatres, but with varying success, depending in great part upon the materials of which the buildings are constructed, as we shall see later, and influenced largely, among other things, by the boxes, which Scott Russell says are favorable to the laws of sound, while Zamminer declares them to be monster traps for strangling it! Theatre-planning and arrangement have proved an attractive theme to many writers, and I need not here enlarge upon it; the well-known works of Lachèz, Langhaus, Saunders and Wyatt, and more recently the paper read before the Institute by Mr. Ralph Nevill [*F.*],[6] and the articles by Mr. Woodrow still appearing in the *Building News*, form an ample field of research for those interested in this branch of design.

Of composite types of plan, difficult to designate by any distinctive word, may be mentioned one, the original suggestion of which is apparently Chladni's, namely, that in which the walls at the rear of the speaker or orchestra are formed as a truncated pyramid, diverging outward, with the seats arranged in a semicircular or other curve. This plan appears to be adopted with success at the Hall of the Midland Institute at Birmingham, and is figured in outline in the *Handbuch der Architektur;*[7] and in the new Grand Theatre, Islington. Outline plans, to scale, of several buildings are given in the *Handbuch* referred to — of the Albert Hall, London; the Trocadèro, Paris; Concert-hall at Leipsic; La Scala, Milan; the Birmingham Institute; and of the Houses of Parliament, Vienna.

We have to this point been considering those plans which are often designated "halls," that is to say, buildings in which there is no division into arcades, as in churches and cathedrals. It has been urged by many, as to this latter — the avenue — type of plan, that the columns which carry the arcades cause sound-shadows, and are, therefore, objectionable. In this matter we again find most contrary opinions expressed. Scott Russell says: "In a long gallery with wings, the sound cannot be reflected back or rolled along so as to create disturbance, because it goes round and escapes into the transepts; consequently these are favorable to the laws of sound." Radau conversely insists that "the transepts of a church are most inconvenient to a speaker, because of the repeated reflections from these recesses, which greatly weaken the sound of his voice." A recent writer in the *Building News* considers the effects of transepts doubtful, "especially those of much depth, as they tend to absorb the volume of sound at its initial point or to disperse the waves. . . . Transepts of small depth and of good width may even be found helpful in breaking up the echo and in diffusing the sound, as we find in many examples of recent churches." Dealing with church architecture and its acoustics, one of the most suggestive papers I have noticed is that by the Rev. Compton Reade,[8] in which he does not spare the members of our profession, if I may quote the following:

"One might have presupposed that architects, in designing churches for special forms of worship, would have been guided by the failures and successes of the past. The reverse is the case; indeed, I question whether acoustics ever have come into consideration, it being assumed that all mediæval buildings must be more or less respectable in respect of acoustic properties. Some mediæval churches were indisputably models of acoustic excellence; others, models of acoustic deficiency."

We nearly all fall under his lash, Churchman and Dissenter alike receiving castigation:

"All Saints', Margaret Street, and St. Alban's, Holborn . . . . possess acoustic properties of a satisfactory character. They stand alone in this respect, St. Andrew's, Wells Street — a church celebrated for the excellence of its choir — being architecturally feeble and acoustically atrocious . . . . They are ugly and cacophonous. Nor have the Nonconformists eclipsed us. Mr. Newman Hall's pretentious tabernacle boasts an effective exterior, with a gloomy, cold interior, utterly destitute of the grace of congruity. Dr. Parker's Temple is light and bright, well adapted, moreover, to his form of worship, and acoustically perfect — for preaching purposes — but architecturally it may be styled a façade concealing a concert-room."

The main contention of his article is that churches which are good acoustically for oratory are least suited for music, and he instances Magdalen Chapel as a most striking example, attributing the peculiar excellence of this building to its T-shaped plan — choir and transepts, without a nave, and without aisles. Westminster Abbey and Christ Church Cathedral, Oxford, are cited as unacoustic. The reverend writer has the courage of his convictions, and says:

"For my own part, were I called upon to erect a church on acoustic lines I should imitate the plan of Mayence Cathedral, and place the organ behind a magnificent reredos at the extreme east end. My church should be T-shaped, as was Bristol Cathedral till recently, and as are the chapels of Magdalen, Merton, New College, and All Souls' at Oxford; and I would separate the choir from the transepts by a light screen, after the model of that of Hereford. I should thus obtain an æsthetic and an acoustic effect well nigh perfect."

The effect of pendentives and of hammer-beam and other timber

[1] "*Wonders of Acoustics*," p. 111.
[2] Vol. i. Third Series (1894), p. 371.
[3] Figured in Van Nostrand's *Engineering Magazine* (1881), vol. xxv., p. 238.
[4] Figured in *Handbuch der Architektur* (1893), Theil. iv. p. 281.
[5] Figured in *The Builder*, vol. lx. (1891), p. 128.
[6] "The Auditorium of a Theatre," *The R. I. B. A. Journal*, vol. iv., n. s. (1888), p. 125.
[7] *Op. cit.* (1893), p. 281.
[8] "Church Architecture and Acoustics," *Religious Review of Reviews*, and the *Building News*, vol. lxv. (1893), p. 37.

roofs on the reverberation of sound is also dealt with in this telling article.

Seating. — Where we require both to see and hear speakers or actors, there is probably no better method of seating to be adopted than that described by Scott Russell and by Gwilt.[1] In churches and other buildings where it is not practicable to arrange the seats on the *isacoustic* curve, it has been proposed that steps might be formed to elevate the preacher so that the curve would be approximated to. This has been discussed fully on more than one occasion, and need not be further enlarged upon here.[2]

Section. — We have indicated that plan does not wholly influence the sound in buildings, as we find those of similar types behaving in different ways. Let us now consider what influence the section of structures has on the propagation of sound. As to walls and ceilings, most writers are agreed that smooth surfaces reflect sound, while broken or rough surfaces disperse or absorb it, so that in some instances it may be found advisable to break up the ceilings with rafters, or to form recesses or projections in the walls. Each case must be considered on its merits, and no hard-and-fast line can be laid down for our guidance unless all the circumstances are dealt with, and one of the most important considerations in this connection is the size of the room. In large buildings, or where the dimension exceeds that calculated to produce an echo, we must endeavor to break it up and destroy it, according to most authorities, while in rooms of smaller dimensions, reflecting surfaces may be better. "A sharp, quick sound can produce an echo when the reflecting surface is 55 feet distant, but for articulate sounds at least double that distance is necessary" [Ganot]. Opinions are quite as conflicting in regard to the form of ceiling which should be adopted as they are in most other points in regard to acoustics architecturally considered.

H. H. S. (Mr. Statham, I assume), writing in *The Builder*,[3] claims that "a flat, or nearly flat, ceiling is the best form for a large music-hall. It breaks up and assists in destroying echo, while a semicircular vault collects and focusses it." Others insist upon a curved form for the ceiling; but the nature of this curve is the difficulty. If it be parabolic or semicircular, we have the danger of foci being formed by the reflected sound-rays, and it is probably due to this consideration that some urge that the curve should be "in the shape of a coach-roof" [Brewer]. Here, again, the size of the hall is of importance, together with the height at which the ceiling is situated. All appear to be in agreement that it is bad to have right-angle junctions between walls and ceilings, as confusing reflections then ensue; and to obviate this, some form of cove has been usually adopted. In the Queen's Hall, Langham Place, a convex cove is used, following the example, Mr. Knightley tells us, of the room used by Mrs. Siddons for her readings at Brighton. On the other hand, many buildings with a flat ceiling and an ordinary concave cove have proved acoustically successful, as, for instance, the Cincinnati Music-hall. Concave surfaces generally seem to be particularly difficult to contend with, and where they are successful it will, in all probability, be found that some projecting cornice or other feature is interposed in such a manner as to split up the sound-waves and prevent their reflection. The difficulties presented by concave curves are well shown by the failure of most domes or cupolas in an acoustic aspect. The circumstances which produce a whispering-gallery under the cupola of St. Peter's at Rome; the peculiar and prolonged resonance of the Pantheon at Rome and of the dome of St. Paul's Cathedral, London; the echo and pronounced resonance of the elliptical cupola of the Baptistery at Pisa; and, to cite a more recent example, the failure of the glass domical roof of the Albert Hall, London, all serve to show the acoustic difficulties presented by such forms. The dome of St. Mary's at Dresden is mentioned by Radau as being remarkable for the absence of resonance, and he also points out that the failure of domes is usually due to their producing powerful and prolonged resonance. In the case of the Albert Hall,[4] one writer claims that the glass roof does not provide sufficient resistance to produce resonance, while another (H. H. S.)[5] attributes the defect to the reflection of sound from the hard concave surface of the glass, and states that the *velarium* was put in to absorb some of the sound.

To prevent the loss of sound upward it is probably best to keep ceilings moderately low, consistent, of course, with good proportion. In our House of Commons it was found, for instance, that the ceiling was too lofty; it was lowered, the angles were canted off, and the ceiling formed of wood, with improvement so far as its acoustics are concerned.

Proportion. — In what relation should the dimensions of a building be to ensure good acoustic results? may be our next inquiry. We have already seen that one writer (Dr. Brewer) considers the length should be about two-thirds greater than the breadth, and that the height should somewhat exceed the breadth, while many urge strongly the use of what is known as "harmonic proportion." This is well described by Mr. W. Fletcher Barrett[6] in the following words:

"It appears that for good acoustic properties a building should be so constructed that its different dimensions shall be in some simple relationship to each other. An analogous effect is well known in music, for if two notes have the simplest possible relationship to each other's rate of vibration, as 1 to 2, or an octave, the combination of those two notes is more harmonious than any other combination. Next to this would be the ratio of 2 to 3, or the fifth, and next the ratio of 3 to 4, or the interval of a fourth, the harmony decreasing with the simplicity of the combination. Further, in the case of three numbers a musical or harmonic proportion exists, when the first is to the third as the difference of the first and second is to the difference of the second and third: thus 2, 3, 6 are in harmonic proportions, because 2 : 6 :: 1 : 3."

