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BASIC THEATER PLANNING

BY

LEE SIMONSON

I. THE OLD TENANT

THE typical American theater plan, like many other type plans in this country, has been dictated by the real estate speculator. Until the last few years, a successful theater could yield a landlord profits greater than any other form of real estate investment. The tenant, the producer of a play, agreed to pay 40 per cent of his gross box office receipts as rent and to vacate the premises within two weeks whenever this 40 per cent fell below a stipulated figure, usually $5,000 per week. This process of dispossessing tenants kept up until the theater housed a "hit," and a hit could average anywhere from $20,000 to $30,000 a week, or over, and run for a year or more.

But even on the 60 per cent left by the theater landlord, the producer might make a fortune running to half a million dollars from a New York hit and two or three companies on "the road" reproducing it throughout the United States. He had no commitments beyond the cost of settings, costumes and dress rehearsals, and a guarantee of two weeks' salary to his cast who rehearsed four weeks free. This original investment might run anywhere from $10,000 to $50,000. But with the possibility of making anything up to 1,000 per cent profit, it was easy to raise money to back a "show" or to build a theater. Competition for speculative profits led to rival chains of theaters in every large city outside of New York City as well as in New York City itself.

Theaters were accordingly overbuilt on plots whose cost, both in site value and taxes, was steadily driven higher by competition for desirable locations in congested centers. As in the case of every other type of building designed to get maximum returns from inflated land values, theaters did so at the expense of their tenants. They represented a maximum of extravagance on inessentials, facade, trimmings, ornament and gilt gewgaws of all sorts, intended to impress temporary tenants and compensate them for unsound planning. The total plot was invariably too small in the first place. The stage space was reduced to a minimum, too shallow to set scenery, shift it or light it without a maximum waste of time and labor. A minimum of lighting and scene shifting equipment was provided. The landlord was selling site value; his calculations were based entirely on getting the maximum number of seats and a minimum stage on the smallest piece of expensive real estate that would hold them. But even so, audiences were made as uncomfortable as possible by narrow aisles, bad sight lines and lobby space so inadequate that during an intermission they usually found themselves on the street. Any attempts to improve theaters either architecturally or mechanically were met by the invariable answer of a landlord profiting by urban congestion: If the tenants did not like it, they could go elsewhere. Why should he pay for more space and unnecessary improvements? If the play were a failure, the audiences did not come; if a hit, they were glad to get even the bad seats. If a producer had a hit, he could easily afford extra stage hands. If he had a failure, his extra expenses ended in two weeks anyway. Why should the landlord worry? It was a great business for anyone who knew how to play the game.

This type of theater has collapsed with every other form of speculative real estate based on inflated land values and high rentals. In New York most theaters cannot earn their carrying charges. This deflation is not primarily due to the present depression, which has merely administered a *coup de grace*. The sure-fire popular appeal, the big money and the easy money have been drained off into the movies. The movies have also reduced the potential audiences for New York "hits" to a sophisticated minority far more difficult to please than formerly. The commercial theater has been so overbuilt that even a sudden return of prosperity and boom times could hardly fill the theaters already constructed. The theater architect will do well to prepare himself for a new client.

II. THE NEW CLIENT

THE demand for new theaters has not stopped. It comes from a new source: community centers, universities, colleges, schools and high schools, and local "art" theaters scattered throughout the country. And in increasing numbers they command the funds necessary to build theaters for themselves. This non-commercial theater is underbuilt; its needs are growing and its programs continue to expand as the field of the commercial theater grows more and more restricted. The collapse of the road will increase the number of Little Theaters originally founded by cultured minorities disgusted with second-rate road companies playing stale Manhattan successes.

As a result of the original impetus given by Professor Baker's theater workshop at Harvard, courses in dramatic production are continually being added to the curriculum of colleges and universities. Endowments are forthcoming for university theaters; or university theaters are being made an integral part of current programs of university expansion. College graduates, as instructors, carry the impetus to the secondary schools. The auditorium of a new high school is no longer planned solely for "morning assembly" or graduation exercises but is expected to provide a stage where plays can be given. Play-giving is part of the educational program of the increasing number of the so-called "progressive" or "modern" primary schools.

A theater will presently be as necessary an adjunct to a completely equipped school or college as a science laboratory or a gymnasium is today. And the new impetus given to community and town planning by the collapse of speculative housing will increase the number of community centers, like Westchester County's at White Plains, N. Y., where an entire county can gather in an auditorium holding an audience of three thousand to hear not only their local choruses and amateur players, but visiting professional companies, "grand opera," symphony orchestras, and recitalists.

The requirements of these new play producers are in every way exactly the opposite of the commercial theater's, and the architect must realize this clearly enough to plan for them. The commercial producer is a temporary tenant; these new producers are permanent ones. They are committed to yearly programs of repertory ranging from the unit set of classic tragedy to expressionistic plays in fifteen or twenty scenes. Although the cost of union labor is not an item, students or amateurs are not free to spend ten or twelve hours a day on scenic rehearsals nor can ten experienced stage hands be called in at the last minute to help run a show. Scene-shifting apparatus, mechanically complete and efficient, that reduces hand labor to a minimum, complete and flexible lighting equipment, including a switchboard large enough to allow for an expert use of the lighting effects that are so large a part of the technique of modern production, are essential. This equipment like everything else in the building should reduce obsolescence and upkeep to a minimum; there will be no large box-office receipts to pay for expensive additions or replacements. Scenery cannot be ordered from city contractors a few blocks away. Ample workshops for building and painting settings have to be incorporated with the stage proper, also ample storage space for "properties," such as furniture, to avoid the cost of hauling.

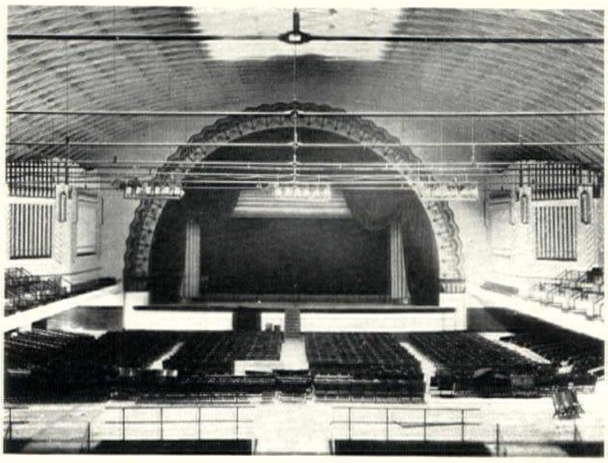
These theaters at the outset may be Little or "amateur" theaters, but they will not remain so; if they continue, they are bound to become more expert and to put on productions that are increasingly ambitious and elaborate. Inadequate technical equipment is certain, sooner or later, to hamper future growth. A completely equipped stage may be an immediate asset; it enabled the Westchester Community Center to give performances by the Metropolitan Opera during its first seasons which not only added to the interest of its program but were a valuable source of revenue as well.

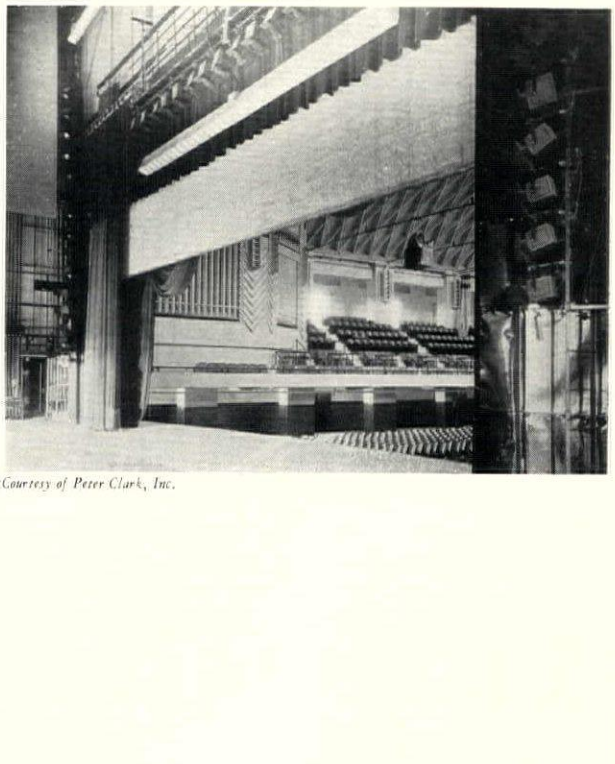
However, these theater buildings cannot be wholly specialized. They are the center of all a community's cultural interests and must be flexible enough to be easily converted for concerts, choruses, moving pictures, public lectures, regional conventions, commencement exercises, traveling or local art exhibitions. Attendance may fluctuate from a few hundred to a few thousand. Many of these theaters will tap a territory of several thousand square miles on a radius of an hour's or an hour and

a half's automobile drive, so that the building must often be related to parkways, landscaped approaches or large parking spaces. Box-office facilities must be provided for maximum demand even though it is only occasional; too small an entrance lobby, one, instead of two, box-office windows, may create the worst kind of congestion. In general, ample lobby space and promenades will be an important not a negligible feature. These theaters will be meeting places for an entire community, social centers where conversation between the acts with acquaintances, colleagues or neighbors will be part of the festiveness of an evening in the theater. Arrangements for circulation between the acts will be as important as seating arrangements during the acts, and those in the audience who come several hours by car will need restaurant facilities as well.

Planning these new theaters is therefore an architectural problem of the first order. The standardized commercial theater plan, like the standardized city apartment plan, could be done from the top of an architect's mind; both were, in most cases, turned out by second-rate architectural hacks. Non-commercial theaters, like the new housing developments, require maximum architectural imagination and resource. The profit-making theater was a boarding house for temporary tenants who had to provide excess profits or vacate. These new non-commercial theaters are permanent workshops for tenants felt to be of enough cultural importance to be endowed, if necessary. As a result, the new types of American theater will, in plan and equipment, be much more like German civic and state theaters of 1900–1920 than American theaters built during the last twenty years.

Westchester County Center, White Plains, N. Y. Walker and Gillette, Architects. Plays, recitals, operas and various types of exhibitions are given in this auditorium which was designed to fulfill many functions





Courtesy of Peter Clark, Inc.

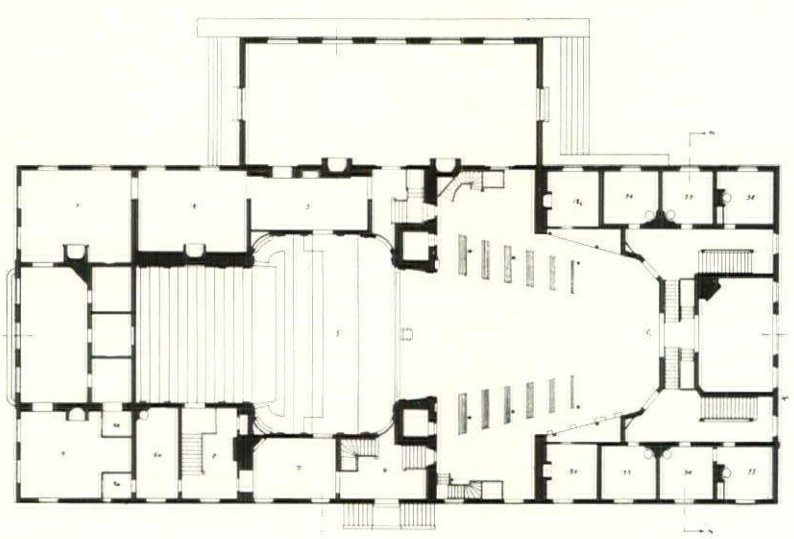
Rosenberg

The theater of Drottningholm, Sweden, which dates back to 1766 has a lesson for modern designers in at least one respect: an adequate stage size. A reference to its plan, below, and Figure 12 on page 191 will explain the illusion of great perspective achieved with a long stage and the use of parallel scenery "flats"

III. PROGRAM AND PLAN

THE chief obstacles at present are inexperience and ignorance on the part of both the architect and his new clients. For the first time he learns that there are such things as theater switchboards, gridirons, fly floors and pin rails, elevator, sliding and revolving stages and cycloramas. A theater commission is rarely important enough to warrant an architect taking a trip to Europe in which he might study the civic and state theaters of Germany. He is likely to look at a certain number of the more recent Broadway theater plans or take a contractor's word for the type of scene-shifting and lighting equipment needed and produce a theater which in externals is a creditable piece of architecture but in plan continuously handicaps the organization that has to use it.

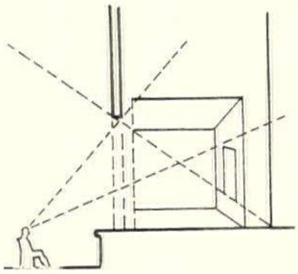
His clients are often more inexperienced and often have no better idea of the technical requirements of the kind of productions that they are planning to undertake for the first time. Their funds are often insufficient for an adequately equipped building; their programs are often so vague as to number and size of productions, actual and eventual audiences, requisite staff organization and general plan of operation, that it is difficult to plan a building to fit them. The architect may easily find himself in much the same dilemma as though he were asked to plan a country house for someone who said, "I have no idea of what my income will be; I may have a family of two or ten; three servants or sixteen; I may or may not give large dinners several times a week; perhaps I'll have week-end parties of half a dozen guests at a time, and perhaps not; but be sure to make the house Georgian." The ignorance of amateurs is often matched by their obstinacy. They forget that buildings are not rubber.



The plan of the Drottningholm Theater. The relative size of stage to seating space is remarkable. Much of the scenery was of parallel "flats" which could be pulled out from the sides. The large room at the side of the building, accessible to both audience and actors, might well be incorporated in a plan today to serve as the spacious "Green Room" of a community theater

Figure 1 (below)

Figure 2 (right)



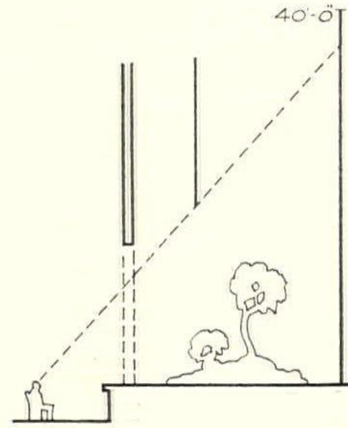
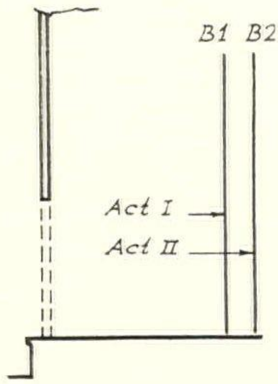


Figure 3



IV. THE PRIME ESSENTIALS

HEIGHT of the stage house (*width, height and depth*). If one of the major opportunities of American architecture at present is not to be bungled at the start, there is urgent need for a clearing house of theater experts in all fields which would act as a consulting and distributing center for all the special technical information needed in theater building and which could be consulted when a new theater was being planned.

Pending this, I shall attempt to indicate a few of the essentials of planning, principally in regard to a workable stage, which are usually neglected.

A stage is not only a space where scenery is used but a space where large amounts of scenery not in use have to be stored out of sight even during the performance of a single play. Therefore a maximum of stacking and storage space in addition to the playing area of any stage is a necessity. The playing area cannot be constricted because actors, being human beings, have more or less standard dimensions. Scenes in which six or seven of them have to move about freely at one time are not unusual; also scenes where mobs of twenty or thirty have to move, in addition to the leading players. Too many stages are still being planned on the principle of a box car. Drama cannot be mobilized on that basis. Furniture is also more or less standardized in dimension; several roomsful may be needed in the course of a single play. Despite all the theorizing on the subject of abstract and stylized methods of production, realistic plays are still being written in quantity, and a bulky sideboard or even a grand piano may be essential to the action of a play. No abstract substitutes for tables and chairs have yet been discovered.

Moreover, offstage space for circulation is also necessary. An actor should not be expected, during Act I, to leave a room by a door on Stage Right and be able to re-enter it by a door on Stage Left two minutes later only by climbing over a stack of furniture waiting to be used in Act II. In open-air scenes, if there is not space enough between the actors and a backdrop, they will throw their shadows against the sky. Broadway theaters have been built where just this sort of thing happened, where in fact many plays could be performed only by keeping furniture or scenery in the alley. Unfortunately, many new theaters are imitating their ridiculous inadequacy.