An exhaustive paper dealing with harmonic proportion by Mr. A. F. Oakey[7] cites as illustrative of the value of harmonic proportion, the following successful buildings:

Old Theatre at Lyon, in proportion of 4 : 4 : 3. Free Trade Hall, Manchester: height, 52 feet, or as 2; unit, 26 feet; width, 78 feet, or as 3; length, 130 feet, or as 5. Cincinnati Music-hall: height, 80 feet, or as 2; unit, 40 feet; width, 120 feet, or as 3; length, 200 feet, or as 5. University of London, Lecture-room: height, 52 feet, or as 2; unit, 26 feet; width, 52 feet, or as 2; length, 78 feet, or as 3.

He also mentions that the Boston Music-hall, one of the best American examples of acoustically successful buildings, is in harmonic proportion; while Her Majesty's Theatre, in the Haymarket, which was of horseshoe form and not in harmonic proportion, being 67 feet long, 56 feet at its greatest width, and 57 feet high, was bad. Other examples of buildings, in harmonic proportion, which are described as good for sound are:

Royal Institution Theatre:[8] height, 30 feet, or as 2; unit, 15 feet; width, 60 feet, or as 4; length, 45 feet, or as 3. Westminster Chapel: height, 50 feet, or as 2; unit, 24 feet; width, 67 feet, or as 3; length, 120 feet, or as 5.

Mr. F. R. Farrow,[9] in his Godwin Bursary Report, mentions the proportions of the following buildings in Vienna, which he states possess good acoustic properties. Taking the measurements by scale, they are very nearly as follows:

New Opera-house, Vienna: length, 80 feet, or as 4; unit, 20 feet; width, 60 feet, or as 3; height, 60 feet, or as 3. Volks-halle in the Rath-haus: length, about 80 feet, or as 5; unit, 16 feet; width, about 32 feet, or as 2; height, about 32 feet, or as 2.

In the same Report the late Baron v. Hansen's opinion as to proportion is mentioned, he having found from experience that good acoustic results are obtained in halls whose length is twice, and height, one and a half times, the width.

In the paper by Mr. Oakey, already referred to, he describes the alterations made by him to some old buildings which were acoustically defective, and lays stress on the fact that in one case — that of the town-hall in a village (*sic*) in Massachusetts — he reduced the room to the proportion of 3 : 4 : 5 by the introduction of some shelving on which books and periodicals were stored: an acoustic success resulted.

Construction and Materials. — It will be conceded by all that upon the selection of proper materials for the construction and decoration of buildings their acoustic properties greatly depend. Unfortunately we here again find the greatest possible difference expressed by architects and scientists alike; indeed, it would be hardly too much to say that complete agreement even upon the main lines of the subject is not to be discovered. Now, whatever may be the opinion of individual observers, facts remain as stubborn things, and experiment by competent judges can alone determine the value to be attached to each material. No doubt, the divergent views are again to be partly accounted for by the varying requirements of different edifices; in buildings where resonance is demanded, the most elastic materials are needed, while in others some less elastic substances may suffice. As the volume of air contained within any room is the medium by which vibratory movements are transmitted to our ears, it follows that as the vibrations of various bodies differ, their effect on our auditory senses will also greatly vary.

That an inelastic substance, such as felt, prevents the transmission of sound is well shown by the common experiment of a bell under an air-pump receiver — where, if the sounding-bell be allowed to touch the air-pump plate, sound is audible; but an inelastic material deadens the sound in such a manner that if perfectly insulated, all sound is absorbed. The transmission of sound is largely affected by the molecular structure of the material; if it be homogeneous, sound is transmitted through it equally well in every direction; but if it possess a definite structure, its sound-transmitting capabilities greatly vary; thus the velocity of sound in wood across the fibre is, at least, two or three times its velocity along it. Some excellent experiments are recorded by Mr. W. Fletcher Barrett in his lectures,[10] in which a set of sound-tight boxes were used, in the innermost being placed a sounding body. When a light rod is pushed through the small valve left in the boxes, and discs of varying materials are tested, the following results are recorded:

Wood, sound well heard; slate, but little sound; tile, but feeble augmentation of sound; plaster, practically no reinforcement; and the importance of this in buildings will be realized. If the walls of the building be covered with such materials as plaster, slate, tile or stone, they are almost or entirely unable to reinforce the speaker's voice, whereas if they be lined with wood, it is strongly reinforced.

[1] Gwilt's "*Encyclopædia*" (edit. 1881), p. 1047.
[2] *Building News*, vol. lv. (1888), p. 1195.
[3] *The Builder*, vol. xxix. (1871), p. 543.
[4] *Ibid.* p. 440.
[5] *Ibid.* p. 469.
[6] *Ibid.* vol. xxvii. (1869), p. 404.
[7] Van Nostrand's *Engineering Magazine* (1881), vol. xxv., p. 228 *et sqq.*
[8] *The Builder*, vol. xxvii. (1869), p. 404.
[9] "*Transactions*" (1885), vol. i. N. S. p. 55 *et sqq.*
[10] *The Builder*, vol. xxvii. (1869), p. 403.

Mr. A. F. Oakey, in the paper already quoted, points out that, "our choice of material must depend upon one fact that is seldom the same in any two apartments, namely, the relative capacity, that is, the number of cubic feet of space, for each person. The most exhaustive experiment has determined that when the number of cubic feet of space for each person exceeds 195, it becomes necessary to adopt a resonant material for ceilings or walls, or both; that when the space exceeds 210, both walls and ceiling should be of wood, and the greater the space per head beyond this, the softer and more porous the wood must be, and the greater the necessity of perfect construction, so as to preserve the continuity of the fibre, and the thinner the wood employed should be, the necessity always increasing for an air-chamber back of this wooden surface, as the proportion of space increases." When the cubic feet per person falls below 195, a hard, repellent surface is recommended; and if below 150, stone or artificial stone, or even thick iron-plate, has been found advantageous.

The value of wood for reinforcing by its vibrations the volume of sound of the speaker's voice or of instruments is well known, and the subject was very fully dealt with by the Congress of Architects and Engineers, held in Italy in 1880, as reported in *The Builder*,[1] dealing especially with theatres, and the following summary of the resolutions arrived at may prove useful:

Wood of uniform fibre, and especially fir, is recommended to augment the sound of music. One kind of wood only should be used in any one room to secure uniformity and distinctness. Floorings, under any sonorous body, should be hollow, placed over a hollow; also of fir. A lining of wood isolated from the walls is recommended. It is also suggested that the soffits of the theatre, the fronts of the boxes, etc., should be covered with thin planks. If columns are necessary, they should be of wood and hollow within. Other recommendations, as to the form and design, are included in this report, but the materials alone are now under consideration. For the same reasons, namely, the necessity of reinforcing sound for musical purposes and for speaking, it is urged that pulpits should be constructed with a false bottom, and in a discussion in *The Builder*,[2] on the value of materials in regard to sound, the editor remarks in one instance, it was proposed that a solo-singer should "leave the stalls and sing from the choir steps, facing the middle aisle." "Then," said the principal soprano, "I hope you will have a small staging of boards, even if it is only raised three inches, for *no one can sing off stone*."

Dealing with a similar question, Brewer, in the work already alluded to, says:

"All musicians know if they sit on a soft cushion or sofa, the sound of their voice or instrument is much more feeble than when they stand on a platform or sit on a hard seat — not so much because the cushion stifles the echo or resonance as because it does not vibrate."

Now, as opposed to this, we have the claimants for a more solid type of construction and material. Among older writers, mention may be made of Lachèz and Guillemin, and, more recently, some of those who took part in the discussion upon the reading of Mr. Ralph Nevill's paper before the Institute,[3] Mr. William White and Mr. Robert Walker especially recommending the use of concrete for floors of concert-rooms and lecture-halls, the latter citing Terry's Theatre and the Alhambra Theatre, both constructed of fireproof material, of iron and concrete, as wonderfully resonant. In another case, Mr. Charles Fowler[4] instanced an old country church, where the substitution of a wood-block floor for an old boarded one deadened the sound, so that the preacher had considerable difficulty in making himself heard.

The materials employed in some of the buildings in Vienna are described in Mr. Farrow's report (1885).[5] Of the Houses of Parliament he says: "The ceiling is flat, and constructed of iron and plastered brick, a portion of the surface being occupied by a flat ceiling of iron and glass. The walls are plastered or lined with marble slabs." In the same report, mention is also made of the materials used in other of the principal Viennese buildings in regard to their acoustic effects.

A happy compromise between the contending views seems to have been arrived at in the Queen's Hall, Langham Place, and in the Comedy Theatre, Manchester. Fibrous plaster has been adopted for the lining of walls, ceilings, etc., throughout in the latter; and in the former, the walls are described as intended to be "lined with wood, fixed clear of the walls on thick battens: coarse canvas will be strained over the wooden lining, on which will be spread a film of composition, and on this will be raised ornament."[6]

The question of material is one of the most important for acoustic considerations, and some careful experiments seem much needed to ensure the best results being arrived at. The lining of buildings, such as theatres, with wood throughout, brings with it such frightful risks from the possibilities of fire that its use cannot be thought of with equanimity; but the fact remains, apparently, as well demonstrated that by far the most reliable material to produce a satisfactory resonance when required is undoubtedly wood, and that by preference fir. It must also be borne in mind, that plastered surfaces have a much more deadening effect upon sound when they are newly formed; as they dry out they improve, in all probability because the material then becomes more homogeneous, and, consequently, more elastic.

Heating and Ventilation, and their Effect on Sound. — The propagation of sound is greatly affected by the condition of the air through which it passes, both the *velocity* and *intensity* being dependent upon the *density* and *uniformity* of the atmosphere or other media through which the sound-waves pass.