The maximum dimensions of scenery are determined by a balance of sightlines. The balcony looks down, but most of the orchestra looks up,

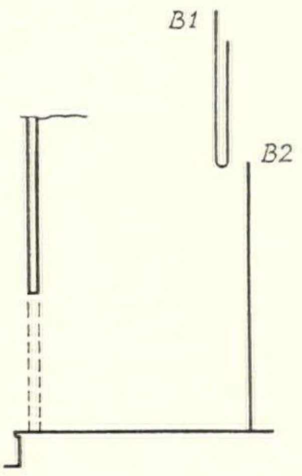
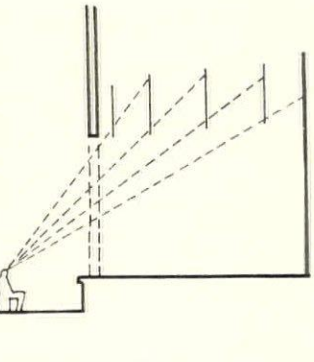


Figure 4 (Above)

Figure 5 (Below)



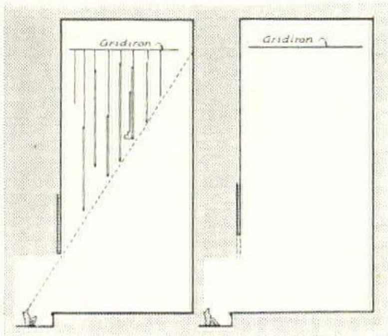


Figure 6

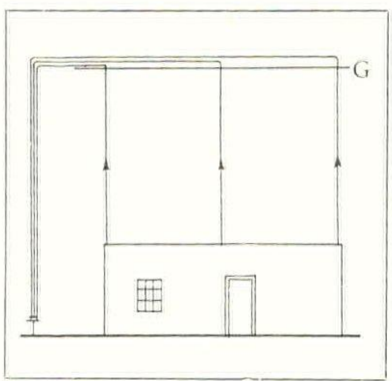


Figure 7

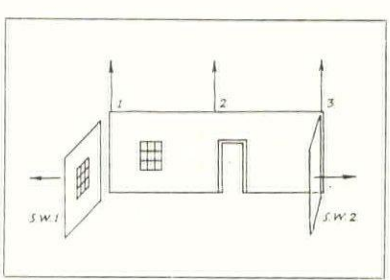


Figure 8

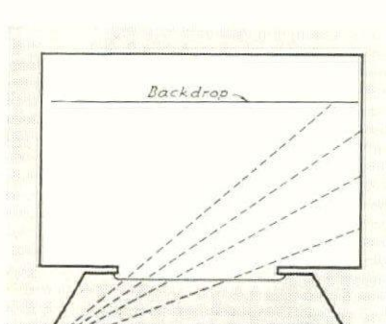


Figure 9

a fact often forgotten. The curtain is rarely raised more than 12 or 15 ft., at most. Many plays involve realistic interiors, and if their walls are higher than 15 ft., their proportions are not plausible. On the other hand, if the curtain is raised less than 12 ft., the rear of the balcony cannot see enough of the room (*Figure 1*). In open-air scenes, a spectator toward the front can look up so high that the skydrop or backdrop must be 40 ft. high (*Figure 2*). But often two backdrops are needed (*Figure 3*). Drop B^1 used in Act I must be got out of the way and out of the line of sight so that backdrop B^2 can be seen in Act II. The most practical way to do this is to haul B^1 out of sight. There must be room enough above the stage to do this. If there is not enough room above the stage, the bottom of drop B^1 will hang down over B^2 during Act II.

There are then only two ways to avoid this, to double up drop B^1 (*Figure 4*), called "tripping," which slows up scene shifting and is mechanically cumbersome, or to hang borders (*Figure 5*) which will break the line of sight and hide the bottom of backdrop B^2 hanging down into the scene. But these borders are so destructive of atmospheric lighting and the illusion of *plein air*, making the heavens look as though bed covers were hanging there to dry, that the entire technique of modern stagecraft has struggled since 1870 to do away with them.

The stage-house, therefore, must be a shaft providing ample aerial storage space above sightlines. The proscenium opening is a small slot at the bottom of this shaft (*Figure 6*). Unless it is high enough to take the tallest pieces of scenery out of sight, it is useless. A stage with too low a stage-house is as preposterous as a ten-story office building with an elevator shaft running no higher than the third floor, or a public library with enormous reading rooms and stacks too small to hold even 2,000 volumes. A stage-house to be efficient, particularly for a repertory theater, must be high enough and large enough to store out of sight the settings for a number of productions (*Figure 6*).

The system of hanging flats is diagrammatically shown in Figure 7. A drop is hoisted by three lines, preferably cables, which run through slots in a metal gridiron G at the top of the stage-house, and then descend to the stage floor where they are tied off to a pin rail. A counterweight balancing the piece to be hung reduces the dead weight in hauling to a minimum.

However, only part of any setting can be hung and let down in place: namely, the part parallel to the footlights. Pieces set perpendicular to the footlights, as the side walls of a room (*Figure 8*), cannot be expeditiously handled in this way. If they are not to block the passage of other drops used in previous subsequent scenes, they would, if hung, have to have their lines snapped off, be swung into place, and then swung back into a parallel position and have the lines snapped on before being hoisted out of sight, a cumbersome process that slows up scene shifting. These side walls (such as *S W 1* and *S W 2*, *Figure 8*) are usually carried into place by hand, attached (*lashed*) with a cord (*lash line*) running through cleats to a back wall, then unlashed (*struck*) and taken offstage (*stacked*).

Ample hanging space above the stage must therefore be supplemented by ample stacking space on the stage floor itself, not only for furniture but for parts of stage settings, often the cumbersome parts containing niches, reveals, porticos, exterior stairways, etc., and for the platformed parts of stage settings, mounds, terraces, etc., which also are not easily hung.

The stacking space required and the size of the stage floor are again determined by the relations of storage area, playing area and sightlines, particularly in open-air scenes. A spectator will look past the ends of any skydrop set at the rear of a stage and see the brick walls of the theater if there is nothing to block his vision (*Figure 9*). The skydrop is therefore usually curved (*Figure 10*), a cyclorama. But in order to give any illusion of distance at the sides of the scene, these side arms have to be well back of the proscenium opening. If the offstage space is not ample, the arms of the cyclorama are so close to set pieces, such as a portico or trees (*Figure 11*), and so little space is left behind them to light the sky that any æsthetic quality the scene might have is made impossible by a house or a tree plainly touching an expanse of unlighted canvas. If shoved off almost to the side walls of the theater, no stacking space is left. The only alternative system is to set up parallel flats at each side stage (*Figure 12*), the "wood wings" of the old theater. But their pictorial effect is so contrary to the entire vision of modern art that except for consciously archaic revivals, they cannot be used.

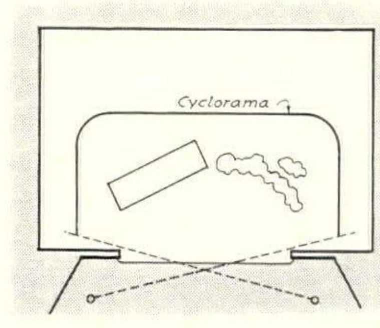


Figure 10

The width of the proscenium opening is again determined by the relation of auditorium sightlines. To get in seats for enough spectators, the architect must spread them in a fan shape. In doing so, with too narrow a proscenium opening, a large section of the auditorium at the right and left see only two-thirds of the stage. If he enlarges his proscenium opening (*Figure 13*) he is likely to destroy the necessary stacking space on his stage (*Figure 14*). If he cuts down the fanlike spread of his auditorium in order to improve sightlines, he reduces his seating capacity (*Figure 15*).

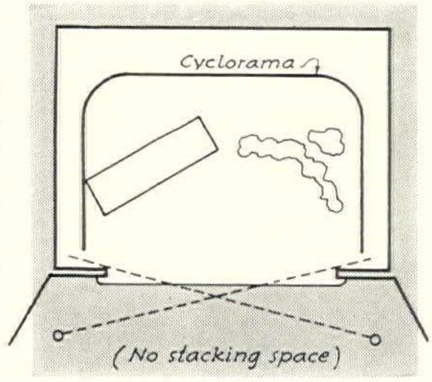


Figure 11

On the basis of some twelve years' experience with almost every method of stage setting, both at the Garrick Theater and at the Guild Theater (the former small, the latter large), I should counsel the following proportions of stage-house and stage floor, width and depth, and proscenium opening:

WIDTH OF PROSCENIUM: 30–32 ft., ample for even the largest productions. Never less than 25 ft.

HEIGHT OF PROSCENIUM: This is unimportant except as it affects the design of the auditorium. The height of the stage as played in is determined by the height to which the curtain is raised. This can rarely be more than 15 ft.

TOTAL WIDTH OF STAGE FLOOR: Minimum at least twice the proscenium opening allowing stacking space at each side of one-half the proscenium opening, i.e., for a 25-foot proscenium 12½ ft. offstage R and L, total width of 50 ft. For 30-foot proscenium a total of 60 ft., 15 ft. offstage each side. *But this is a minimum* and provides a stage too narrow in width for the best use. A properly planned stage in width should be three times the proscenium opening, i.e., 90 ft. for a 30-foot proscenium.

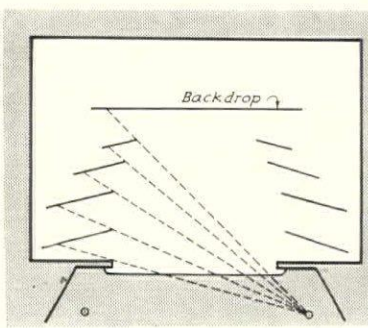


Figure 12

DEPTH OF STAGE FLOOR (to the rear wall of the stage-house): Minimum at least one and a half times the width of the proscenium opening, 45 ft. for a 30-foot proscenium. It is preferable to make the total depth of the stage twice the width of the proscenium opening, i.e., 60 ft. depth for a proscenium width of 30 ft.

HEIGHT OF STAGE-HOUSE AND GRIDIRON: Never less than two and one-third times the width of the proscenium opening, preferably two and one-half times, i.e., 75–90 ft.

A permanent theater is a workshop; its core an adequate stage. The core of theater planning is the stage-house, a cube roughly 90–100 ft. wide, 50–60 ft. deep, 75–90 ft. high. This is the central form about which a theater must be built, and is as much a determinant of the total design as a skyscraper tower is for the setback of the skyscraper. It should provide the dominant mass of the theater building, be boldly emphasized rather than concealed. The attempt to dwarf the stage-house results in an unworkable theater; the attempt to conceal the stage-house, instead of making it the dominant feature of the facade, results in the worst kind of architecture, i.e., a building whose exterior does not express the essential features of its plan. The other cubes necessary for

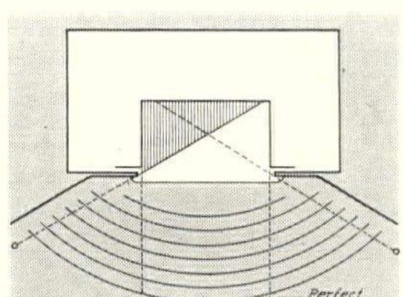


Figure 13

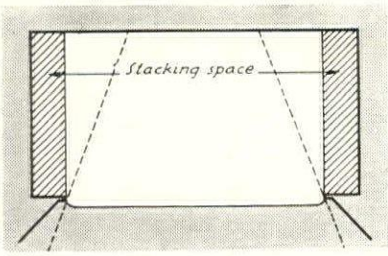


Figure 14

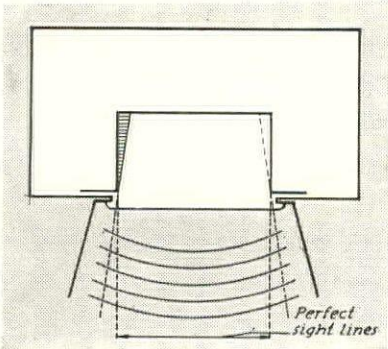


Figure 15

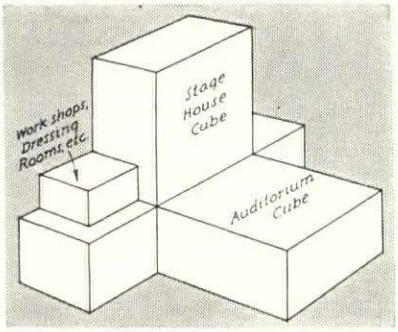


Figure 16

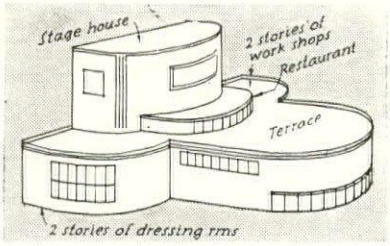


Figure 17

auditorium, workshops, dressing rooms, storage space, classrooms, etc., must then be related to the stage-house as an organized architectural composition (*Figures 16* and *17*).

Sliding Stages. The gridiron system for "flying" scenery is not by any means the ultimate one. It literally grew up during the eighteenth and nineteenth centuries when stage settings were almost exclusively made of painted flats on which even furniture was sometimes painted. Modern methods of production, in response to the tactile values of modern art and the realistic trends of modern literature, are plastic and tend to build cornices, porticos, window trim, etc., rather than paint them. Stylized or abstract methods (expressionism, constructivism, etc.), even when eschewing ornament or decoration, tend to massive forms, terraces, plinths, trestles, stairways. The bulk and weight of much modern scenery involves a mechanical problem that is not met by the gridiron and aerial stacking space. But on a sufficiently wide stage this can be solved with sliding or wagon stages (rolling platforms, 6–9 in. high, *Figures 18* and *19*), each the width of the proscenium and 12–15 ft. deep, completely set with both the scenery and furniture necessary for each act and rolled successively into place.

This system of scene shifting has many advantages in saving both in production and rehearsal. Instead of each set having to be dismantled, sides unlashed, ceiling flied and all the furniture carted offstage and stacked, the setting remains intact and can be rolled into place in a minute or less. Heavy pieces, such as stairways, porticos, hillsides, etc., are much more easily and expeditiously handled. The details of this system of scene shifting relative to a cyclorama for open-air scenes, tracks, electric or hand power, etc., are beyond the scope of this article. I cite it simply as an instance of why a stage sufficiently wide and deep is the basis for a sound technique of play production. Even where the stage-house is not wide enough to hold such wagon stages, they can be housed in the lower portions of studio or storage space outside the stage proper, if planned in conjunction with offstage workshop, studio, or class room space (*Figure 20*).

For our newer theaters, site value is fortunately not a factor that limits an adequate theater plan. These new theaters are not placed in congested centers; their site is already part of a university campus or provided by a county on low-priced land. The architect who insists on adequate space on which to develop a theater is not blocked by the necessity of asking his clients to invest several hundred thousand dollars in added plottage. He has therefore every reason to demand an adequate plot on which to build a theater that is efficient enough from a technical point of view to become a permanent center of play production.

Flexibility. Our newer theaters are likely to be put to so many uses, local amateurs with light productions and small audiences one week, and the next visiting orchestras, opera companies, metropolitan plays on tour with large audiences, that the maximum flexibility of the

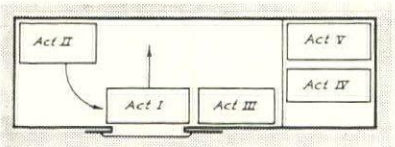


Figure 18

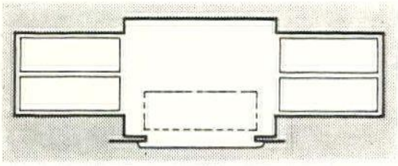


Figure 19

auditorium is important. The one thing that kills the projection of a play is too much empty space into which it has to be projected. No small company of amateurs can get anywhere by being forced to play in an auditorium planned to hold 1,000 or 2,000 who come to graduation exercises or to symphony concerts. Seating must be planned so that part of the auditorium can be skillfully cut off by temporary partitions without damage to the acoustics.

Where the theater project is large enough, it is advisable to provide two theaters, one small, the other large. This is best done by a common stage-house (*Figure 22*) with a large fire-proof sliding portal connecting the two stages and making it possible to shift scenery and properties easily from one to the other, giving access to common storage space and centralizing electric conduits for the lighting system as well as the gridiron and scene-shifting apparatus. But two theaters can also be built as separate units, as in Stuttgart (*Figure 23*), and the connecting building used as common workshop and storage space.

Another valuable aid to interior flexibility is an elevator platform immediately in front of the proscenium. When not in use (*Figure 24*), it can be used as part of the orchestra floor, with seats on it. These can be taken off and the elevator raised to hold a recitalist's piano or a small orchestra, such as a quartet, the stage curtain supplying a background. Or it can be used in conjunction with the stage for large orchestras, orchestras and choruses, or supply a forestage for revivals of Greek Drama, Elizabethan or Restoration plays.

There is not space to touch on the use of elevator sections on the stage proper, cellar space immediately below the stage floor, systems for trapping the stage floor, where elevator platforms cannot be used, space needed for adequate electrical switchboards, lighting apparatus and its control, provision for front stage lighting from the ceiling of the auditorium, canvas and plaster cycloramas, relation of dressing rooms to the stage, including reserve space for mobs and choruses, auxiliary elevators for handling scenery in construction and getting it from workshop to stage. I have been able to indicate only the basis for planning our new theaters. An architect can study these further details in the illustrations of Kranich's two volumes on Bühnentechnik der Gegenwart, in Pichel's excellent monograph On Building a Theater, in the monographs (usually published by Wassmuth with complete architectural plans) of German state and civic theaters, and in addition attend some scenic rehearsals at the Yale School of Theater or The Theater Guild where he will undoubtedly be made welcome. He will then understand why it is important for him to insist on maximums rather than to accept minimums.

For the term Little Theater is a vicious misnomer. The business of the amateur is not to remain amateur but to become expert. A theater that lives can do so only by attracting audiences, even though most of the time they are given free seats. A theater that is planned never to seat more than 200 people had better never be begun. Our new theaters must be planned so that they can grow, in buildings planned not only for today but for tomorrow.

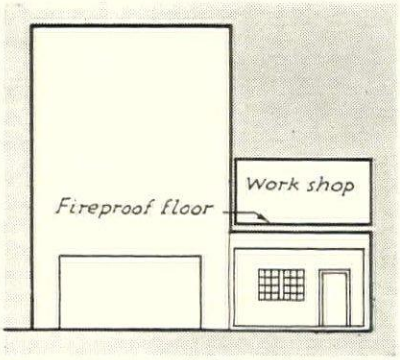


Figure 20

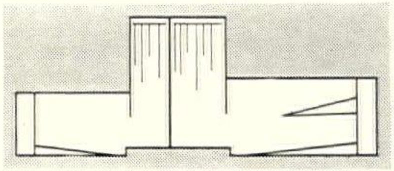


Figure 21

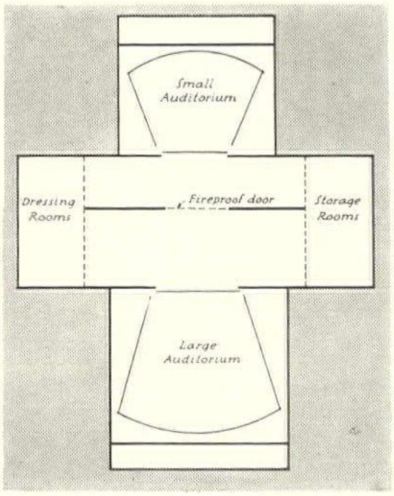


Figure 22

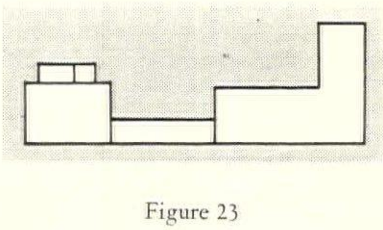


Figure 23

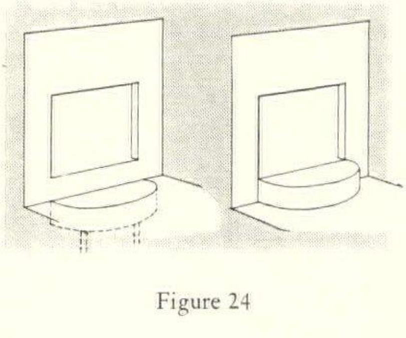


Figure 24

THE ARCHITECT AND THE BOX OFFICE

BY

S. L. (ROXY) ROTHAFEL

AS TOLD TO JOHN CUSHMAN FISTERE

IN ATTEMPTING to translate into words the experience of a lifetime to find an answer to the question, "What makes a theater pay?" I am inclined to reply, "Good entertainment," and offer no further qualifications. Such an answer would be misleading, however, because I mean by good entertainment much more than would be included in the usual understanding of the term. I prefer to use the word entertainment in the same sense that it is used in the relation between host and guest. Theater entertainment, by my definition, takes place, not only on the stage, but at the box office, in the lobby, the foyer, the rest rooms, and the auditorium itself. Once within the doors of the theater, the purchaser of a ticket becomes the guest of the management, and the management's simple duty is to entertain him until he leaves.

Under the expanded definition of entertainment, the theater building itself assumes added importance, and the architect of the building a more significant rôle in contributing to the entertainment of theater patrons. As a consequence, the architect's work has a direct bearing upon the commercial success of the theater he designs.

Admitting, of course, that what transpires upon the stage or screen is the chief source of theatrical entertainment, we may pass on to those related factors with which the architect is more intimately concerned, bearing in mind that these considerations contribute to the success or failure of the show itself as well as to the guest's entertainment in general.

It is said occasionally, by critics and others whose interest in the theater is chiefly literary, that a good performance in a barn is just as exciting to the audience as the same performance would be in a comfortable, well-equipped theater. Those who subscribe to this belief recall the barren stages of Elizabethan days, or cite the example of Eugene O'Neill's success in the converted stable which housed the Provincetown Players in New York. This, they claim, is proof that the building has an innocuous influence upon the reactions of the audience. What they are actually proving, however, is only that a good play may succeed *despite* the surroundings.

The few conclusions which I shall draw in this discussion are based, I think it might be interesting to point out, upon a close study of audience reactions as well as upon experience in general theatrical production. From a location completely concealed from the audience, I have watched through field glasses the behavior of hundreds of individuals, studying their facial expressions, trying to get their reactions to what was going on upon the stage. I have learned much about audience temperament. Occasionally, I would single out a bored spectator and invite him to my office to find out why he had not enjoyed the performance. On many occasions, I received valuable suggestions, but on more than a few occasions I learned only that the pained expression which I had observed through the field glasses was due, not to the performance, but to something the spectator had eaten at dinner.

Although my experience has been limited chiefly to New York, I am inclined to believe that the theater patron of Dubuque appreciates just about the same type of performance that draws applause from the reputedly more enlightened metropolitan theater-goer. I believe this is more true today than it was before the time of those two important levelers, the motion picture and the radio. Consequently, whatever observations are made should have national application.

In the general design of the exterior, it is important to remember that the building is, in a sense, a show window. This is particularly true of motion picture theaters, and other types that are partially dependent upon attracting passers-by. The purchaser of a ticket must be invited to attend the performance. In small as well as large towns, the public is in the habit of walking or driving past the theaters to see what the attraction is before it buys. The article for sale might be no more than a name — Maurice Chevalier, John Barrymore, Greta Garbo, Al Jolson; or it might be a title that probably suggests wickedness in its most popular theatrical form. If the performance is of the type produced in the burlesque houses, the article for sale would be a graphic portrayal of what the patron will see inside, or at least what he would have seen before the manager received a visit from the district police captain.

The architect must recognize this advertising quality of the theater, and realize that it will be used to its fullest by the manager. The building should not, in my opinion, look like anything but a theater, with full provision made for electric signs and displays. It must also be remembered that the signs will be in competition with other signs, advertising other theaters, or possibly cigarettes and tooth paste. If the theater building is on a corner, the sign which identifies the theater should be so placed that it is seen from all four points of the compass. The two theaters in Rockefeller Center, for instance, are on Sixth Avenue, one block away from the present Broadway theatrical district. It is necessary, consequently, to design identifying signs that are large enough to be seen from that distance, and to place them so that they may be easily visible to the theater crowd strolling up and down Broadway, making up its mind where it is going to spend the afternoon or evening. Since the architects for Rockefeller Center are fully conscious of this condition, they have been able to create signs which are consistent with the general design of the theaters.

The lobby plays an important part in inviting the public into the theater. It should be exciting and stimulating to the passer-by, colorful but not ornate. The ticket booths should be prominently located, and large enough to eliminate, or at least to reduce excessive waiting in line. Ticket selling facilities in the large New York motion picture theaters have often proved inadequate to handle the large crowds which storm the doors when an unusually attractive performance has been running. A long line waiting to buy tickets may be an advantage from the standpoint of mob psychology, but it is discouraging as well.

I have always believed that the patron must begin to feel what might be called the spell of the theater before he reaches his seat. It is possible by a combination of circumstances — courteous service, proper interior design and color treatment, a convenient route to the auditorium entrance doors — to encourage in the theater-goer an appreciative mood. Conversely, long flights of stairs, a circuitous route to the entrances, inadequate smoking and rest room facilities, jarring decoration of the lobbies and lounges — such a combination would transform a prospectively enthusiastic spectator into one who is "dead" from the performers' standpoint. Architectural responsibility in this connection is a very positive thing.

One extremely important feature of theater planning that has a definite relation to successful performances is the shape of the auditorium. There has been a noticeable trend in the past few years toward intimacy between performers and the audience. In a large theater, the problem of maintaining intimacy is a difficult one. We believe we have solved it in the International Music Hall, however, by incorporating runways on both sides of the auditorium, extending from the stage to the first mezzanine level. The result is a stage that almost encircles the audience in the orchestra, and brings the performers closer to those in the mezzanines.

Another common practice which interferes with desired intimacy is that of dividing the audience in two by incorporating one long mezzanine into the plan. Enthusiasm is contagious, but it is almost impossible for those sitting in a long mezzanine to catch a mood from the orchestra audience, or to transmit their enthusiasm to those below. Furthermore, there is a decidedly bad psychological effect produced upon those sitting under a long mezzanine.

It is depressing. In the Rockefeller Center theaters, we have three short mezzanines, with adequate headroom between. The resulting sidelines make it possible for those in the rear of the orchestra to see the entire proscenium opening, and for those in the mezzanines to see the front of the stage as well as the back. We will have only one audience, and, according to our present plans, we will have only one price for all seats.

The decorative treatment of the auditorium is a subject upon which a volume could be written, since it is so important as an influence upon the mood of the audience. The eye and ear of the audience must be permitted to focus on the actions which are transpiring on the stage. An ornate interior, one which is as garish as a Mardi Gras setting, is a possible danger to the performance; and the same is true of a theater with poor acoustics. Each of these elements has a definite relation to the theater's success, and should be studied with this in mind.

I think we have made sufficient progress in the science of acoustics to eliminate all possibility of error in reverberation and absorption. One thing we have learned, and that is that it is no longer necessary to design walls and ceilings with dust-catching broken surfaces. Although good acoustics will demand, in most cases, breaks in the ceiling, we have passed beyond the point of believing that the entire ceiling must be uneven on a guesswork basis. Expert acoustical engineering advice is absolutely essential.

Because the audience itself is an important part of the color scheme of a theater, the interior should be as neutral as possible, preferably limited to the primary colors. A woman in a vivid yellow evening gown might upset the decorative scheme, or a preponderance of blue might exert an unhappy influence. Red has always seemed to me to be a fortunate color choice. It is exciting to the audience, and except in some shades, forms a good background for other colors. In general, I think it is advisable to retain simplicity in the interior treatment, and to devote the money saved to equipping the theater properly.

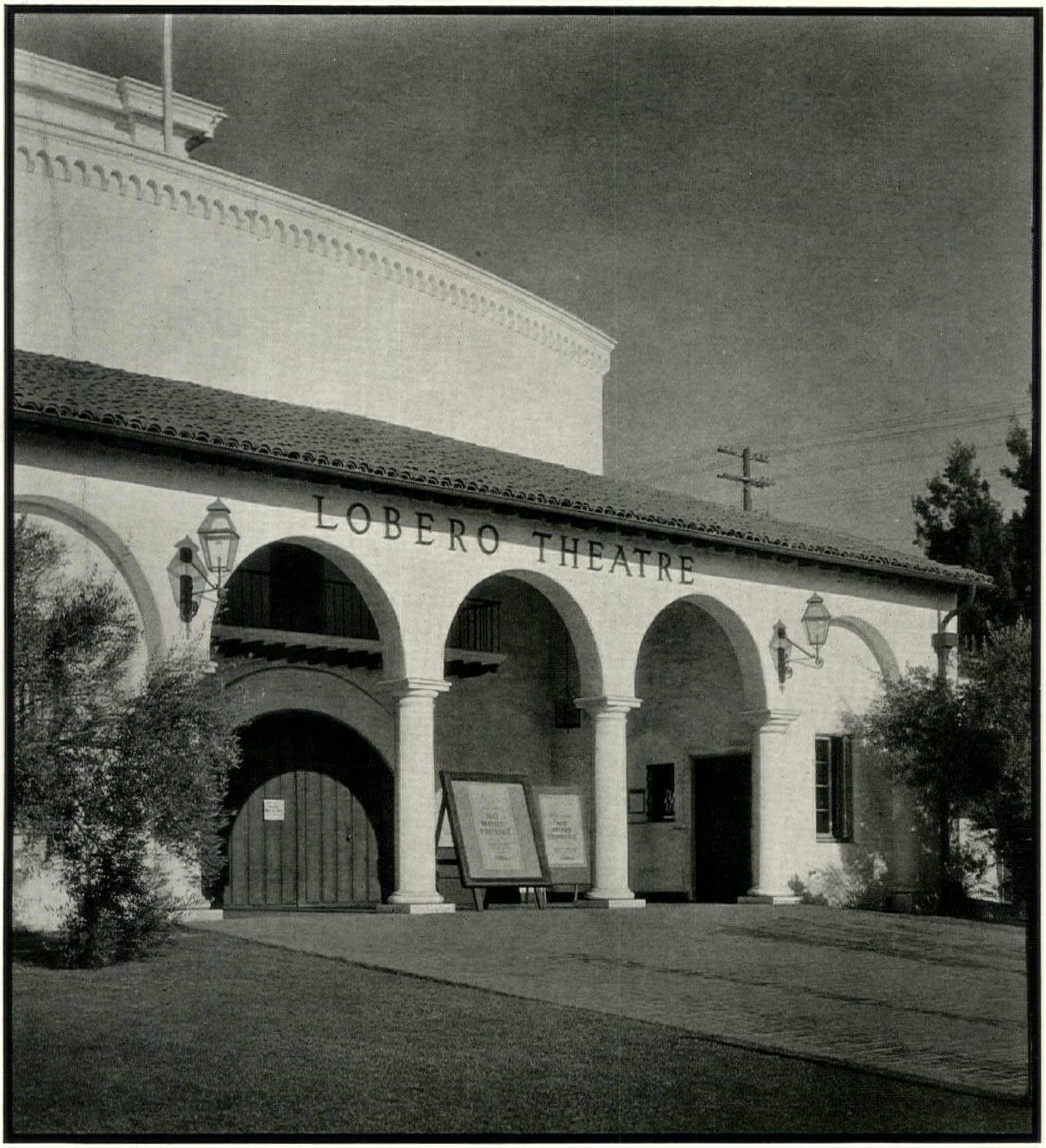
The importance of auditorium lighting suggests itself in connection with interiors. Lighting has come into its own as a decorative element. Heretofore, the lighting consisted principally of exit signs and a huge chandelier suspended from the middle of the ceiling. We thought we had reached the peak of dramatic lighting when we learned to dim the lights slowly or quickly, and bring them on again. The development of colored lighting, and the greatly improved methods of control give the architect an opportunity for interesting effects that he did not have before. In the International Music Hall, we are to have a light conductor's pit directly behind the orchestra pit, from which both the stage and auditorium lighting will be controlled.

The air conditioning of theaters has become so inevitable a part of modern theater equipment that we are likely to forget perhaps what a tremendous influence good air conditioning has upon the box office. I have in mind the review of a motion picture that I read only a short time ago. After damning the picture with considerable vigor, the critic recommended attendance because the theater was cool. It used to be a good advertising stunt for a manager to advertise his theater as "the coolest place in town." He commissioned his art department to create billboards with icicles and frozen letters all over them. The situation became so competitive, with all the theaters trying to live up to the coolest-place-in-town slogan, that more than one owner was sued by a patron because of illness contracted in an over-cooled theater. The architect must take it upon himself to convince the overzealous owner that, after all, a theater is not a cold storage plant.

The architect should also remember that an audience, with the exception of the unfortunate standees, is seated. Comfortable chairs are necessary for enthusiastic reception of a performance. The hard, curved back, once standard in all theaters, is not nearly so comfortable as a straight-backed chair with stuffed spring cushions. It supports the spectator at the small of the back, and greatly adds to his attentiveness as well as to his comfort. In collaboration with the manufacturers, we have developed such a chair for the Rockefeller Center theaters. Instead of adhering to the minimum seat width of 18 in., we have decided to install chairs with widths of from 20 to 22 in. from center to center; and we have increased the back to back spacing from the minimum of 32 in. to 35 and more.

Having always been a firm believer in the need for courteous service on the part of theater attendants, I feel strongly about the desirability of including adequate accommodations for the ushers and other theater employes. Rest rooms, lounges need not be expensively finished, but they should be clean, ample in size, and comfortable. They help tremendously to maintain an *esprit de corps* that is essential to good theater management.

Stage equipment is a subject which architects, in justice to their clients, must study thoroughly. A producer who finds himself handicapped by limited accommodations and equipment is limited in the degree of perfection with which he can produce his shows. Stagecraft has progressed so rapidly in this country that it is possible to do almost anything on the stage that can be done anywhere else. Architects should know what goes on behind the scenes during a performance, during rehearsals, so that they can give full measure of cooperation to the producers upon whom the success of the architect's theater depends.