Under favorable conditions sounds of small intensity may be heard over very great distances, as has been well shown by the records of several Arctic expeditions, in which it is stated that conversations have been carried on at distances of more than a mile and a quarter. It has also been recorded by Humboldt that sounds gain considerably in intensity at night, his observations on the cataract of the Orinoco demonstrating that sounds were three times louder at night than by day. This augmentation of sound at night may in part be accounted for by the increased condensation, producing a denser atmosphere, while in the daytime upward currents of air are generated by the sun's rays, by which the air is rarified.

Sound is conveyed with difficulty in a rarified condition of the atmosphere; and if the attenuation be continued till vacuum is produced, all sound is lost. On the other hand, a dense atmosphere is a good conductor of sound; but Tyndall[7] states that "the intensity of a sound depends on the density of the air in which the sound is generated, and not on that of the air in which it is heard," and points out that the velocity is also affected by temperature, augmenting, from a velocity of 1,090 feet per second at the freezing point, nearly 2 feet per second for every degree Centigrade added to its temperature.

If the atmosphere be perfectly homogeneous in composition, sound is propagated in regular waves; but whatever tends to break up or disturb the regular propulsion of these waves confuses and lessens, and may even totally absorb them. This was well shown in one of Captain Parry's voyages, where conversation was being carried on from opposite sides of Port Bowen Harbor, a mile and a quarter apart; but a thaw coming on, the sound could be no longer heard, even by loudly shouting.

Some of the most striking experiments were carried out by the late Professor Tyndall in his researches on the acoustic properties of the atmosphere, whereby he demonstrated that, while optically transparent, it could be and often is, acoustically quite opaque; and, further, that this acoustic opacity can be produced by varying the uniformity of the air by introducing gases of different densities, by variations of temperature, and by the presence of air saturated with various vapors. He showed that the mere occurrence of rain, hail, snow and fog has no sensible power to obstruct sound. "So long as the air forms a continuous medium, the amount of sound scattered by small bodies suspended in it is astonishingly small."

Contrary, too, to what we should expect, wind does not favor the propagation of sound in its greatest intensity to the windward, but, as has been shown by De la Roche and others, the range of sound is greatest at right angles to the direction of the wind. It is not due, according to Professor Stokes, to "a stifling of the sound to windward," but to "a tilting of the sound-wave over the heads of the observers that defeats the propagation in that direction."

Now, if the above-stated facts be true for the open air, shall we find the same, or similar effects inside our buildings? If the air contained within the walls of any edifice could be maintained in a perfectly homogeneous state, we should be led to infer that its acoustic properties would be better than when it was in a heterogeneous condition, and *vice versa*. But the presence of an audience, exhaling dense gas and water vapor, together with the heating apparatus and lighting, increase the temperature and produce very distinct changes upon the condition of the air, giving rise to acoustic clouds, and consequent partial reflection and confusion of the sound-waves.

To pass now in review some of the opinions expressed on this subject by various writers, as far as buildings are concerned. The late Dr. Reid, so long ago as 1836, urged that "the air should be maintained as uniformly equal as possible." In Radau's "*Wonders of Acoustics*" there is the following note, but as no reference is given I have not been able to verify the statement:

"At the time when the ventilation of the Houses of Parliament was under discussion, it was stated that the current of heated air which rose from the hall prevented the voice of the speaker being heard at the opposite side."

The same writer says:

"The most original project for improving the acoustics in theatres is that suggested to Chladni by Langhaus, of Berlin. He would direct from the stage to the spectators a slight current of air, which should carry the words of the actors. It would be produced by skilful ventilation."

Prof. T. Roger Smith, in his work on "*Acoustics of Public Buildings*," stated that —

"An obstruction to the free passage of sound is presented by every adverse current of air and every variation in the quality of the atmosphere or its temperature, and, further, that even a very gentle current exercises a strong influence upon the course of sound, favoring or opposing its progress, as the case may be; and that, consequently, in arranging for ventilation it will be best to avoid creating

[1] *Ibid*, vol. xxxviii. (1880), p. 560.
[2] *The Builder*, vol. liv. (1888), p. 100.
[3] "The Auditorium of a Theatre," The *R. I. B. A. Journal*, vol. iv. N. S. (1888), p. 125 *et seqq*.
[4] *Journal*, vol. i. Third Series (1894), p. 376.
[5] "*Transactions*," (1885), vol. i. N. S. p. 55.
[6] *The Builder*, vol. lx. (1891), p. 129.
[7] "*Sound*," p. 10.

a current that shall set in from the audience toward the speaker, or even one that shall pass across the space between them, but that it will be of advantage to direct the ventilation so that whatever movement takes place in the air shall follow the same direction as that towards which the speaker throws his voice."

Tyndall's experiments would tend to show that the *direction* of the ventilation is not of so much moment as is here insisted upon, but rather that the first statement should be regarded as of importance, viz, to maintain the equality of the air.

Writing in 1873, Alexander Saeltza [1] laments the neglect of this subject, and, with characteristic transatlantic assurance, states that his work "is the first attempt, in its peculiar nature, ever presented to the public," and that "he cannot find a book in which ventilation is touched upon in connection with acoustics." But, while regretting the boldness of this statement, a perusal of his work will well repay attention, as the matter is well discussed and the importance of good ventilation clearly demonstrated. He states that in some of his own buildings, where the ventilation was shut off in the confusion and hurry of an opening night, the sound became perfectly unintelligible; but, that when the apparatus was set in working order, in half an hour "the sound became perfectly clear and distinct."

By far the most important communication I have noticed in this connection is a valuable paper, by Mr. W. W. Jacques,[2] in which are recorded the results of a series of researches.

The first experiments were carried out in the laboratory, and by them he showed that currents of air of varying density not only decrease the intensity of waves of sound, but they also cause indistinctness of hearing by modifying the form. An apparatus was formed in such a manner that a given sound — of a musical instrument or a man's voice — was caused to pass over substances artificially heated to imitate the density of air found in various auditoria, and it was found that in addition to the decrease of the intensity of sound, it had also lost its distinctness. The same effect was produced when the source of origin of the sound was varied, an organ-pipe with a known and constant pressure of air, and a man who spoke with a clear voice, being in turn experimented with. With the voice it was found the intensity was decreased, and the articulation rendered indistinct and confused. The explanation is to be found in the fact that rays of sound striking upon one current of air are in part carried on and in part reflected; and the portion carried forward is subjected to a similar treatment, so that, in the words of the author, "each reflection being thus again and again reflected and divided, we have, following close upon the primary wave, a multitude of secondary waves, which, falling upon the ear, greatly mask the distinctness of the original sound."

He then shows that similar interference and confusion are brought about in buildings, the Hall of the Massachusetts Institute of Technology being first experimented upon, to confirm, if possible, the laboratory experiments on a large scale. The hall was first dealt with, with windows, doors and ventilators closed, and by suitable means, explained in detail by the writer, the paths of the sound-waves were traced out. Windows and doors were then opened to admit the cold wintry air, and the ventilators were also opened to allow air, heated to a temperature of about 100° Centigrade, to flow into the room. Confused and varying currents were thus introduced, and precisely similar effects to those observed in the laboratory experiments were reproduced.

In the third, and last, series of experiments carried out by the same author at the Baltimore Academy of Music most important data were established. The ventilation of the house is thus described:

"The ventilation of this house is so arranged as to prevent largely the formation of air-currents of unequal density. According to a survey made with thistle-balls and the anemometer, of the space contained within the walls of this theatre, the movement of the air is as follows:

"The whole supply of fresh air is admitted at the back of the stage, is there warmed, then crosses the stage horizontally, passes through the proscenium, and then, somewhat diagonally, towards the roof, across the auditorium in one grand volume, and with gentle motion, so as to almost entirely prevent the formation of minor air-currents. It is exhausted partially by an outlet in the roof, and partly by numerous registers in the ceilings of the galleries. From this central outlet, and from the large flues of the registers, the air passes into the ventilating tower over the great chandelier, which supplies in its heat a part of the motive power of the circulation. It is farther expelled from the tower by means of large valves, so contrived that, while they offer no obstacle to the *egress of air*, they completely *deny it entrance*. The amount of air so passed through the house is, as determined by a series of experiments, about fifteen thousand feet per minute. This amount, sufficient to ventilate the house, is just what seems to be required to impress the proper movement on its atmosphere. That it is amply sufficient for ventilation is shown by the fact that the thermometers of the upper circle do not vary perceptibly from those of the orchestra circle."

The seating of the building is stated to be for 1,600, and a strong consensus of opinion is quoted to show that the acoustic properties are almost perfect. The author then shows by a striking series of tests that the good acoustic qualities are largely due to the *condition of the air*, and not to the plan, or to the materials of which the building is constructed. Observers were placed at various parts of the theatre, without being cognizant of the nature of the experiments about to take place, and were requested only to take note of any times during which the sound varied. The ventilation was interrupted at certain intervals, and at times, agreeing with the cessation of the ventilation, a perceptible difference was recorded by each of the observers in the acoustic properties of the theatre.

The ventilation in one case was reversed from 8.30 to 9 o'clock, and the following is given as the result of the operation:

A. Observers in Orchestra: . . . to 9.15, very indistinct; 9.15 to 10.0, much better.

B. Observers in Right Balcony: 8.45 to 9.15, sound was dead; 9.15 to 10.0, decidedly better.

C. Observers in Left Balcony: 8.0 to 8.40, good; 8.40 to 9.15, confused; 9.15 to 10.0, good.

D. Observers over Stage: 8.0 to 8.30, good; 8.30 to 9.0, strong draught, hearing better; 9.10, draught disappeared.

It will be noticed that each observer recorded a period of half an hour during which the sound was interfered with; the 10 to 15 minutes elapsing between the alteration of the ventilation, of course, being easily accounted for by the fact that the condition of the air would not in either case be momentarily changed. The improvement of the ventilation over the stage caused the observer placed in that position to hear *better*, the air then being in a more equable condition. On another occasion similar tests were repeated, with corresponding results.