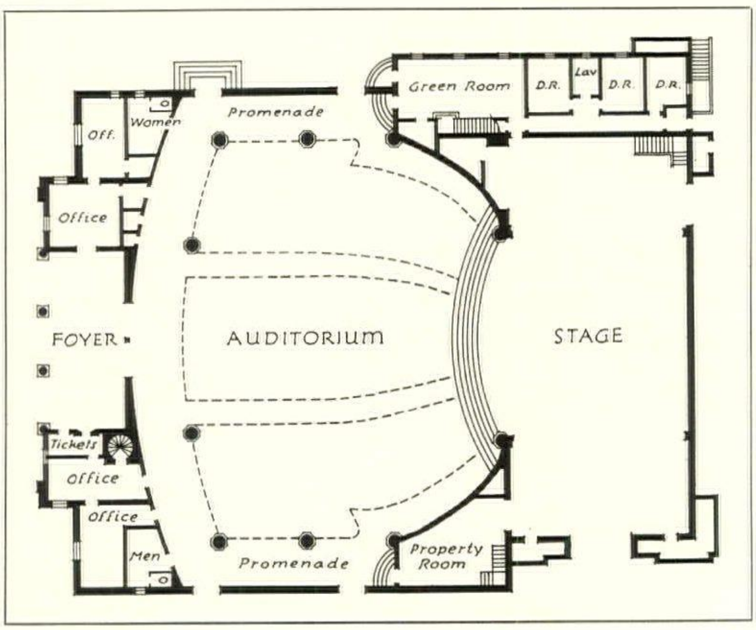


LOBERO THEATER

SANTA BARBARA, CALIFORNIA

GEORGE WASHINGTON SMITH, ARCHITECT

Dapprich



LOBERO THEATER

SANTA BARBARA, CALIFORNIA

GEORGE WASHINGTON SMITH, ARCHITECT

Dapprich

LOBERO THEATER

SANTA BARBARA, CALIFORNIA

GEORGE WASHINGTON SMITH, ARCHITECT

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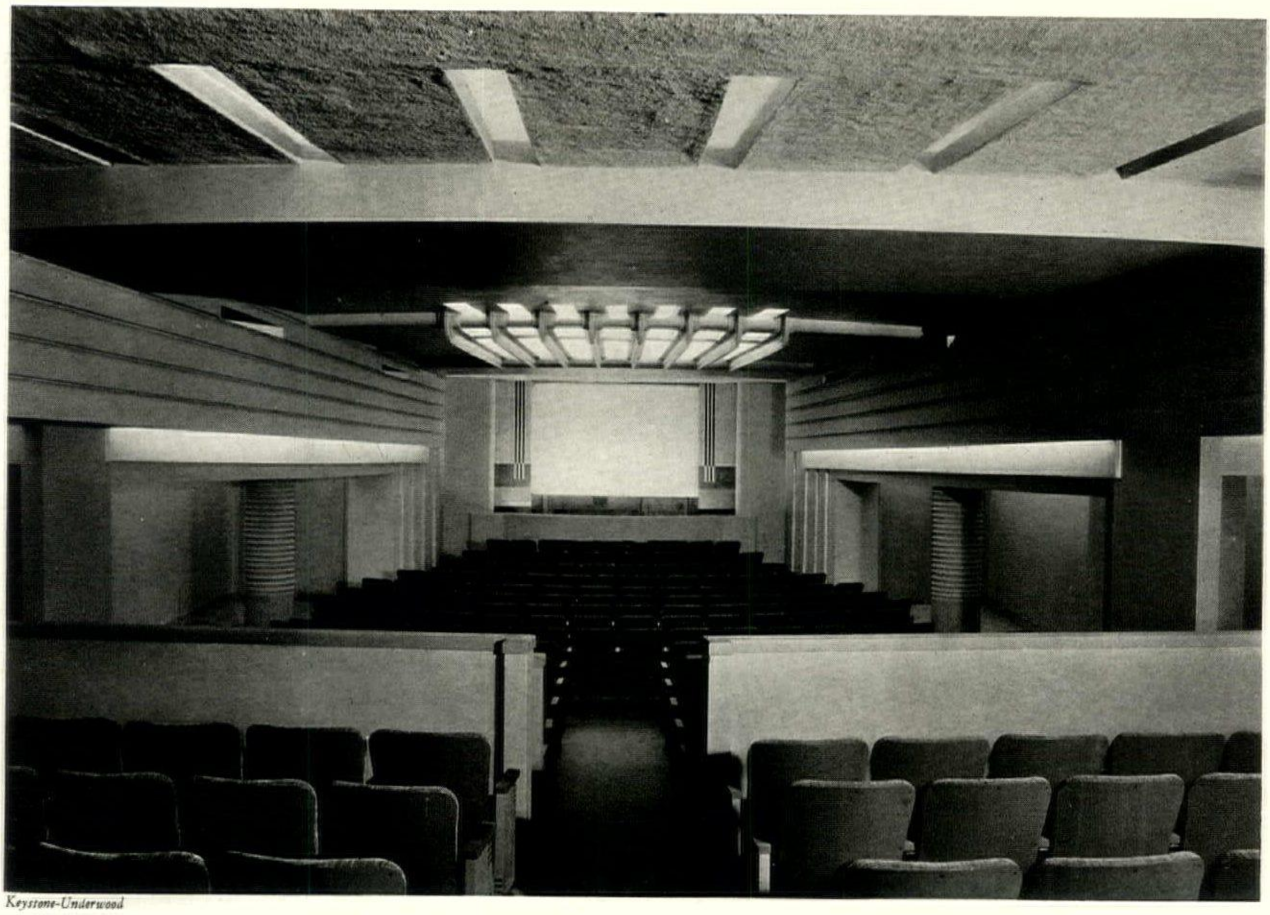
LOBERO THEATER

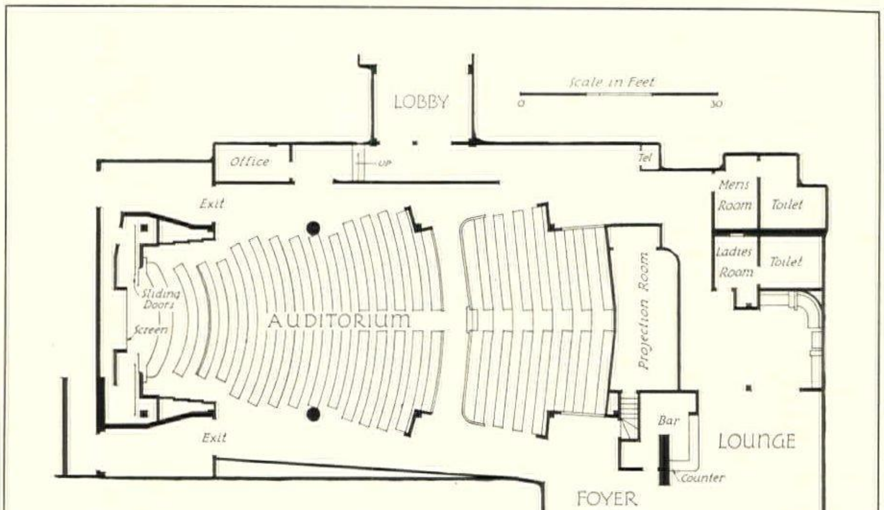
SANTA BARBARA, CALIFORNIA

GEORGE WASHINGTON SMITH, ARCHITECT



Keystone-Underwood

THE auditorium of this theater has been planned for the presentation of motion pictures only, and in its plan have been included many innovations unusual in the ordinary motion picture theater. The details of this system of planning and an explanation of the theory which brought it into being are given in an article by Ben Schlanger on page 253



THALIA THEATER

NEW YORK, N. Y.

BEN SCHLANGER AND R. IRRERA, ARCHITECTS

Keystone-Underwood

Irving Browning

THE illustration above is of the auditorium looking toward the projection booth. At the left is a view of the lounge which opens directly from the foyer and is easily accessible from all parts of the theater

THALIA THEATER

NEW YORK, N. Y.

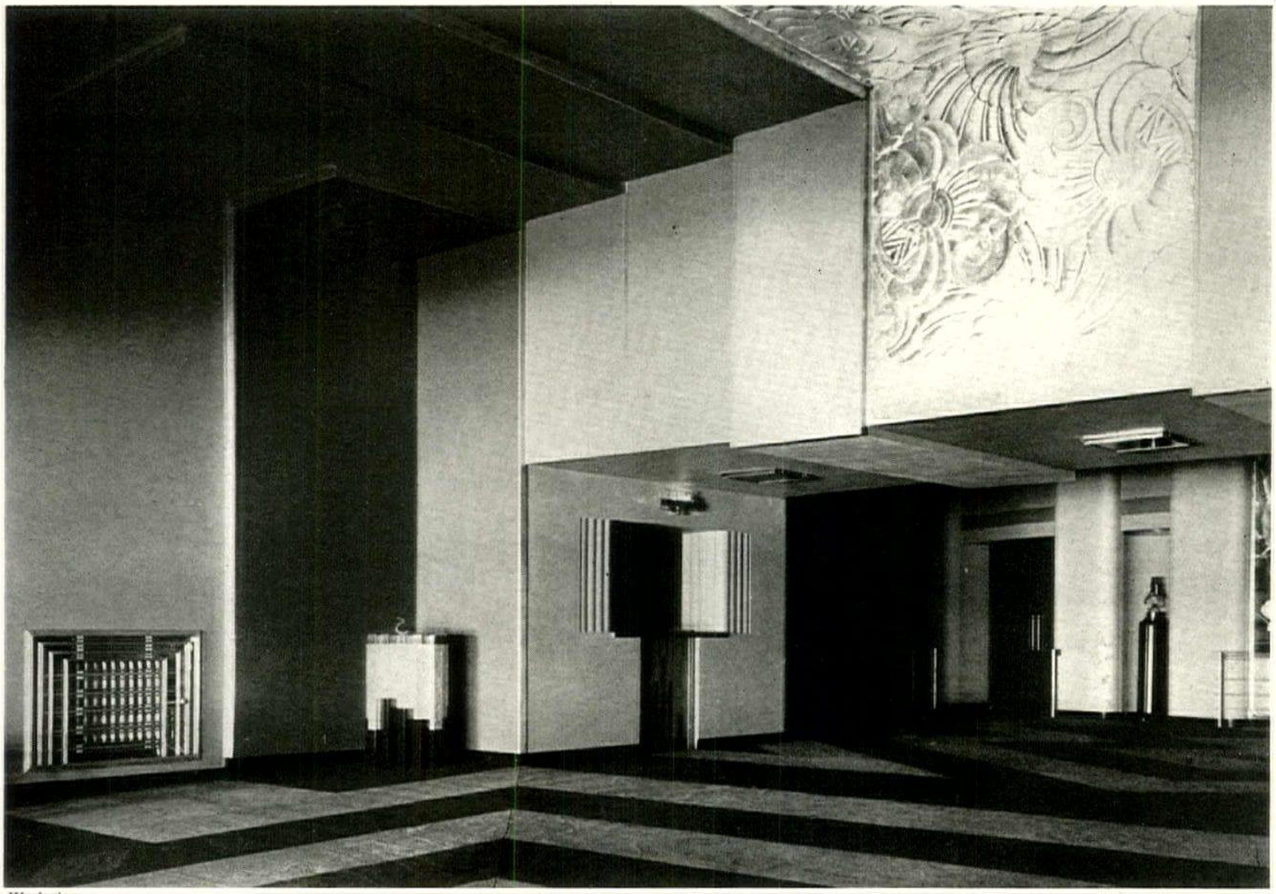
BEN SCHLANGER AND R. IRRERA, ARCHITECTS

Woodcock

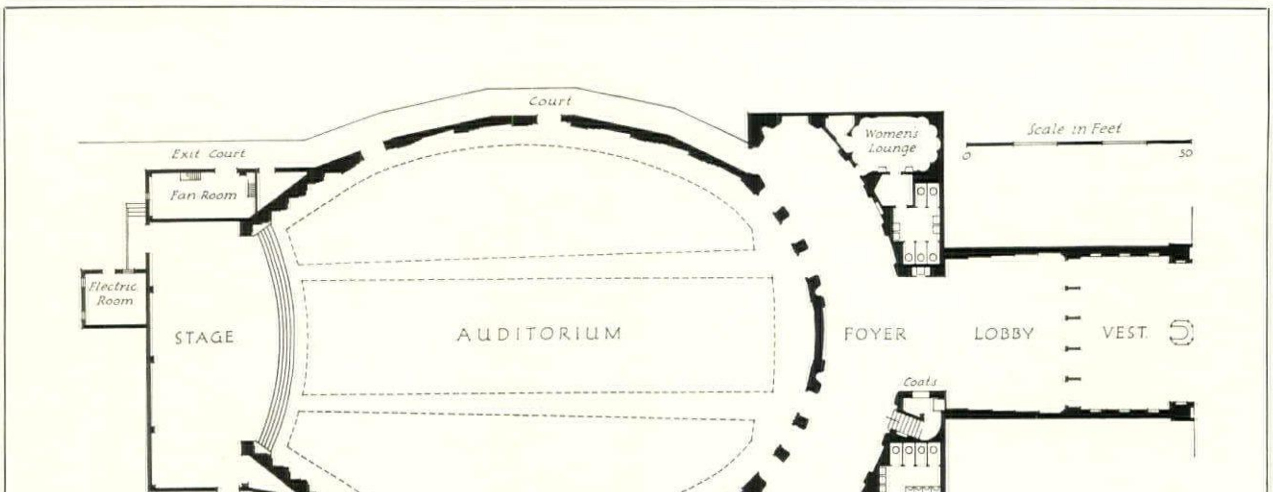
LEIMERT THEATER

LOS ANGELES, CALIFORNIA

MORGAN, WALLS & CLEMENTS, ARCHITECTS



Woodcock



LEIMERT THEATER

LOS ANGELES, CALIFORNIA

MORGAN, WALLS & CLEMENTS, ARCHITECTS

Mott

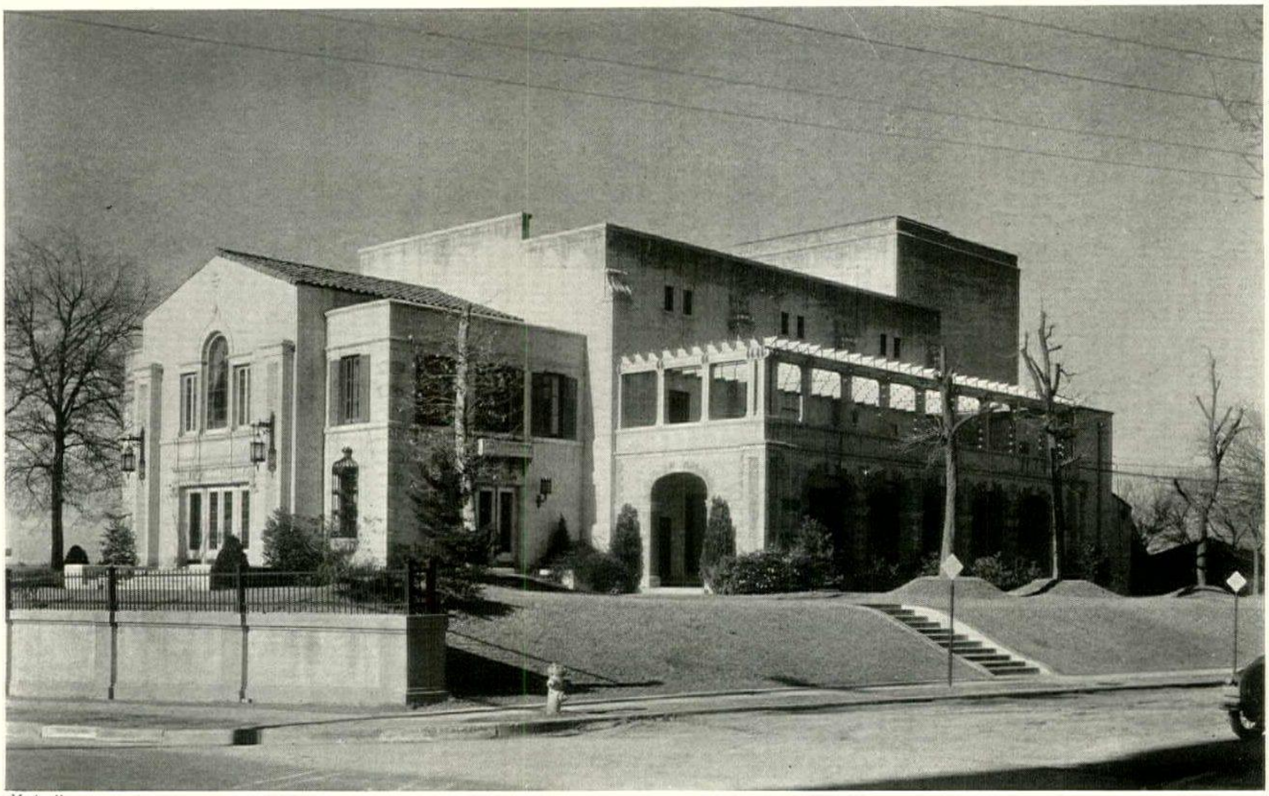
Woodcock

THIS building shows in both plan and elevation the increasing tendency toward simplicity in theater design. It has been planned especially for motion picture presentation, although the stage is adequate for legitimate performances which do not require elaborate scenes, properties or lighting. The exterior of the building is entirely of exposed concrete, including ornamentation on the facade and on the sign tower over the lobby. The concrete is painted a light neutral color. On the interior the decorative effect is gained by a combination of plain painted surfaces, silvered ceilings, and a small amount of colorful and modeled decoration

LEIMERT THEATER

LOS ANGELES, CALIFORNIA

MORGAN, WALLS & CLEMENTS, ARCHITECTS



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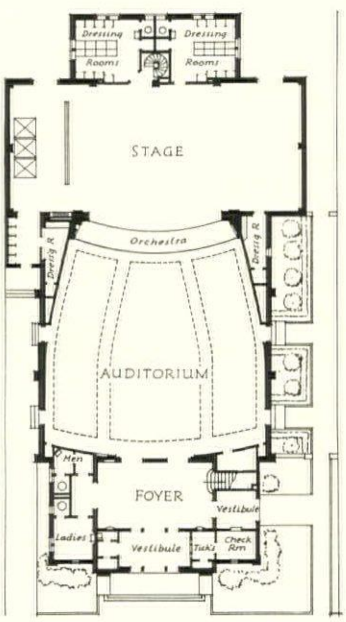
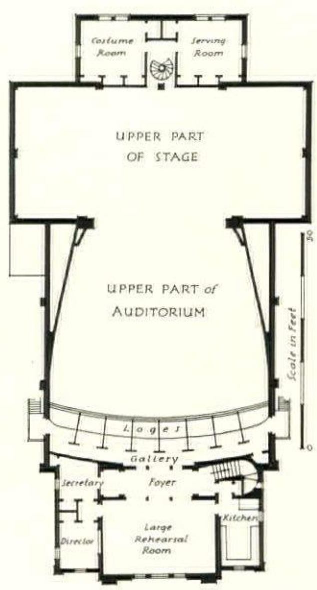


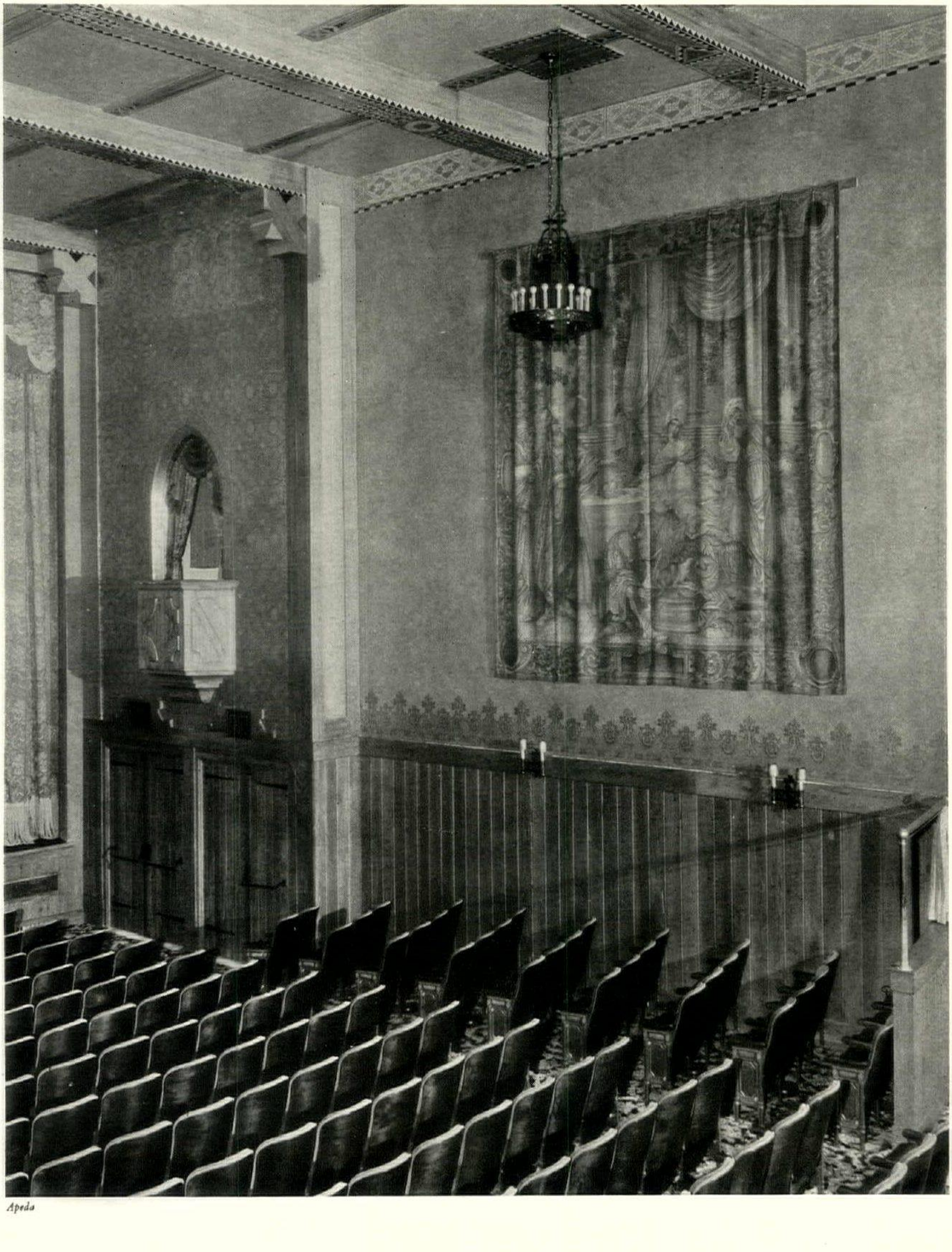
THIS building, completed in 1928, is built with a reinforced concrete foundation and floor slabs and hollow tile walls. The exterior is faced with stucco, trimmed with brick and stone. The roof is covered with clay tile on the pitched areas and with composition on the flat decks. The interior is plastered throughout. The floors in the lobby and vestibules are slate, and in the remainder of the building, wood. The building contains 345,000 cu. ft., and cost $100,000, or approximately 29 cents per cu. ft.



DALLAS LITTLE THEATER

DALLAS, TEXAS

HENRY COKE KNIGHT, ARCHITECT

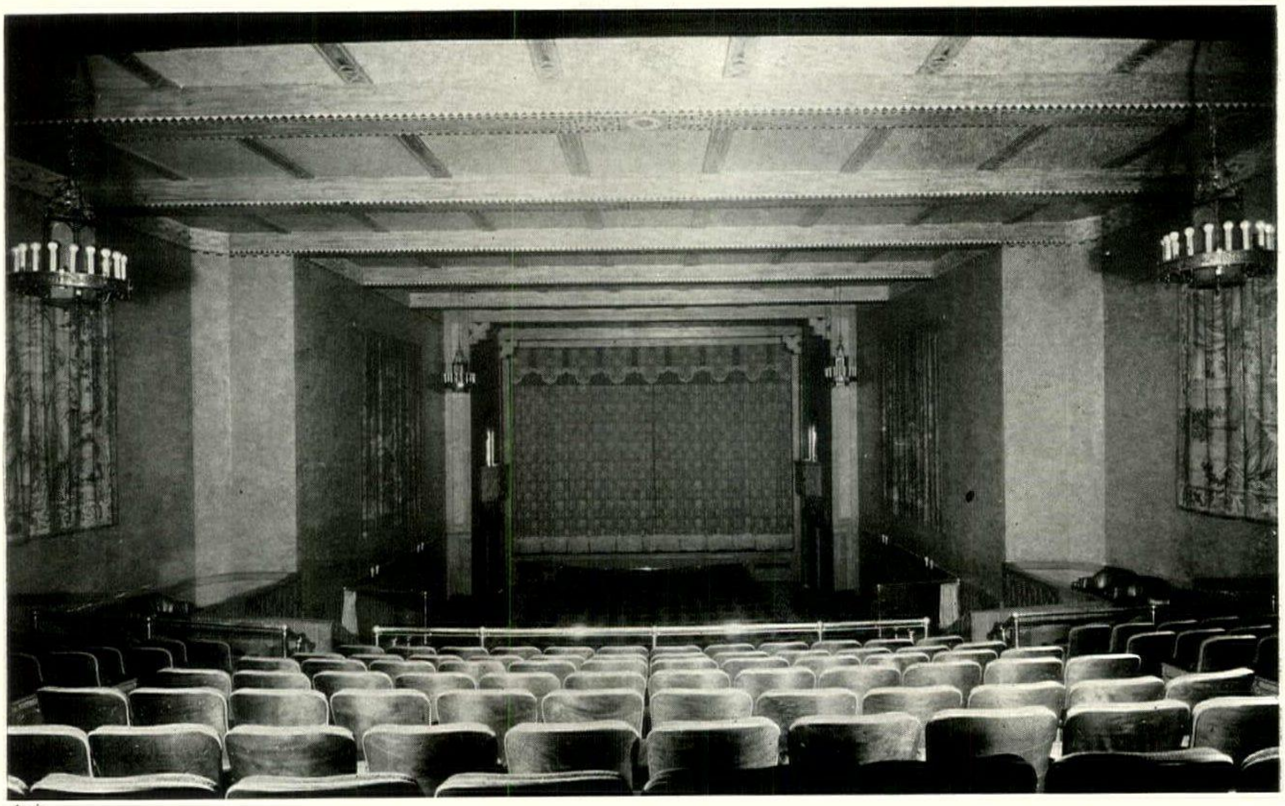


Apeda

LITTLE PLAZA THEATER

NEW YORK, N. Y.

HARRY C. INGALLS, ARCHITECT



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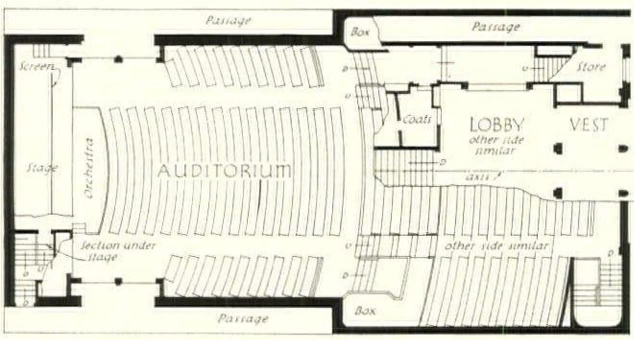
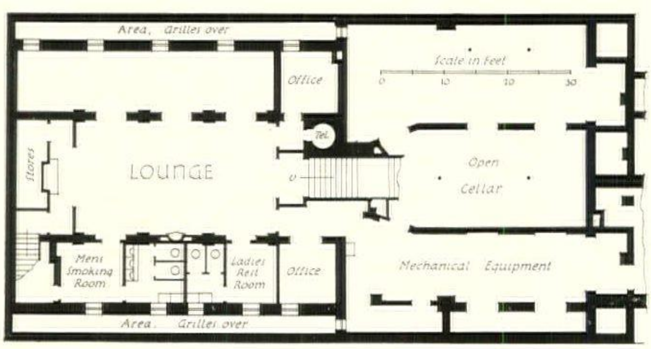


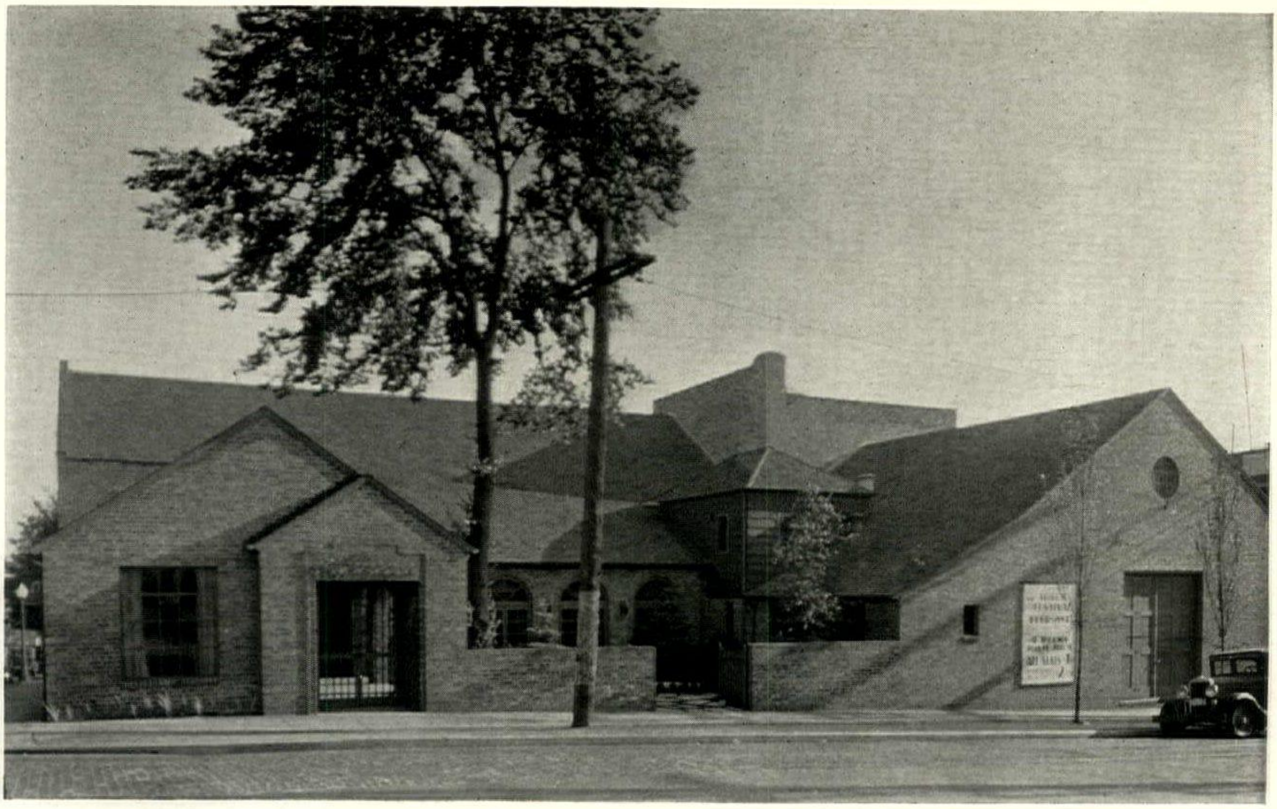


THIS theater, planned for the presentation of motion pictures alone, was remodeled from an old stable. The walls throughout the building are of rough, hand-made plaster tinted in parchment shades. The wainscot is of cypress, rich brown in color. The lighting fixtures are of hammered, antique-finish metal and the upholstery of the chairs is dark red. The beams of the auditorium are decorated with bright colored stencils in keeping with the period design of the room

LITTLE PLAZA THEATER

NEW YORK, N. Y.

HARRY C. INGALLS, ARCHITECT



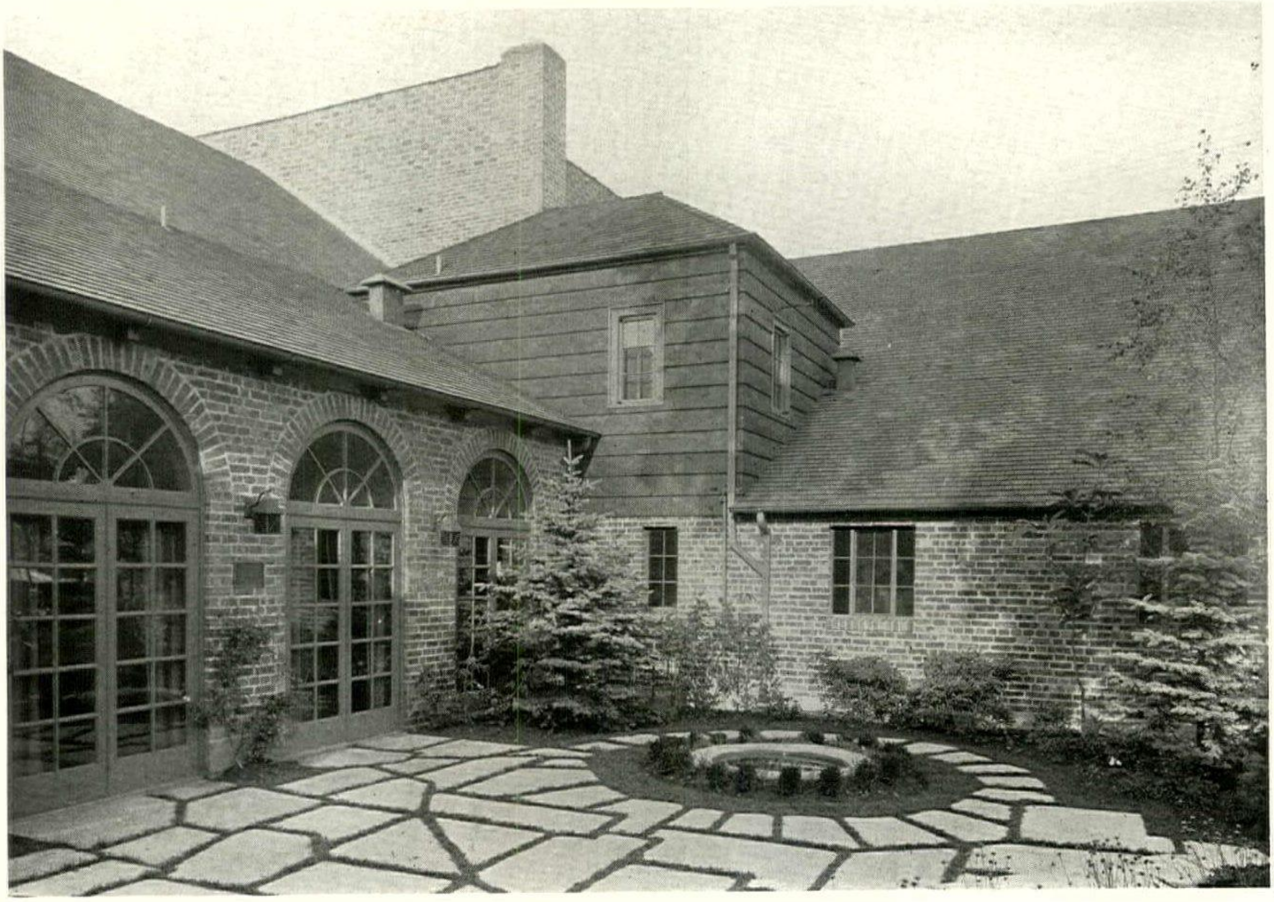
THIS building is the result of an alteration to an abandoned store. The exterior is faced with common brick laid in light, buff colored mortar. The trim is of natural color wood and the pitched roofs are covered with shingles. The illustration at the right is typical of the interior treatment. The brick walls have been painted a putty color, and the exposed wood of the ceiling stained a blue-green. In the lounge the floor is laid in dark blue asphalt tile; elsewhere throughout the building the floors are of cement