I have thus ventured to somewhat fully quote an author whose experiments go far to show the extreme importance of good ventilation in regard to the acoustic qualities of buildings; and this more particularly as the ideas, verified as they are by careful experiments, were claimed to be new.

Dealing with the same question, Mr. Ralph Nevill, in his paper read before the Institute on "The Auditorium of a Theatre," [3] quotes Saunders's opinion, that, "it makes no little difference to sound whether with or against the wind," and says: "I am sure no one will agree with him; most of us will say, from actor to audience," and still further says:

"Prof. T. Roger Smith quotes experiments to show that sound travels better with the wind than against it, and that it travels *still better across the wind*. The importance of this does not seem to have been noticed. If it be true, one great objection to the central ventilation-flue disappears. For acoustic reasons, therefore, we may say that any extraction of air from such places must be from the back or the ceilings."

By reference to the Godwin Bursary Report for 1885, already referred to, it will be seen that the buildings in Vienna described by Mr. Farrow as good acoustically are also well ventilated; indeed, the system of ventilation is of the most elaborate and complete description, and it may well be that the admirable acoustic properties are as much to be attributed to this as to any other consideration. I particularly allude to the Houses of Parliament, the Opera House and the Rath-haus. The systems of ventilation adopted are fully described and illustrated by Mr. Farrow.

Considering all the evidence, so far as I have followed it, the conclusion seems carried home to one that the *direction* of the ventilation should not be confounded with wind as we know it in the open air. In the more or less confined space embraced within the walls of a building, nothing is quite comparable to the action of wind; and if it were, we should be justified, in the light of Tyndall's and other researches, in regarding the *direction* of the ventilation as of but little or no moment; for we have seen that sound is heard not only with the wind, but often much better against it, and, better still, across it. The principal office of ventilation in its acoustic bearings seems to be that it does, or should, render the air free from those acoustic clouds which disturb, divert, modify, or absorb sound-waves as atmospheric clouds modify or destroy light.

Keynote of Rooms. — Many writers have agreed that the acoustic qualities of rooms are best developed when the speaker accommodates his voice to a certain pitch, whereby consonant vibrations of the air are evoked. This has been termed the *note* or *keynote* of the room.

Scott Russell,[4] for instance, states that "a room 30 feet long gives out C natural," and Professor T. Roger Smith, in his book on "*Acoustics of Public Buildings*," alludes to the same property, attributing it, apparently, to the harmonic proportion of the room. Mr. W. Fletcher Barrett,[5] dealing with the same point, states that "the entire mass of air in a large room, if it could be thrown into vibration as a whole, would yield a note of a pitch so low as to be quite inaudible. By subdivision, its parts can, however, vibrate more rapidly, and give rise to that resonance which is often called the *note* of a room," and he thinks it is owing to this fact, that "we have probably the philosophy of the origin and practice of intoning services in cathedrals," as the voice then keeps tune to the musical resonance of the building. A writer in the *Building News* [6] points out that:

"In determining the harmonic properties of rooms, however, two

[1] "*A Treatise on Acoustics in Connection with Ventilation.*" New York.

[2] "Effect of the Motion of the Air within an Auditorium upon its Acoustic Qualities," *Journal Franklin Institute* (1878), Third Series, vol. lxxvi., p. 390.

[3] The *R. I. B. A. Journal*, vol. iv. N. S., p. 128.

[4] *Building News*, vol. iv. (1858), p. 1195.

[5] *The Builder*, vol. xxvii. (1869), pp. 403, 404.

[6] *Building News*, vol. xxxiv. (1878), p. 486.

or three considerations are important. One is the materials of which it is constructed; secondly, the proportions; and thirdly, the fittings. A hall built of masonry has a different note from one constructed of timber, or largely composed of that material."

That the proportion of the room has considerable influence upon sound is well demonstrated by the following remarkable instance, quoted by Lord Rayleigh: [1]

"The late blind Justice Fielding walked for the first time into my room, when he once visited me, and after speaking a few words said: 'This room is about 22 feet long, 18 wide and 12 high,' all which he guessed by the ear with great accuracy."

Mr. A. F. Oakey [2] says that a speaker will find it "less tiresome to talk in that key an octave above or below, as best suits him," and mentions that the old Salle de Concert, at Paris, is particularly sensitive in this respect, the wood lining of the hall having become, like an old violin, well seasoned and tuned to respond readily to the vibrations of both voices and instruments.

Dr. Cutter, of New York,[3] says that the size of the auditorium seems to govern this tone, which has been called the key-note of the auditorium; and he further says:

"No one will dispute that music in the key-note of the auditorium is more effective than when it is not in that key."

He claims that for both music and speech the same stipulations hold good, and as a remedy for faulty auditoria, suggests that speakers should only vary their voices as in a well-regulated song (*e. g.* "Annie Laurie").

The key-note of a room can be ascertained by singing or playing the natural scale slowly and smoothly, and the note most prominent is the key-note. The same writer mentions the following buildings as having been experimented upon successfully: 1. The Cincinnati Music-hall, with seating capacity for 6,000; the key-note was found to be F. 2. The City-hall, Saratoga Springs, was tested in 1890, and a notice placed in the building, "The key-note of this hall is F," and without mentioning the key-note of the rooms, he claims that when it was adhered to in the Prince Albert Memorial Hall, Town Hall, Leeds, and in the rooms of the International Medical Congress, at Berlin, the acoustic effects were successful, whereas, ordinarily, they are pronounced to be bad.

Remedies. — Varied remedies have been suggested to improve the defects of acoustics in existing buildings, and mention may be made of some of them.

It has been noted in dealing with materials that *cushions, furniture, etc.*, deaden sound, as is well known, and in many instances, the use of thick *draperies* on walls has prevented, or greatly modified, echoes, absorbing or quenching the reflections. Radau mentions that at St. Paul's Church, Boston, the preacher can only be heard when the church is *decorated*, whereby the sonorousness of the arches is reduced. *Mattings* and *carpets* and other soft coverings tend to quench sound, and the presence of an *audience* often has precisely the same effect, as recorded by Tyndall in his experiences at the Senate House, Cambridge, where the room, when empty, was excessively sonorous. *Books* and *papers* have a similar effect, as noticed by Oakey in the paper already quoted. The use of a *velarium* is also an advantage at times, where, as in the case of the Albert Hall, sound is lost in the roof or reflected from it. *Flags* and other hangings have occasionally been used for the same purpose with good results. Radau describes the advantages of *Venetian shutters* in the case of a lecture-hall, near Leeds, where a bad echo was quite distressing: they were placed against the windows, and brought forward when the audience was small, and the contrivance is said to have answered admirably.

The use of *sounding-boards* over pulpits and in similar situations is too well known to need more than one word, and the effect of mirrors for reflecting sound, both *parabolic* and *hyperbolic*, is well described by Professor T. Roger Smith in his oft-quoted work. Without being in the least able to account for the scientific *rationale* of the matter, even if there be one, the use of *wires* and *cords* has been recommended, and, at times, stated to be successful. The former were to be used at the Guildhall, Plymouth,[4] and at a chapel in Malvern,[5] and the latter at St. Peter's Church, Geneva, in the Assembly Hall, City Offices, Bordeaux,[6] and at the Presbyterian Church, Valletta.[7] In the last-named case, the method of procedure is carefully described. A patented arrangement of wires (Patent No. 1,955) was tried at the Lecture Theatre, at South Kensington Museum, and is stated to have remedied the acoustic defects of the room.[8] In the face of such categorical statements of success as those above recorded, it is much to be wondered at that so little has been done to test the efficiency claimed for these contrivances.

Acoustic Vases. — Though, possibly, of no great practical importance, allusion may be made to the bygone use of so-called acoustic vases. This subject was very fully dealt with by Mr. Gordon M. Hills [*A.*], in a paper [9] read before the Institute in 1881, together with appendices dealing with the use of brazen vases, or *echeia*, as recommended by Vitruvius. Plans of the buildings containing these vessels, with illustrations of the vases, are given, and in the appendix are added plans and sections of the theatres at Aizani, at Hierapytna, at Gortyna, and at Lyctus.

Subsequent to the reading of the paper, further discoveries at Fountains Abbey were recorded by Mr. St. John Hope, as the result of excavations under the upper rank of stalls, the vases then found bringing up the total at that time to twenty-four. Mr. Hope questioned the theory that they were inserted with a view to augment the sound of music; but the editor of *The Builder* [10] observed that "the idea is a very old one, and not so absurd as Mr. Hope seems to have implied," asking at the same time if he had any other explanation to suggest. None seems to have been forthcoming, so far as I have observed.

Considerable resemblance exists, it seems to the writer, between some of the acoustic vases and the *resonators* devised by Professor Hemholtz, by which, taking advantage of the principle of resonance, he analysed composite sounds. This especially applies to the acoustic vase figured in the Institute "*Transactions*" from the Church of St. Martin, at Angers.[11] In any case, these vases would certainly, even if only to a small extent, augment sounds which were in unison with themselves. Any volume of air contained in an open vessel, if caused to vibrate, yields a certain note, and when that note is sounded in its neighborhood it tends to strengthen it. It is by no means necessary to have a globe for this purpose; jars, tubes, or hollow cylinders, etc., are equally capable of reintorcing sound, or producing *resonance*, so long as the vibrations produced by the sounding-body are proper to the resonant body.

It is much to be regretted that so many of these acoustic vases have been either removed to museums, or destroyed *in situ* during their examination or extraction; as, apart from their archæological interest, the opportunity has been, to a great extent, lost of testing their value or otherwise for acoustic purposes. Is it right to suppose that the ancients and mediævalists were utterly wrong in their use of these vases? They may not have arrived at a scientific determination of their true value, and hence some of them failed in their application; but it would seem fair to infer that some influence was exerted on the quality of sound by their use, albeit the effect was, in all probability, but a small one.

THE BOSTON PUBLIC LIBRARY.[12]—II.

AFTER a brief season of adulation of those responsible for the new Boston Public Library building at the time it was opened to the public, more or less of the Boston daily papers have taken up their wonted attitude of fault-finding and hypercriticism. Nothing which can under any pretext be made a subject of censure escapes their watchful attention. Their rather dull and dreary tirades are seldom anything else, but one of them devised an amusing skit, aimed at the architects, by a slight conversion of the opening words of Cæsar's "*Commentaries.*"

Apparently these critics will never forgive these out-of-town architects for the clever way in which they have led the authorities on, step by step, till they have expended very much more money upon the building than was supposed necessary or was at first intended. Yet when the Library, exclusive of the land but including the building, its furnishing and its decoration, will probably not have cost more than $2,368,854, few who know what such work ought to cost will be willing to declare that the result does not fairly represent the outlay. Still the fault-finders complain loudly that the architects, with much astuteness, forced the hands of the authorities by carrying to completion at an unduly early hour the mosaic-work and latten-work in the lower hall-way. Of course, it would be absurd for Boston's library to have a highly attractive and decorative main vestibule, but to have no other part of the building in keeping with it. It would never do to have to tell foreigners and country cousins that, after seeing this portion, there was nothing else in the great structure that was worth the trouble of ascending the stairs to see. So the vestibule, they feel, caused the authorities to consent to the stairs and the lions, and these led up to the decoration of the stair-case-hall, and that to a similar effort in the delivery-room and so on and so on, one thing setting the next in train for execution, just as in Mother Goose's tale the quenching of the fire set a whole series of efforts in motion and the pig was finally got home. In this case we believe that the architects will succeed in getting their pig home and that it will prove to be an uncommonly fine one, even if the public did have to buy it in a poke. Of course, the building and its creators have their defenders and one of them has brought forward a very apt quotation from Perkins's "*Tuscan Sculptors,*"[13] which shows how Pius II relished the same sort of hoodwinking which we are told has been practised on the Boston taxpayers. The story runs thus:

"In the little town of Pienza Rossellino built a palace, a cathedral, a canonica and a municipal palace in the Renaissance style, of which Pope Pius II gives an elaborate description in his well-known commentaries. The estimated cost of the palace and church was eight or ten thousand ducats, but, as generally happens in such cases, that sum had been immensely exceeded long before their completion. When his holiness was notified of this, he sent for his architect, and

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[1] "*The Theory of Sound*" (1878), p. 68.
[2] "Acoustics in Architecture," Van Nostrand's *Engineering Magazine* (1881), p. 236.
[3] "Phonics of Auditoriums," *American Journal of Science*, vol. xlii., p. 468.
[4] *Building News*, vol. xxxvii. (1879), p. 140.
[5] *The Builder*, vol. xxxii. (1874), p. 6.
[6] *The Popular Science Monthly*, vol. xvii. (1880), p. 141.
[7] *Building News*, vol. xxxiv. (1878), p. 305.
[8] *The Builder*, vol. xl. (1881), p. 359.
[9] "Earthenware Pots (built into Churches) which have been called Acoustic Vases," "*Transactions,*" 1881-82, p. 65.
[10] *The Builder*, vol. lv. (1888), p. 211.
[11] "*Transactions,*" 1881-82, p. 95.
[12] Continued from No. 1006, page 3.
[13] Perkins's "*Tuscan Sculptors.*" Vol. i, p. 203.

instead of upbraiding him, said, 'You have done well, my Bernardo, in exceeding your estimates, for if you had told me the truth I should have refused to spend so large a sum, and this noble palace and temple, which all Italy now admires, would never have been built. Thus through your want of candor these fine buildings exist, which all but a few envious persons praise. We thank you heartily, and consider you worthy of honor above all architects of the century, in testimony of which we shall order that one hundred ducats be given to you, and a new scarlet doublet.'"

It is a story which can hardly be upheld on moral grounds, but where ends so obviously justify means, one can afford now and then to forget ethics and morality.

More than ever just now the Library is the center of interest and Copley Square is frequented by an unusual number of visitors from the city and its suburbs, for within a week or two there have been put in place fragments of the great decorative paintings that were certain either to make or mar a fine piece of architecture. Which it is that they will really do, we are rather uncertain just at present. There is no possibility of disputing the abstract merit of these works of Messrs. Sargeant and Abbey, but it is open to question whether they are subordinates or principals; whether they enhance the architectural effect or whether the Library is to be merely the casket that contains the crowning glories of American art of the nineteenth century. Fragments as they are, they are already the things which visitors go to see, and, seeing, receive impressions the like of which even the most travelled of them have never experienced. They are immeasurably different from what any one could have looked for and as immeasurably better.

There is a great difference between the work of the two men, both in handling and in spirit, though both are unusual and in no sense hackneyed, but absolutely fresh and vigorous in conception, in treatment and in the depth of feeling they have made their brushes declare. Without in any way disparaging Mr. Abbey's frieze, which depicts the story of the search for the Holy Grail, we can avow the feeling that just as Mr. Sargeant's ideal has been a deeper, more lofty one, so the impression produced by his work is the stronger and more enduring and is likely always to remain so. This is only natural, for though Mr. Abbey had a well-defined idealization to present symbolically — the striving after the highest good that man may reach by cultivating all the powers of intellectual and spiritual refinement which lie in him — he has chosen to embody it in a presentation of a semi-familiar legend, which compelled him to come nearer the earth. King Arthur and his knights, while to a degree legendary beings, were still men, and men controlled by earthly longings and passions, and so it is not easy to consider Mr. Abbey's frieze as a lesson, and to most it will always remain a mere story. It will always be one of those things that require a printed explanation and an outline diagram pasted on cardboard and left in the chair or on the table by the last inquiring body who dimly imagined that there possibly was some purpose in the artist's mind when he introduced into a modern public library — an American one, too — such scenes as these.

Naturally, considering his experience as an illustrator, Mr. Abbey's compositions are extremely pictorial and not decorative in the accepted sense. It is not possible to escape the fact that a story is being told which requires to be looked at understandingly and followed through its several scenes with a mental effort, so they are not so much decorative paintings as pictures introduced with the hope that their presence will create a decorative effect. According, therefore, to the mood of the observer, or his habit of regarding such things, these paintings are either a most welcome and interesting innovation or they are just a little disappointing.

It would be bootless to attempt to describe the result Mr. Abbey has accomplished; the same words would convey different impressions to different readers. Neither tongue nor pen can describe a work of art so as to produce a true impression on the mind of another: an intellectural pleasure might be given, but the eye alone is competent to perceive, and alas! there are no really "speaking eyes" outside of novels. Like other things of the kind, these paintings must be seen, and those who have seen need no words to describe the sensation they experienced. It was a distinct disadvantage, even, to have seen, before visiting the delivery-room, the cartoon of the "seat perilous" which was published in Harper's *Weekly* some weeks ago, since it gave a very false impression of the coloration and lighting. So far as light and color in the pictures are concerned, Mr. Abbey has managed them ably and consistently, but it has been found that the lighting of the room itself is not just what the artist expected it would be. Before the frieze was put in place, the delivery-room, with its darkened oak finish and deep red chimney-piece and doorways, gave the impression of being a rather ill-lighted and gloomy apartment; but the frieze introduced so much light and color that the aspect of the room is not only cheerful but absolutely gay, and we venture to think that that is not just what the artist intended. We fancy, too, that certain strong chromes in the lights — which suggest the scene-painter's pot rather more than they do the artist's palette — were used with the expectation that an oak-finished room must be dark, and call for exaggeration of light and color in order to hold their own mid a general gloom. In one other respect it seemed to us as if the artist had misjudged the situation: certain crudities in the drawing, particularly in the foreshortening, suggest that he believed that the frieze would be set higher above the spectator's eye than it is. One cannot help feeling that the room is both too low and too small to allow of so monumental a work as this producing its intended effect.

We do not question that Mr. Abbey made all proper archæological researches before determining on the costumes and the armor in which his figures are clad. The costumes, when they are of stuffs, we believe in, but the armor, while it may be archæologically such as belonged to Arthur's time, is surely not the sort of armor that goes with the Arthurian legend. If it is wrong to think this, it certainly is not wrong to believe that Launcelot, Galahad and their companions were sorry fellows indeed not to be able to poke their lances through half-a-dozen opponents at one thrust, if they were really protected by such flimsy scale armor as is here shown, and painted, too, as if it were pasteboard and not metal plates sewn on a leather jerkin.

But the mere manner of execution and the details of pose and garment and composition are as nothing beside the fact that the artist has behaved as an artist should and used his mind as well as his fingers, and has woven into his work an allegory of great depth of meaning — one which is elevating while it is entertaining.

It is, perhaps, fortunate for Mr. Abbey's work that the visitor naturally sees it, studies it, enjoys it, appreciates it, before he goes up to the "special library" floor where, in the staircase hall, is the fragment of Mr. Sargeant's work; for after seeing that, one is keyed up to so high a pitch that the frieze in the delivery-room, if seen afterward, can hardly escape being held theatrical. If Mr. Sargeant lives long enough and if he is enabled to carry his scheme to completion, it is impossible not to believe that this staircase corridor will contain one of the truly grand works that Art has ever produced.