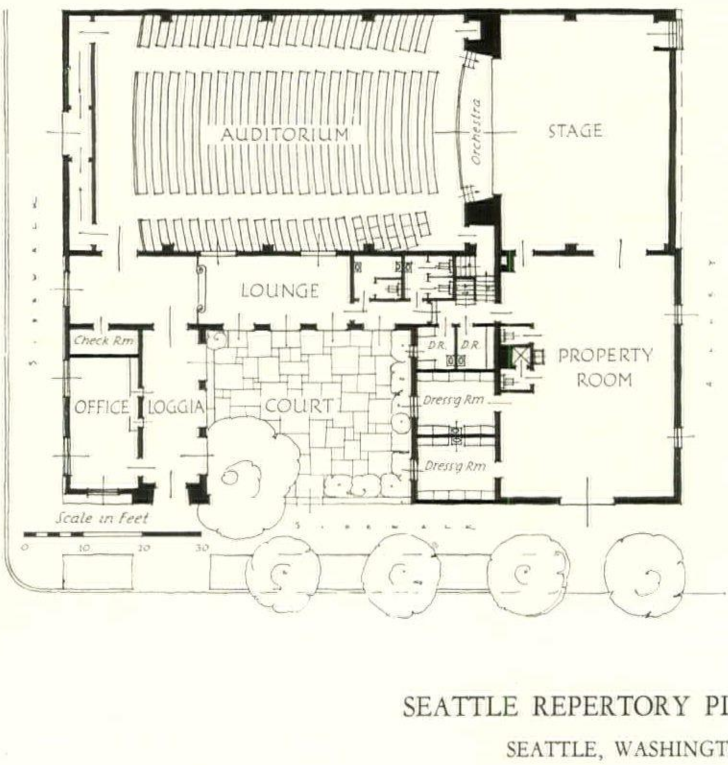
McBride & Anderson

SEATTLE REPERTORY PLAYHOUSE

SEATTLE, WASHINGTON

ARTHUR L. LOVELESS, ARCHITECT





SEATTLE REPERTORY PLAYHOUSE

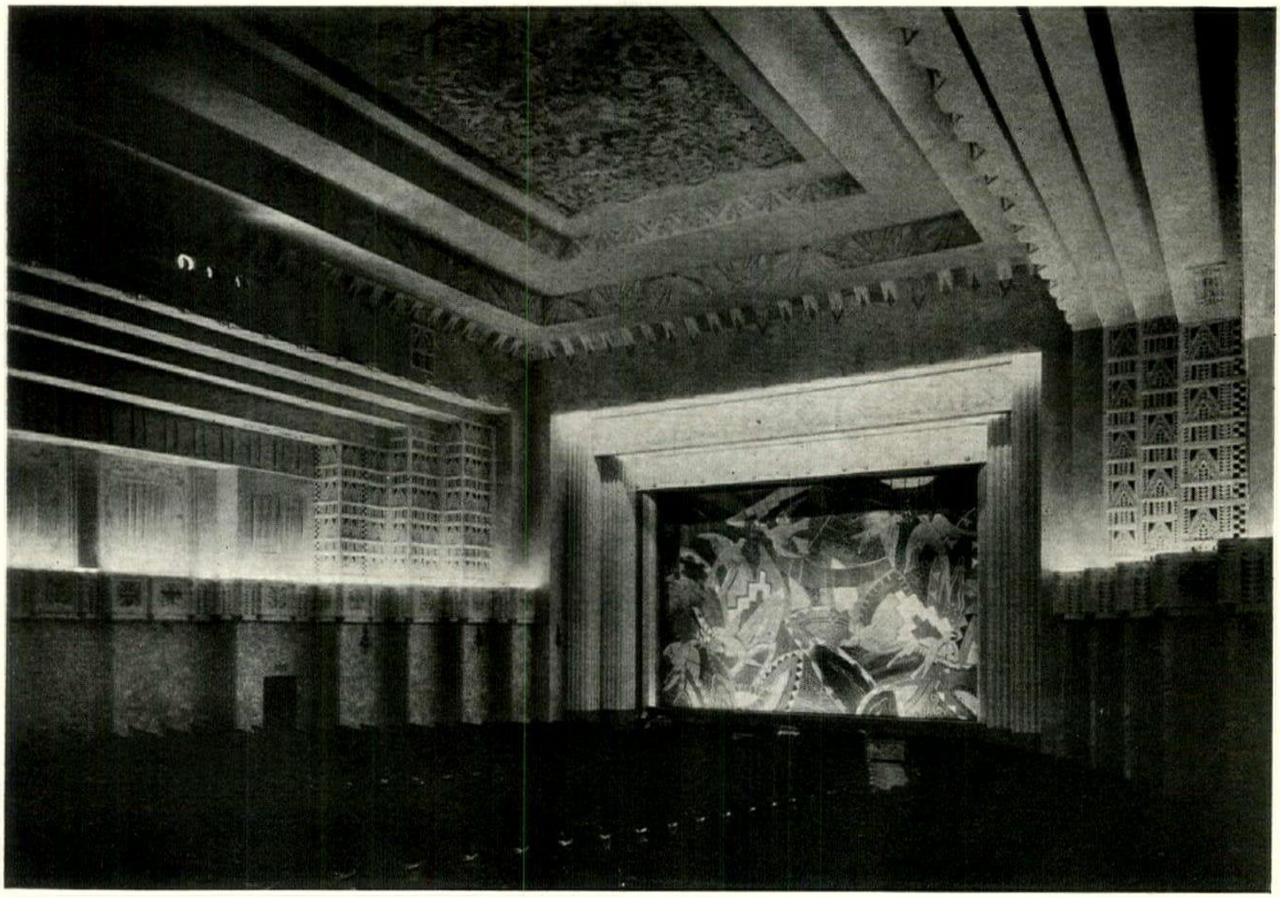
SEATTLE, WASHINGTON

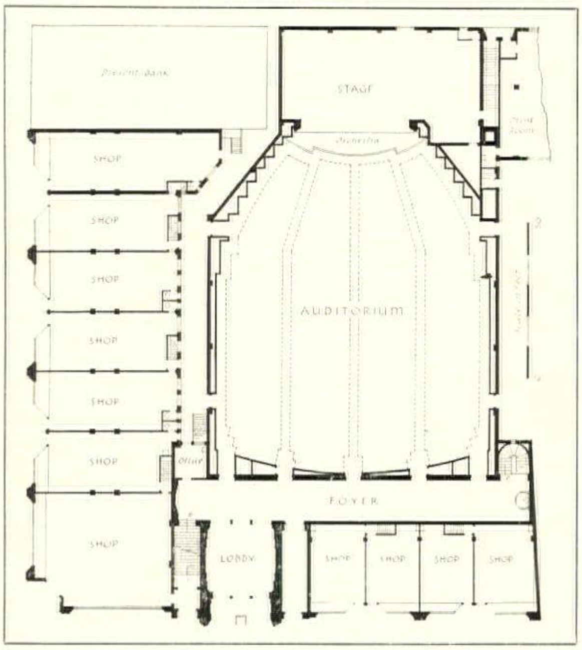
ARTHUR L. LOVELESS, ARCHITECT

PICKWICK THEATER

PARK RIDGE, ILLINOIS

R. HAROLD ZOOK, ARCHITECT

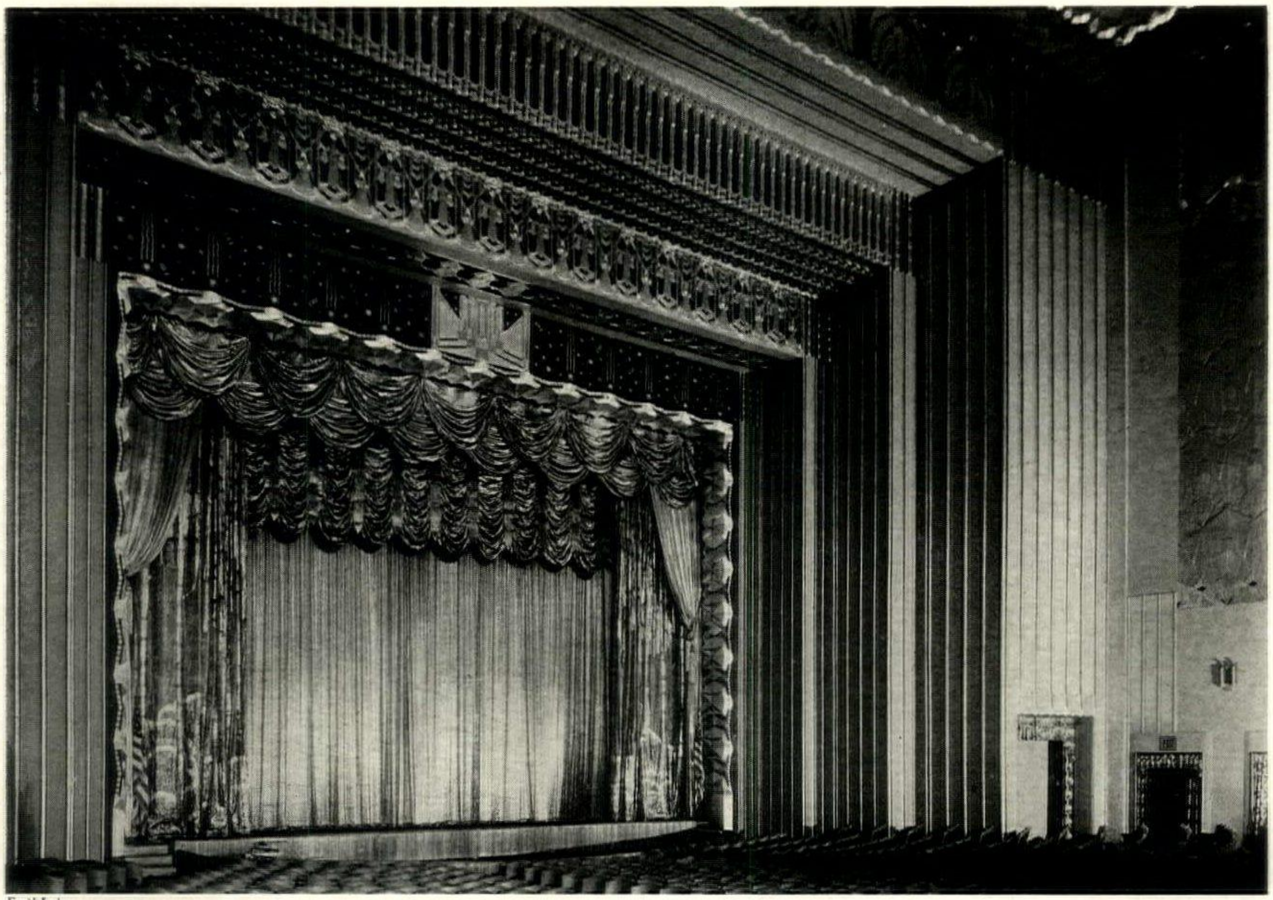




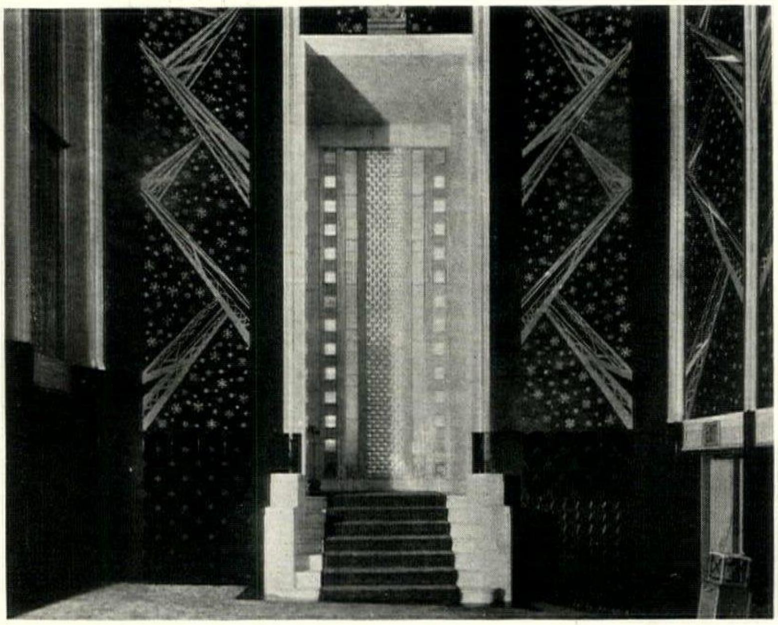
PICKWICK THEATER

PARK RIDGE, ILLINOIS

R. HAROLD ZOOK, ARCHITECT



Emil Luks

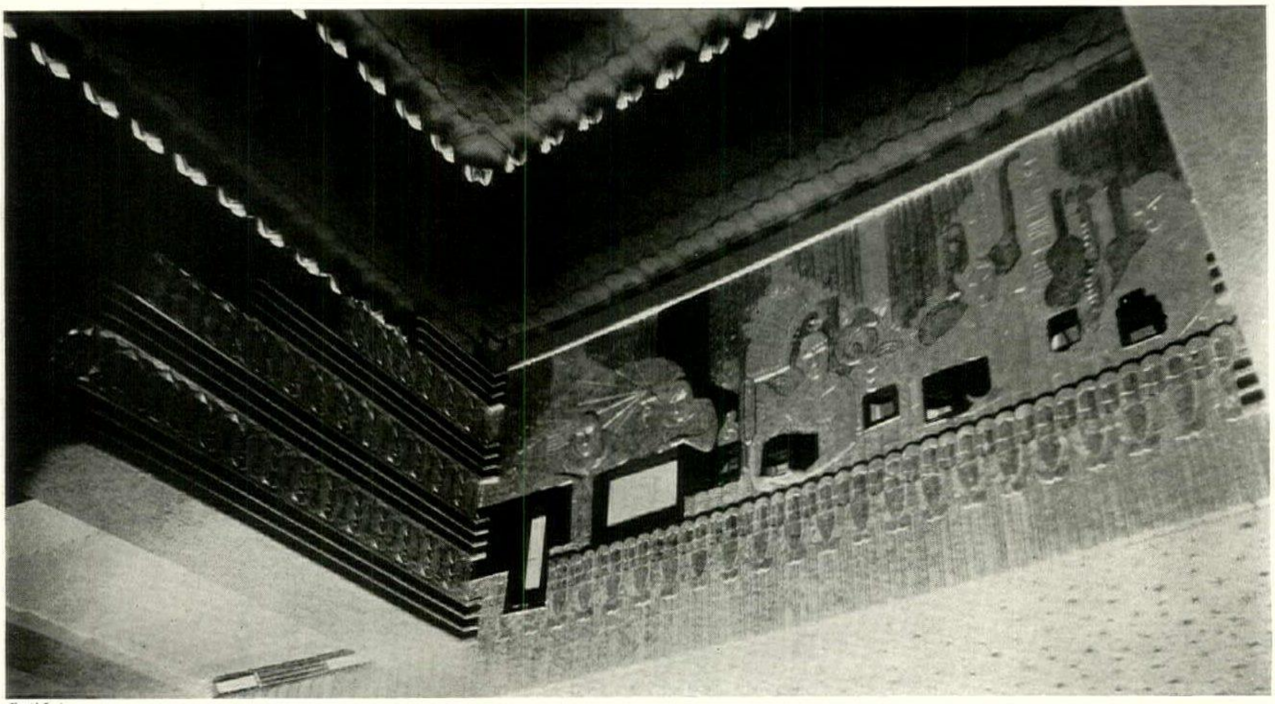


THIS theater which has a capacity of 3,500 persons is equipped for both motion picture presentations and legitimate stage performances. The color scheme in the auditorium shown above is blue, rose and silver, accented with black and gold. The illustration at the right is one of the doors leading from the lobby to the mezzanine. The lobby walls are faced with black glass decorated in blue, silver, rose and black. The stairs are of white marble. The illustration at the top of the following page shows an unusual treatment of the wall enclosing the projection booth. The figures are modeled in plaster and decorated with silver and black