Mr. Sargeant, too, conceived that here was an unequalled opportunity, one where an artist might do better for the city, for his reputation, for Art itself, than by selecting for his theme historical incidents connected with city, State or nation,— better far than by creating a depiction of various scenes in the art of book-making, and at once selected as his theme a subject than which none can be more lofty and ennobling. The demand made upon the mind and soul, and still more upon the imagination, in trying to grapple with the meanings of Religion is the most strenuous that can be made, and the mere attempt to portray the development of religion is an intellectual task of the highest order. Success demands a knowledge of facts, a penetration and depth of understanding and a potency of imagination that would seem to require a life-time of single-hearted devotion, a devotion that seems hardly in line with the ordinary habits of a successful painter of fashionables, male and female.

It really is not too much to say that this stupendous conception — it is quite proper to make use of the most impressive adjective in the language — seems to have been thoroughly comprehended, and the fragment now in place gives promise of its being carried out in the most masterly way.

Here, again, words are fruitless. How can any one understand that swirling nightmare of pagan symbols that crowds the lunette and the adjacent broad soffit, through any combination of words that can be devised? Or how can one's mind comprehend that painting, modelling, gilt rods and jewelled glass have been employed by the artist in producing a wholly novel style of decoration? It might be possible to bring up some feeble idea of the impressive dignity of the range of prophets that form a frieze below the lunette, but these, too, are far easier seen than described. It is enough to say of them that though there are elsewhere figures of the same general type used in decoration, there are few that equal them in individuality of depiction or imaginative force of conception. One may in time tire of Sir Galahad's halting step, but these gloomy and foreboding prophets can be gazed at in wondering awe unweariedly.

We fancy that many a beholder has chuckled to himself, as he left the building, at the thought that such decorations as he had just seen were really placed in an American building, the work, too, of American artists.

A portion of the work of Puvis de Chavannes which is to decorate the main staircase hall is now on exhibition at one of the Paris *Salons*, and the French critics generously declare that never has this great decorative artist produced better work, so we may hope that it will but enhance the effect which Messrs. Abbey and Sargeant have so splendidly inaugurated.

As for the work of Mr. Lindon Smith, it promises to be both graceful and gay, and the vestibule and alcove which have been surrendered to him are sufficiently isolated to allow his work to count by itself without jarring with the neighboring work of the great Frenchman. It seems likely that his coloring will form a proper transition between the low tones and flat tints of Puvis de Chavannes's and the strong color and vigor of Sargeant's work above.

Mr. Garnsey has treated the vestibule corresponding to that of Mr. Smith's in a simpler and more conventional manner, but the result, if inconspicuous, is not unpleasing.

What Whistler will do at the end of Bates Hall no one can guess, but it seems like a rather doubtful experiment to invite so freaky an artist to set the key-note for the treatment of so fine an apartment.

The Trustees now give it to be understood that in the way of decoration, they have expended as much of the City's money as they rightfully can devote to this portion of their trust, as they feel that any further funds that the City may appropriate should be expended in the development of the library and not in the decoration of the library building. The contracts they have already made for decoration — all included in the gross sum mentioned above — cover the

completion of the frieze in the delivery-room, by Abbey; by Sargeant, the treatment of the end of the corridor that corresponds with the part now complete; by Puvis de Chevannes, the staircase hall; by Whistler, one end of Bates Hall. The Trustees feel that with thus much decoration in place, they have done enough to fix absolutely the standard — a very high one — which future work cannot be allowed to fall below, and that so it is safe for them to leave to the future the decorative treatment of the remaining portions of the building and they intimate the hope that private citizens will relieve the City of the necessity of appropriating more money to be spent in fostering Art which ought to be spent for the benefit of Literature.

So far as Sargeant's work goes, we do not echo this aspiration. There should be no hesitation or doubt in the matter: the artist should be at once empowered to proceed with his work and complete it, but there should be no divided responsibility, no sharing of the honor between the City of Boston and any citizen or group of citizens; she ought to feel it a privilege, no less than a duty, to enable, at her own sole cost, the artist to devote himself at a remunerative rate to the development of what may possibly be his greatest achievement, one which will certainly secure to Boston honor and applause enough to offer full compensation for all her outlay, no matter what that may prove to be.

SOCIETIES

SOCIETY OF BEAUX-ARTS ARCHITECTS.

AT the meeting held April 24th, the new Constitution was discussed and unanimously endorsed with but slight alteration from the printed draft. The only changes of consequence, were as follows: Duties of Corresponding Secretary transferred to By-laws; Committee on Education provided for in the Constitution, the statement of duties remaining in the By-laws; President limited to two terms of office; Clause relating to Expulsion of Members omitted; Meeting Days changed to November, February and May, the Annual Meeting being the Monday before Thanksgiving.

The present Constitution requires a two-thirds vote of the Society for amendment, and it was decided to ask for the vote of the members by mail.

Edgar A. Josselyn, *Secretary.*

MEETING OF THE BOARD OF DIRECTORS OF THE AMERICAN INSTITUTE OF ARCHITECTS.

There will be a meeting of the Board of Directors of the American Institute of Architects at the office of the President, D. H. Burnham, Chicago, Ill., on Monday, June 3, 1895.

All persons having matters which they wish to have considered at this meeting will please communicate with the Secretary at Providence, R. I., before the 26th of May, or care of D. H. Burnham, Esq., The Rookery, Chicago, Ill., before the 31st.

Alfred Stone, *Secretary.*

ILLUSTRATIONS

[Contributors of drawings are requested to send also plans and a full and adequate description of the buildings, including a statement of cost.]

MAIN STAIRCASE CORRIDOR: PUBLIC LIBRARY OF THE CITY OF BOSTON, MASS. MESSRS. MCKIM, MEAD & WHITE, ARCHITECTS, NEW YORK, N. Y.

[Gelatine Print issued with International and Imperial Editions only.]

THE NEW CITY COLLEGE BUILDING, NORTH HOWARD STREET, BALTIMORE, MD. MESSRS. BALDWIN & PENNINGTON, ARCHITECTS, BALTIMORE, MD.

THIS building will be completed in the early summer of 1896. The total cost will be $236,000, including $50,000 for additional ground.

The style of the new college will be in harmony with McCoy Hall, by the same architects, the latest of the Johns Hopkins University Buildings, which is erected near by. Between the university and college buildings will be an open plaza 80 feet wide, and stretching 224 feet along its border will be the main front of the college. The building will extend 156 feet on Howard Street. The plaza will be finished with walks, grass and flowers. It will give ample light to college and university buildings, and to avoid as much as possible the dust and noise of Howard Street many class-rooms have been placed along the main front of the building. An inner court 100′ x 160′, which will be used as a playground, will be formed on the south side of the main building, thus providing for plenty of light and air.

The basement will be faced with granite, and the front of the building will be of Baltimore sand brick. The band-courses, cornice and ornamental parts will be of Indiana limestone, and the roof will be covered with Spanish tiles.

The building is arranged with three entrances on the outside and fifteen [*sic*] on the inner or court side for the use of students. Throughout the building, the idea of ample space for quick handling of large numbers is observed. The principal entrance on Howard Street will be used for general business purposes, and adjoins the office of the janitor or superintendent. The north entrance on the plaza will only be used for special purposes and for general access direct to the first floor.

The basement contains a recreation-room, 66′ x 94′, office of janitor, coat, toilet, boiler and fuel rooms. The fuel-room will be fireproof.

The first floor will contain offices of principal, janitor's-room, reception-rooms, nine class-rooms, the commercial department, an entrance lobby and toilet-rooms.

The second floor will have nine class-rooms, a teacher's conference-room, chemical-lecture and store room, with a large laboratory, physical-lecture and store room and toilet-rooms.

Upon the third floor will be five class-rooms, a drawing-room, storeroom, an assembly-room 67′ x 95′, with a stage platform in the rear and a private stairway to the lower floors.

The library has been allotted a room, 35′ x 64′, on the fourth floor; a society-room, 27′ x 36′, and a gymnasium, 36′ x 70′, are on the same floor. The gymnasium is two stories high and a running track with a length of over 200 feet is arranged at the level of the second floor. A bath-room for needle-baths is provided and rooms for lockers, toilet and dressing purposes will be constructed.

The building is to be thoroughly heated and ventilated. Water will be provided in all the class-rooms. Two passenger-elevators will be in the centre of the building. There will be four separate stairways from the bottom to the top of the building.

CARYATID FOR THE SECURITY BUILDING, NEW YORK, N. Y. MR. J. MASSEY RHIND, SCULPTOR, NEW YORK, N. Y.

ENTRANCE FRONTISPIECE OF THE SECURITY BUILDING, BROADWAY, NEW YORK, N. Y. MR. BRUCE PRICE, ARCHITECT, J. MASSEY RHIND, SCULPTOR, NEW YORK, N. Y.

EXTERIOR AND BALL-ROOM OF COUNT RUMFORD'S HOUSE, WOBURN, MASS. SKETCHED BY MR. G. P. FERNALD, BOSTON, MASS.

DETAILS OF COUNT RUMFORD'S HOUSE, WOBURN, MASS. MEASURED AND DRAWN BY MESSRS. G. P. FERNALD AND F. C. ADAMS, BOSTON, MASS.

[Additional Illustrations in the International Edition.]

MAIN ENTRANCE VESTIBULE: PUBLIC LIBRARY OF THE CITY OF BOSTON. MESSRS. McKIM, MEAD & WHITE, ARCHITECTS, NEW YORK, N. Y.

[Gelatine Print.]

EXTERIOR OF STAIRCASE HALL OF THE SAME.

[Gelatine Print.]

SOUTHEAST ANGLE OF THE SAME.

[Gelatine Print.]

EXHIBITIONS

Boston, Mass. — *Pictures loaned by Quincy A. Shaw; Paintings by Puvis de Chavannes; Works by J. F. Raffaëlli; Japanese Paintings; Color Prints by Arthur W. Dow; Line Engravings, Mezzotints, and Etchings by Rembrandt:* at the Museum of Fine Arts.

South End Free Art Exhibition: at 1151 Washington St., opened April 18.

Photographs of Historic Revolutionary Subjects, chiefly near Philadelphia: at the Boston Camera Club, 50 Bromfield St., May 6 to 18.

Chicago, Ill. — *Eighth Annual Spring Exhibition of Works of Architecture and the Allied Arts:* at the Art Institute, opens May 23.

Detroit, Mich. — *Exhibition by the Art Club of Works of Architecture and the Allied Arts:* at the Light Infantry Armory, May 18 to June 1.

Indianapolis, Ind. — *Twelfth Annual Exhibition of the Art Association:* May 10 to June 4.

New York, N. Y. — *Twenty-eighth Semi-annual Exhibition:* at the Metropolitan Museum of Art.

Exhibition of Sculpture by the National Sculpture Society: at the Fine Arts Building, 215 West 57th St., opened May 7.

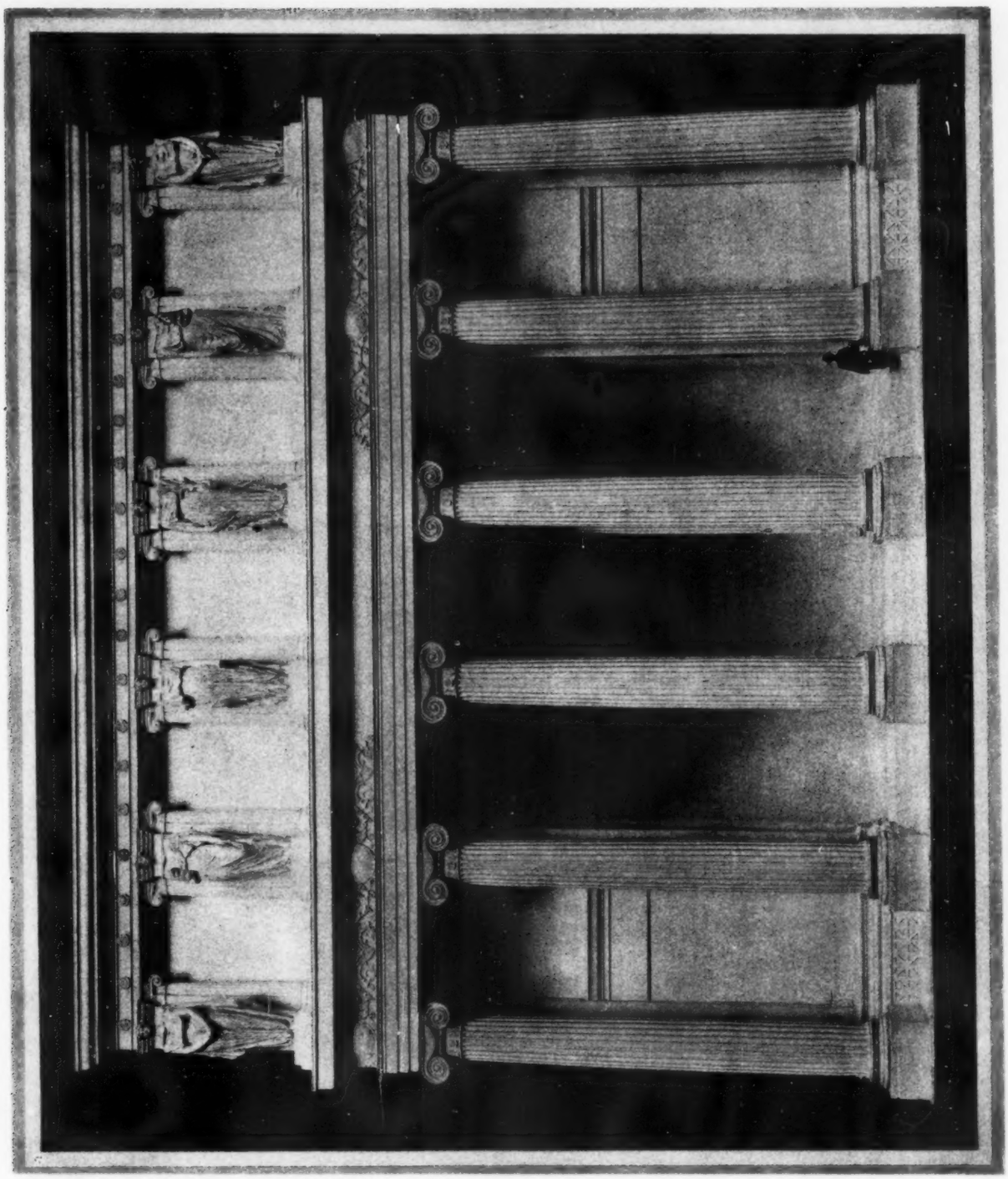
East Side Art Exhibition: at the Hebrew Institute, East Broadway and Jefferson St., opened May 8.

Antidote for Prussic Acid Poisoning. — Cobalt nitrate is found by Dr. Johann Antal, a Hungarian chemist, to be an *antidote in prussic acid and cyanide poisoning.* After having demonstrated its value by experiments on animals, the author administered it to no less than forty persons who had been accidentally poisoned by prussic acid, and in all cases the results are reported to have been satisfactory. — *Journal of the Franklin Institute.*

S. J. Parkhill & Co., Printers, Boston, U. S. A.

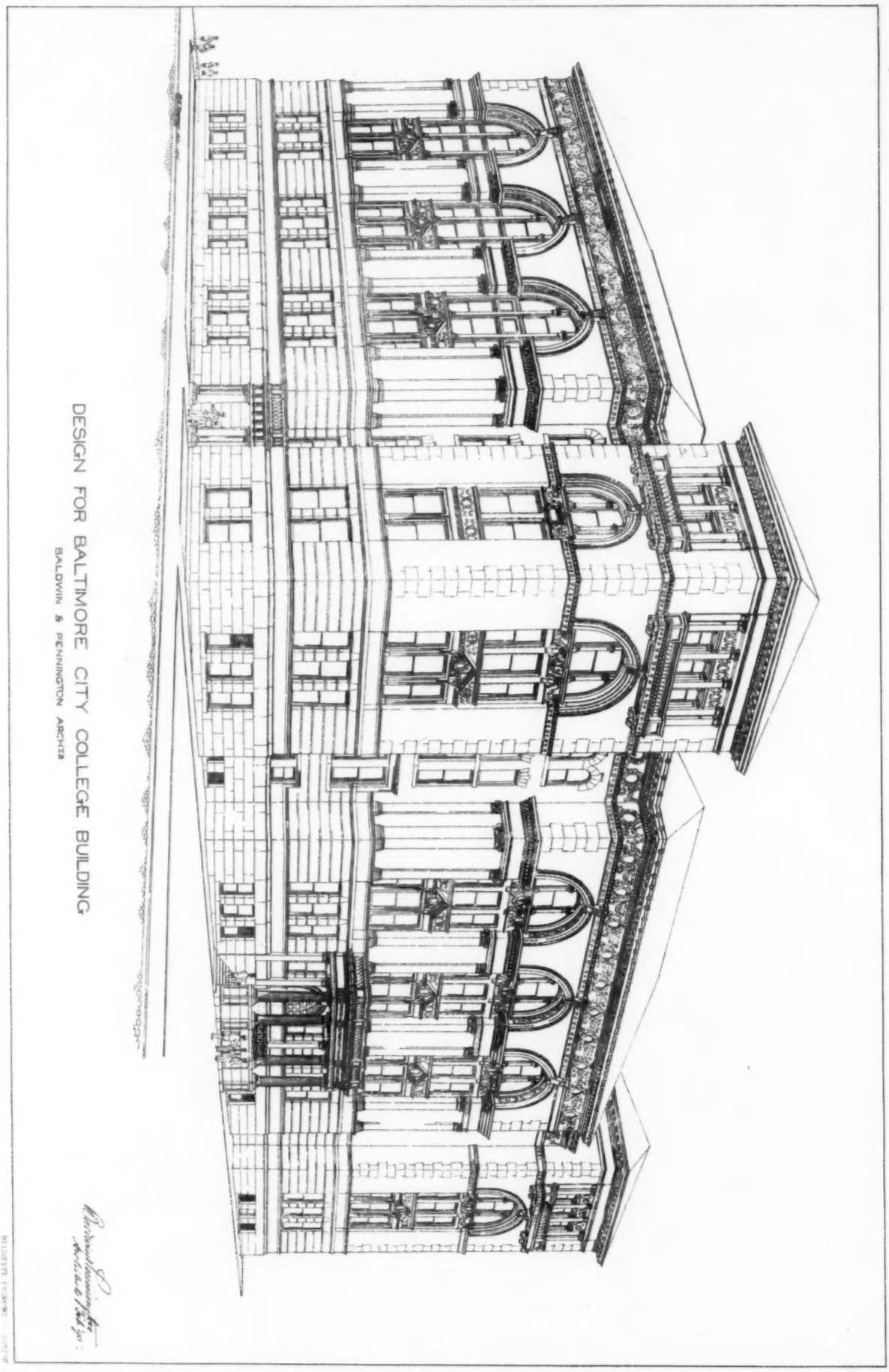
CARYATID FOR THE SECURITY BUILDING, NEW YORK, N. Y.

J. MASSEY RHIND, Sculptor.



ENTRANCE FRONTISPIECE OF THE SECURITY BUILDING, NEW YORK, N. Y.

BRUCE PRICE, Architect. J. MASSEY RHIND, Sculptor.