STATE THEATER

PHILADELPHIA, PENNSYLVANIA

RALPH B. BENCKER, ARCHITECT



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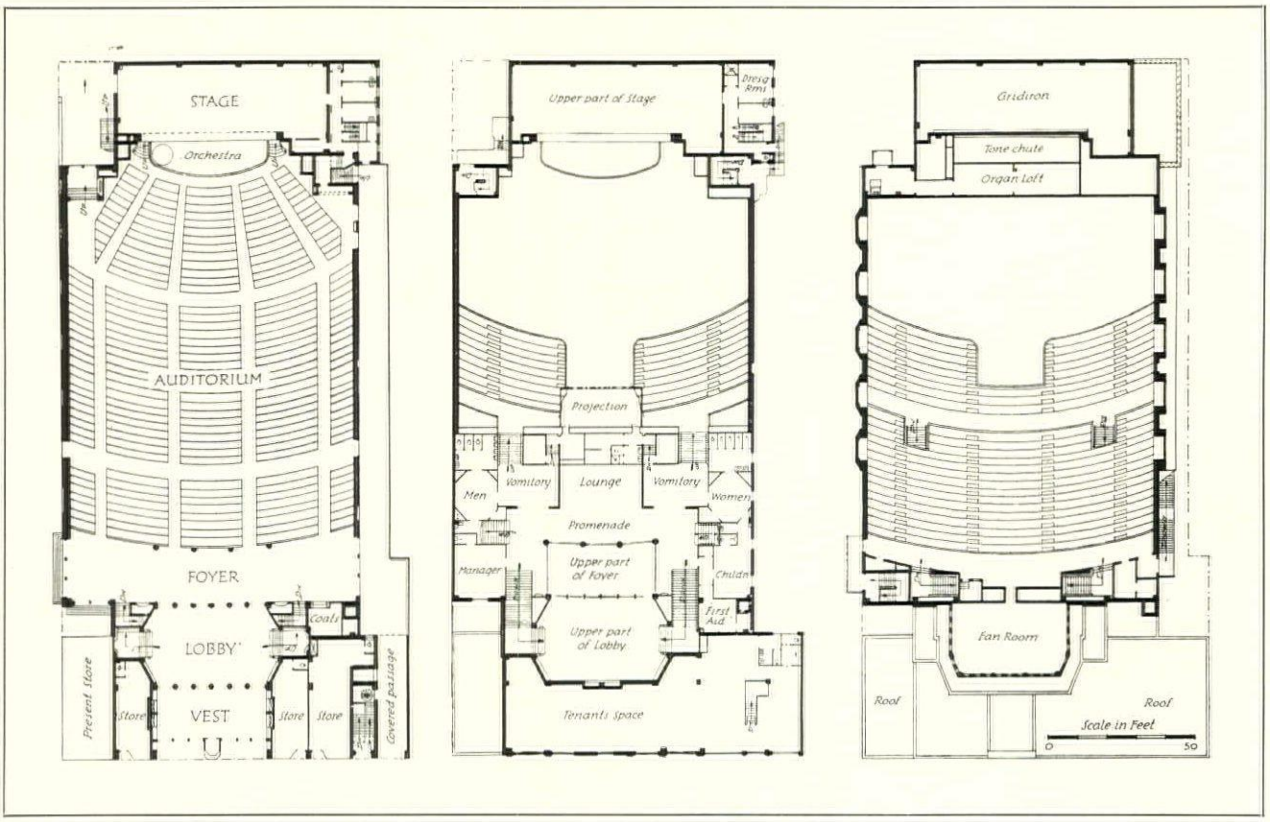
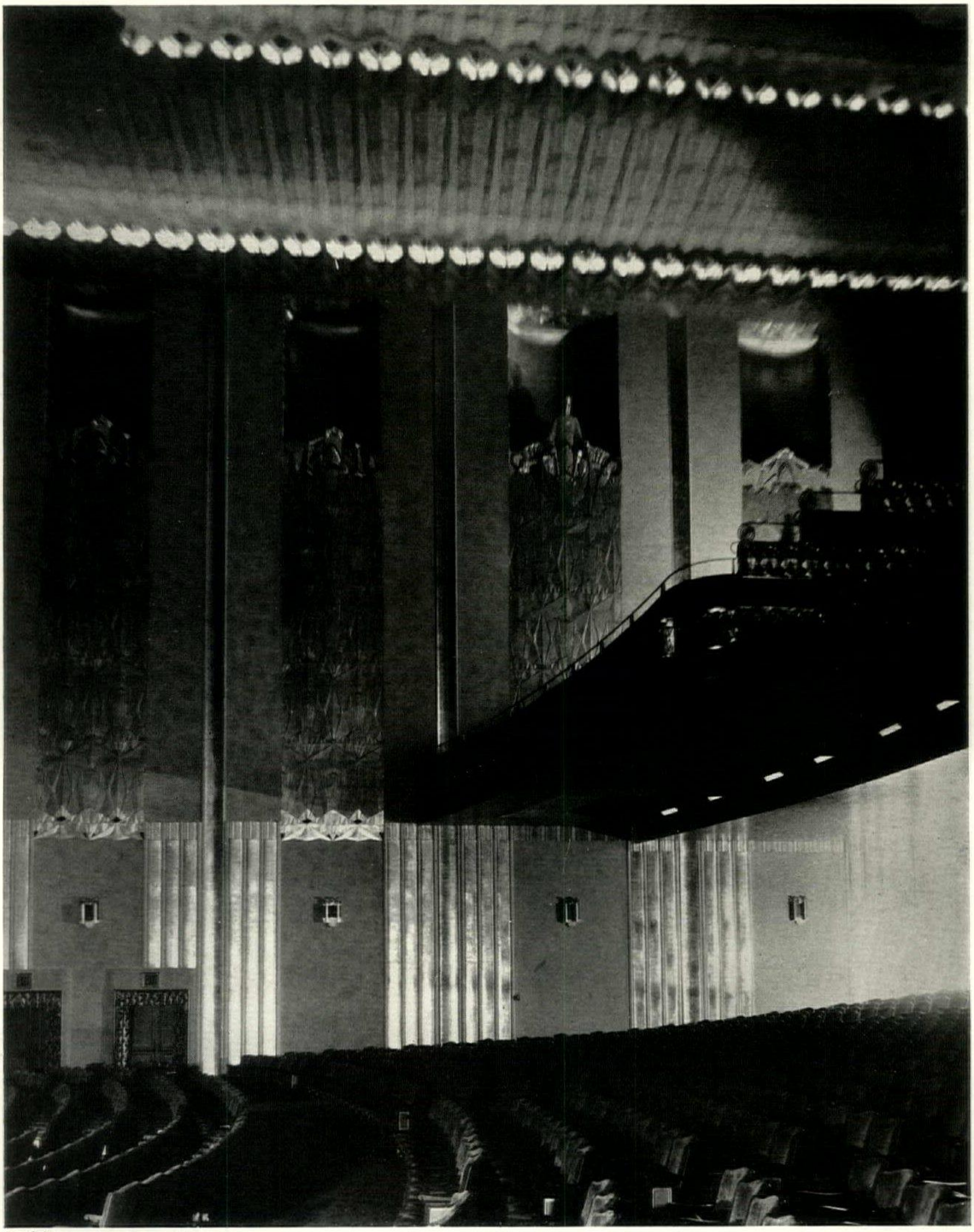


STATE THEATER

PHILADELPHIA, PENNSYLVANIA

RALPH B. BENCKER, ARCHITECT

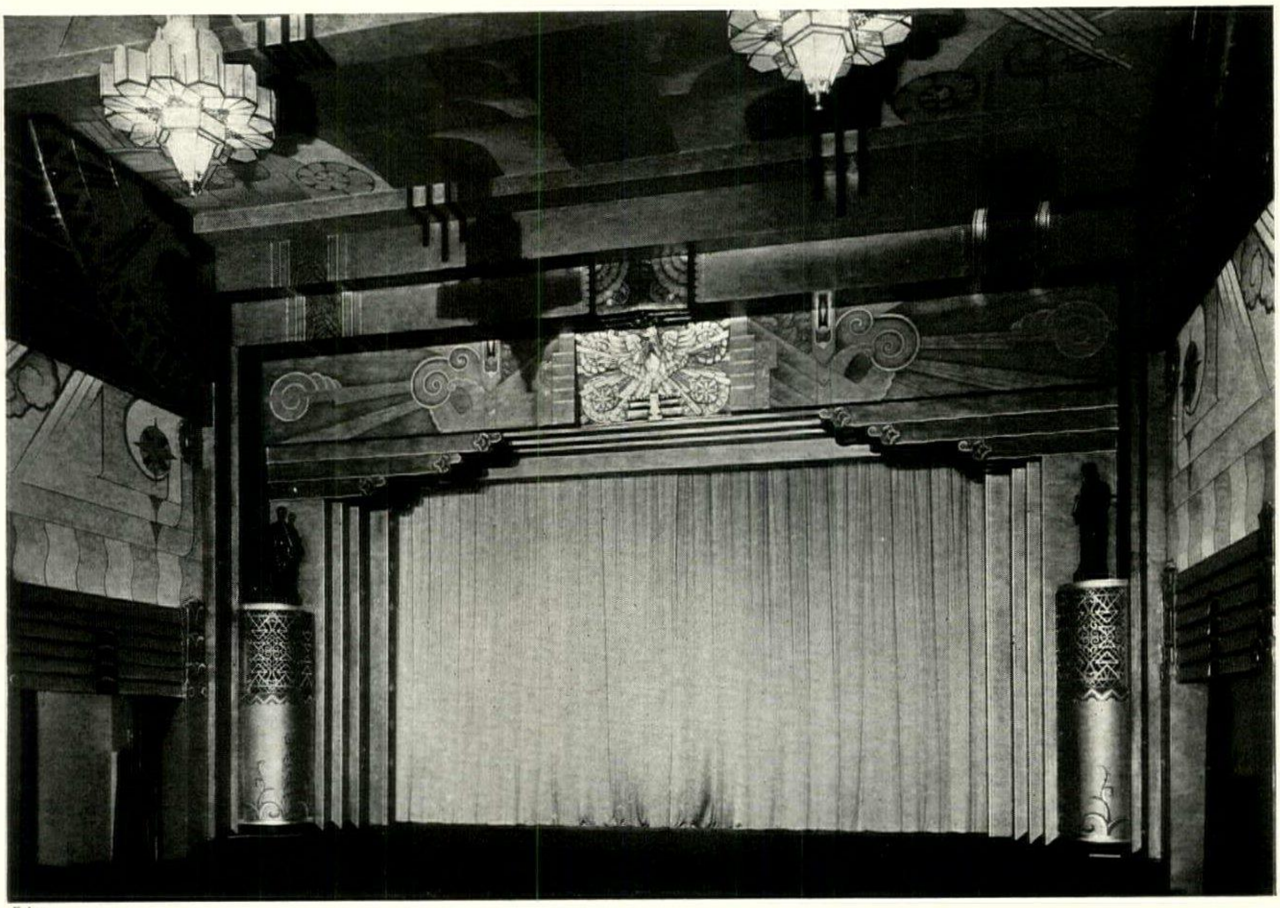


Emil Luks

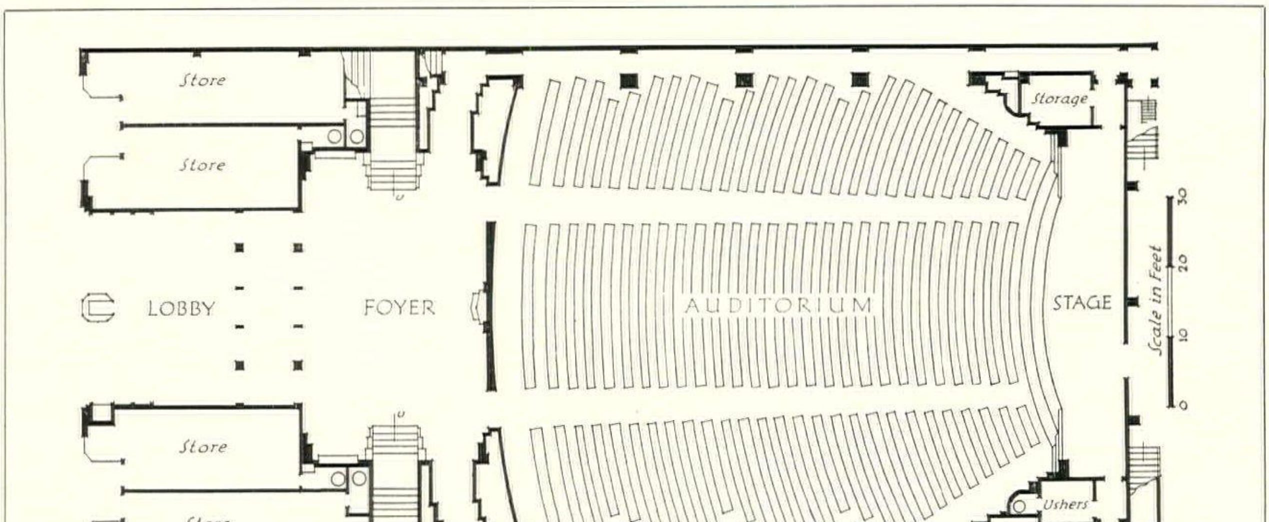
STATE THEATER

PHILADELPHIA, PENNSYLVANIA

RALPH B. BENCKER, ARCHITECT



Folger



BAYWOOD THEATER

SAN MATEO, CALIFORNIA

S. CHARLES LEE, ARCHITECT

Woodcock

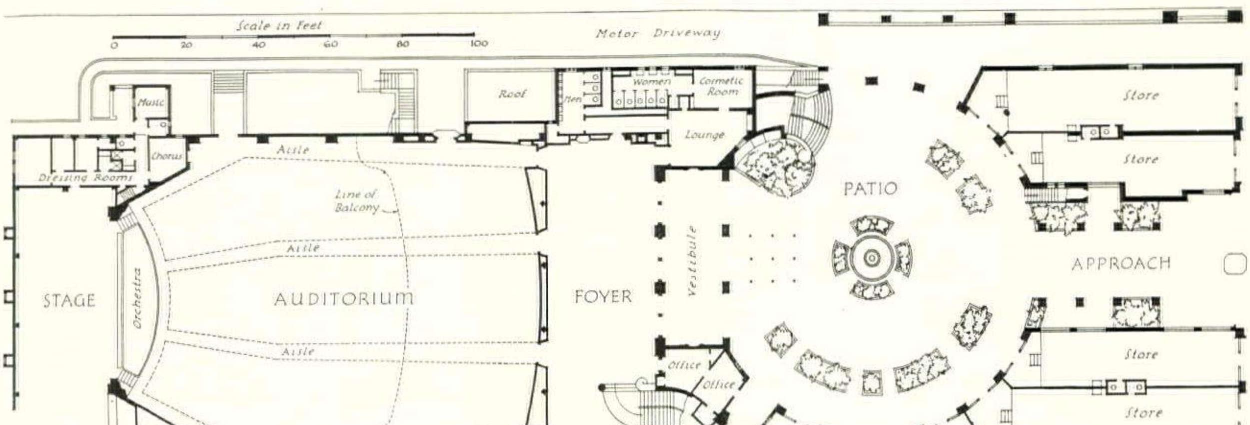
FLORENCE THEATER

LOS ANGELES, CALIFORNIA

S. CHARLES LEE, ARCHITECT

Folger

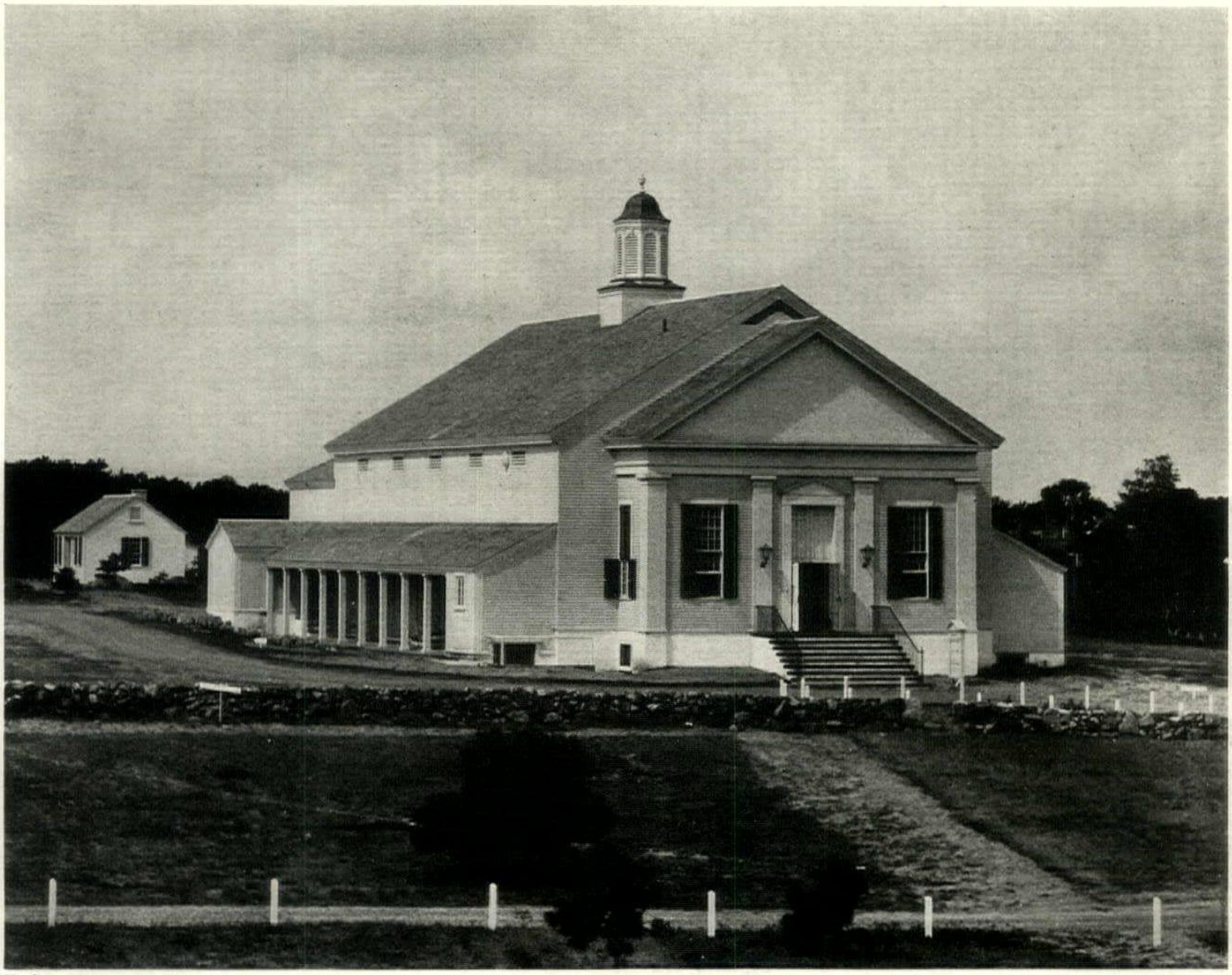
The illustration on the preceding page is of the mezzanine lounge. Above is a view of the patio, looking toward the theater entrance from beneath the arch of the approach