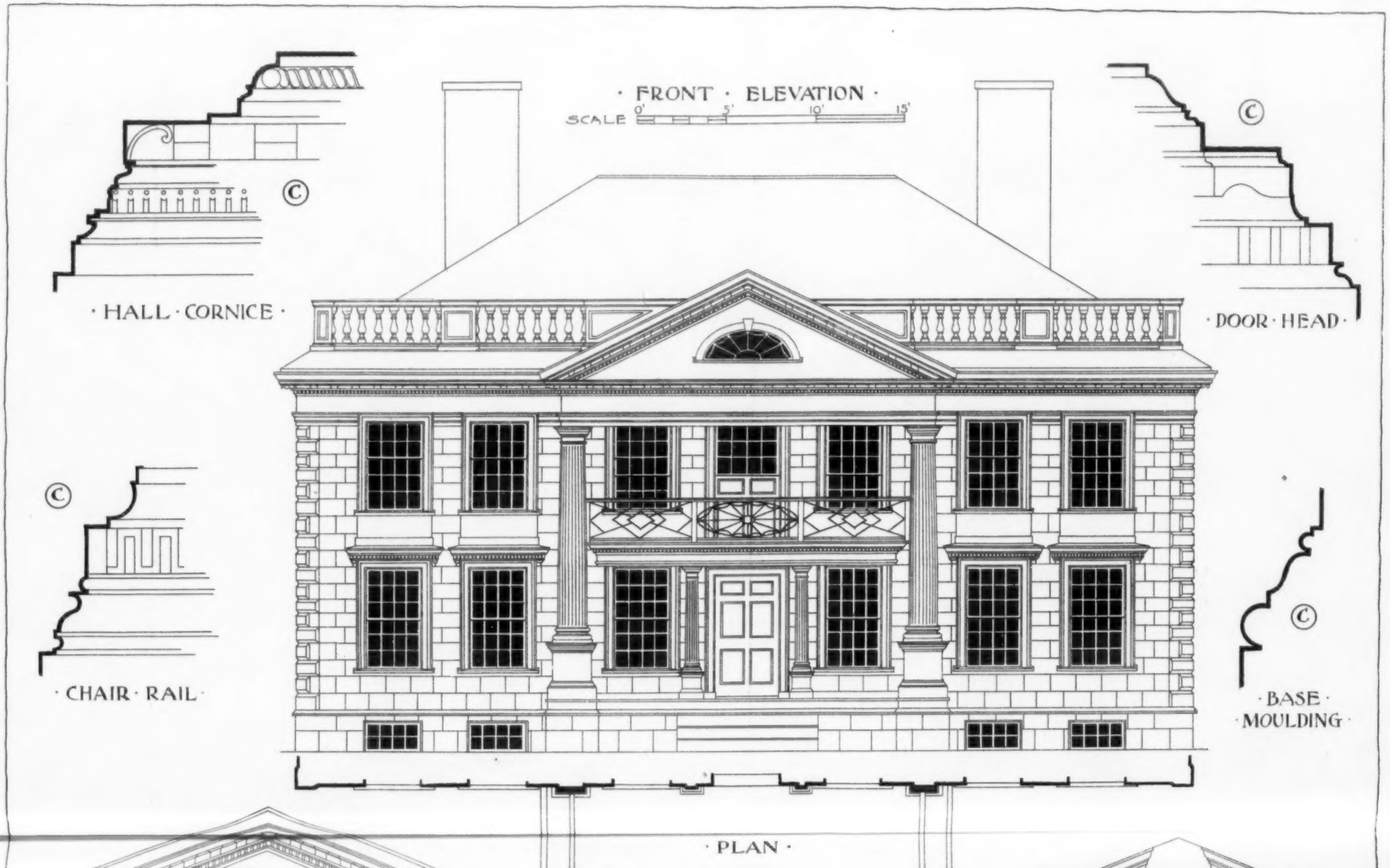
DESIGN FOR BALTIMORE CITY COLLEGE BUILDING.

BALDWIN & PENNINGTON ARCHTS.

Sketch of Ball Room
Count Rumford House
G.P. Fernald Del

Count Rumford House
Woburn Mass
G.P. Fernald

HELIOTYPE PRINTING CO. BOSTON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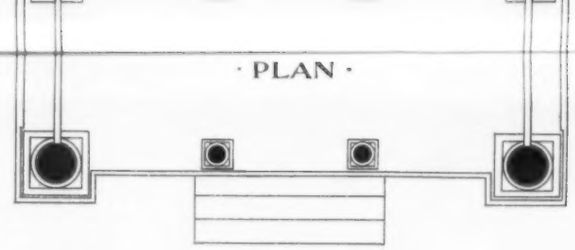

· PLAN ·

OLD · HOUSE, · WOBURN · MASS ·

· BUILT · FOR · COUNT · RUMFORD · ·

AD. 1790.

· AFTER · MEASURED · DRAWINGS ·

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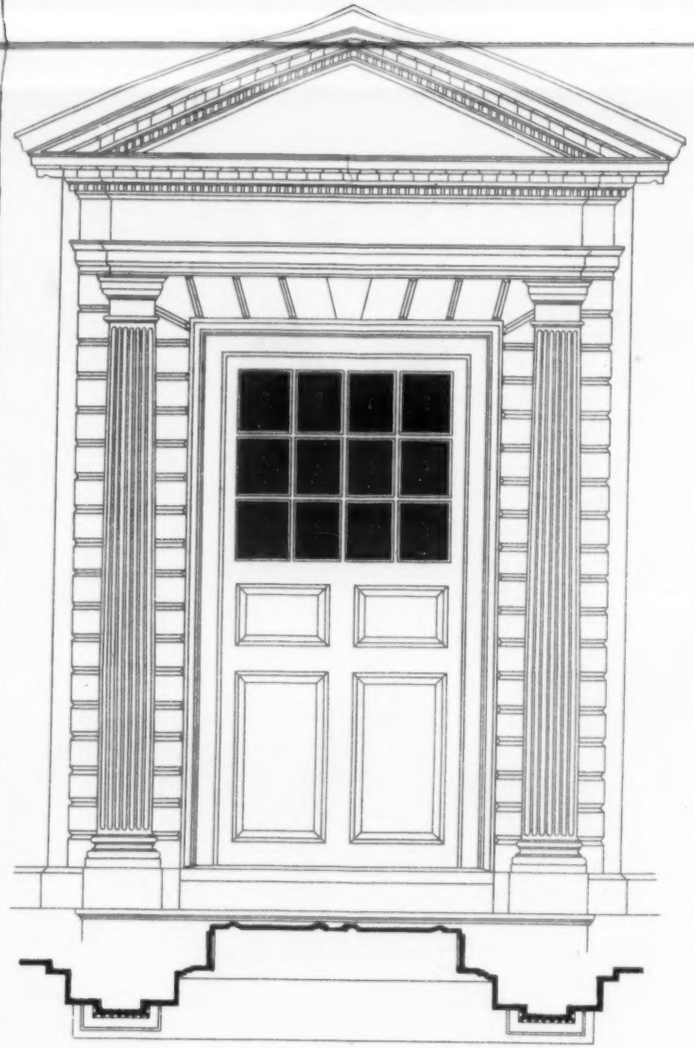

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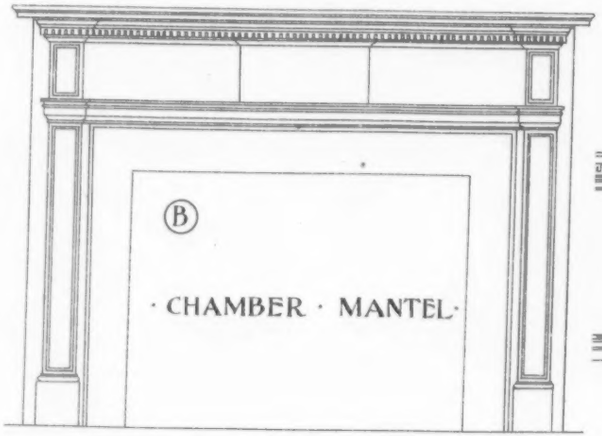

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· CHAMBER · MANTEL ·

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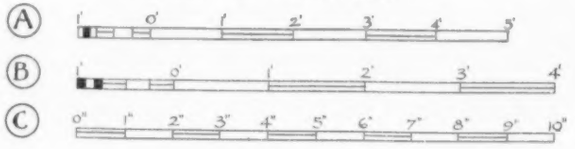

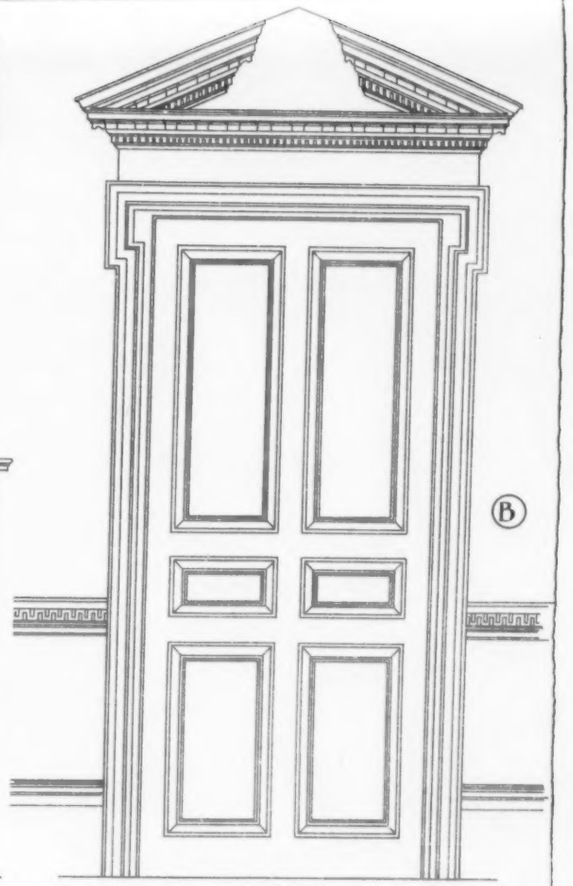

· BALL · ROOM · DOOR ·

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