FLORENCE THEATER

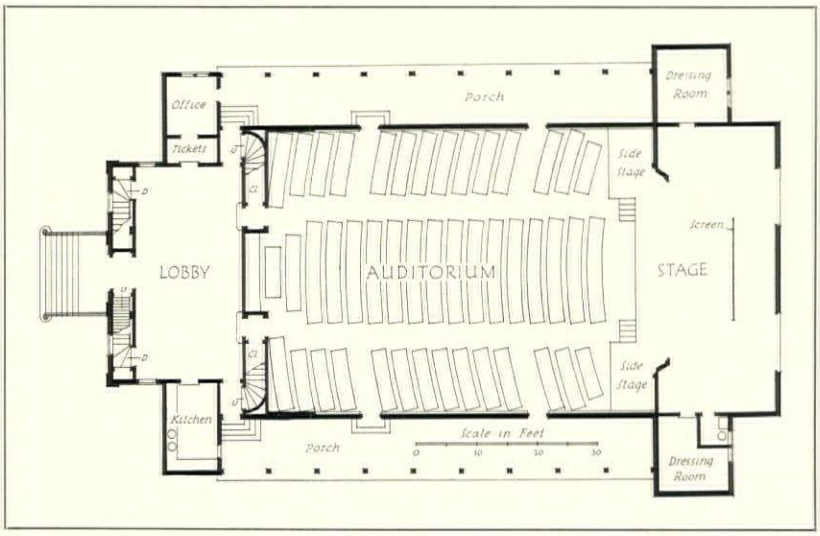
LOS ANGELES, CALIFORNIA

S. CHARLES LEE, ARCHITECT



Vandamm

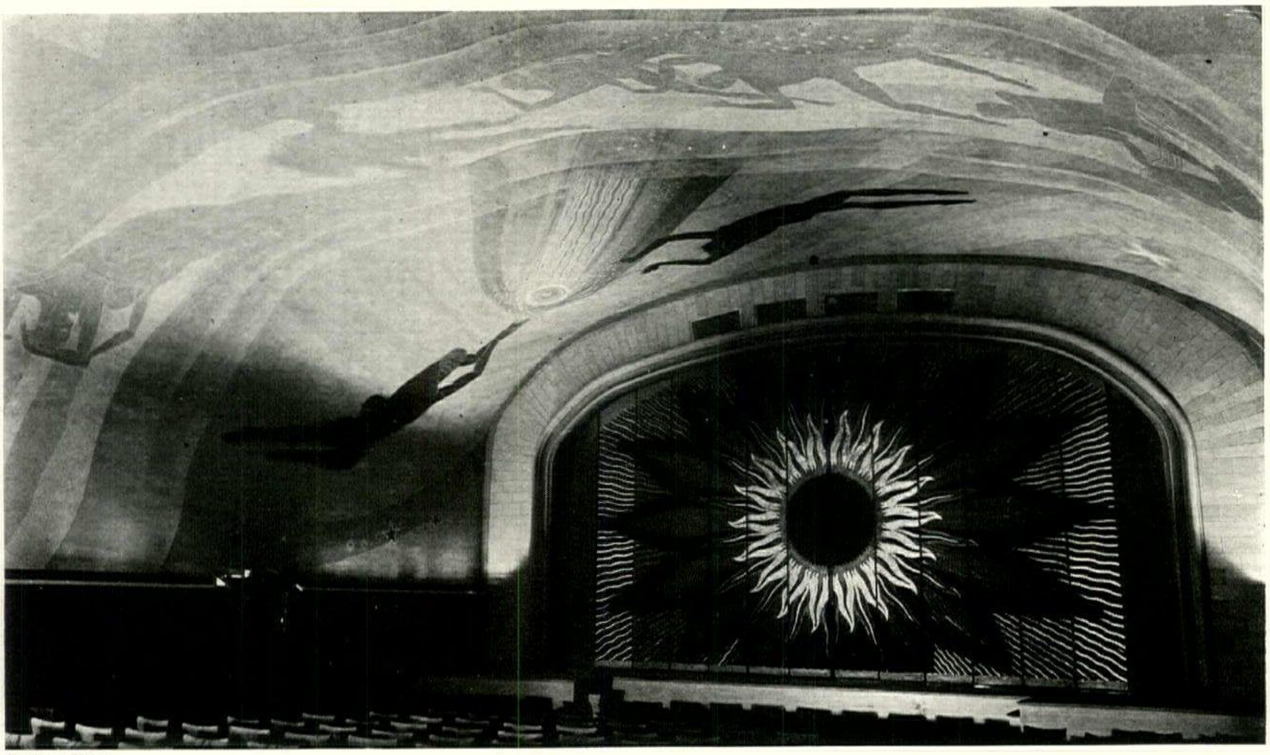
IN SPARSELY settled communities a theater often serves as a motion picture house, a legitimate theater, and a community meeting hall as well. This building has been designed for all these purposes. Particularly interesting in this connection is the inclusion of a kitchen and porches on either side of the building. The illustrations on the following page are of the auditorium, the ceiling of which was decorated by Rockwell Kent



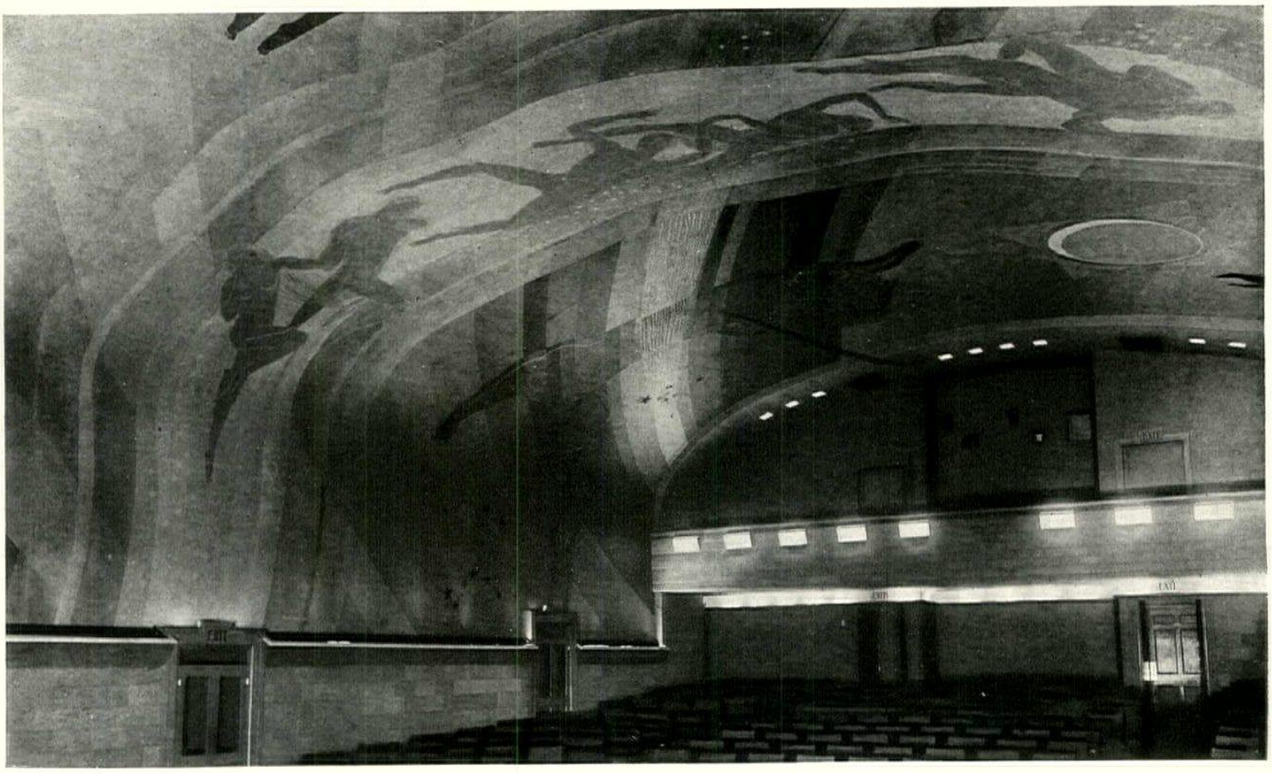
CAPE CINEMA

DENNIS, MASSACHUSETTS

RODGERS & POOR, ARCHITECTS



Vandamm Photos



CAPE CINEMA

DENNIS, MASSACHUSETTS

RODGERS & POOR, ARCHITECTS

THE EDITOR'S FORUM

ARCHITECTS AND THE R.F.C.

THE use of Federal money under the provisions of the Reconstruction Finance Corporation has been safeguarded as far as engineering projects are concerned by the appointment of an advisory board of engineers. This should insure expeditious, economic and efficient control of the engineering projects which form so large a part of the relief work under the R.F.C. provisions.

It is equally important that a thoroughly competent committee of architects be appointed by the administration to cooperate with the Reconstruction Finance Corporation in selecting the projects for slum clearance and housing which will be submitted to obtain the moneys made available through the R.F.C. It is imperative that such a competent body of architects be created to choose only such projects as have real social, economic and architectural values. Any course which permitted the use of these Federal funds for the erection of speculative construction for mere purposes of private profit and the advancement of real estate values without regard to determining social needs would be disastrous to the cause of housing. This obviously implies that the organized bodies of architects, the Construction League of the United States, the Building Congresses and civic bodies, all vitally interested in housing, must continue their efforts to be of assistance to the Reconstruction Finance Corporation and the administration in order to insure that the slum clearance and housing to be undertaken shall be of value to the community and shall set progressive standards for the nation.

The lack of knowledge of the provisions of the Emergency Relief Law on the part of both State and municipal officials will prevent the best uses of the R.F.C. funds unless local architectural bodies undertake to present the facts to them for action. The provisions of the new relief law must be interpreted in the light of State and municipal constitutions and charters to determine the possibilities of using R.F.C. funds for slum clearance.

THE public, the politicians and the press are being awakened to the need and the opportunity of slum clearance and housing. Though it is deemed a "relief measure" for an unemployment emergency, a few who think more clearly see the opportunity to use the present interest as the entering wedge to far-reaching changes and long-term programs for the progressive betterment of living standards through the production of housing environments more conducive to those higher standards. Many interested in housing are formulating Utopias; many prefer to *jump* to new ways of living and new means to their ends and would arrive by one bold stroke, changing habits, customs, procedures, at one fell swoop, to start on an entirely new basis; others scoff with a shrugging "nothing can be done about it."

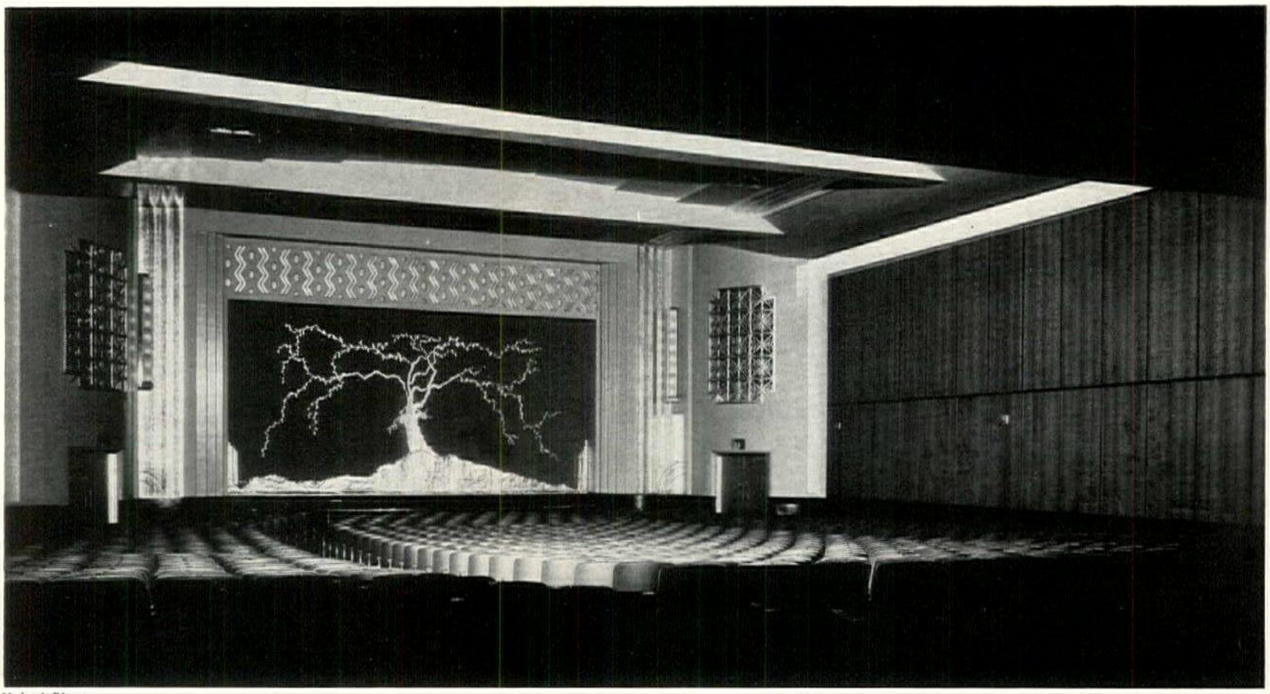
Yet the present legislation makes possible step-by-step progress, however irking it may be to those who would jump, or how prodding to those who shrug. "There will be no housing" — until the initiative is taken in spite of the shortcomings, the "lacks" which we listed here in July. We cannot wait to bring about ideal solutions to the problems of land and its ownership and control, of financing, of taxation, or wait for new housing-corporation laws or new "performance" building codes and all the rest, but some progress can be made in each and all of these directions. Starts have been made in attempting the solutions of each of these problems and it is incumbent on the organized bodies of the building industry to formulate their policies in regard to each and to adopt active programs listing step by step their objectives.

EVEN though the present systems of land ownership, taxation, financing and construction seem to preclude building for the lowest income groups, it is necessary that developments for the lowest possible rentals be constructed *now*, and at the same time changes in State or municipal control and laws be undertaken to make possible really low-cost housing.

The most important immediate step is one of action in putting in motion a "first case" involving housing with the aid of the Federal Reconstruction Finance Corporation to establish a procedure for its slum clearance program. The R.F.C. has not had time either to formulate its policy in this regard or to establish its personnel, but actual projects must be made ready in plan immediately for submission to the Corporation when it becomes active in order that actual construction work may be started this fall. New York is one of the few States which has the requisite housing and limited-dividend corporation laws to enable it to take advantage of the R.F.C. funds. Projects and plans, both architectural and economic, are now under the consideration of the State Board of Housing awaiting its approval and subsequent submission to the R.F.C.

Kenneth K. Stowell

EDITOR



Hedrich-Blessing

The auditorium of the Loyola Community Theater at Chicago, Ill., A. N. Rebori, Architect

NEW PURPOSES, NEW THEATERS

BY

ALEXANDER DEAN*

IT IS a generally accepted theory that as an institution changes in its purposes, ownership and uses, the concepts of its architectural qualities and the form of its practical expression vary radically to conform to its new conditions. This acknowledged theory fails when there is a lack of realization that the institution has actually changed.

In days gone by a theater meant to an architect a certain concept. It usually brought to mind a romantic façade with exaggerated decoration (which was squeezed into a hundred foot frontage and bordered either by other screaming ornamentation or by ordinary store fronts), and an auditorium, bizarre and elaborate, having maximum capacity. The theater itself was behind the neighboring buildings.

At the same time that this was a concept of a theater there were also definite ideas of what a Little Theater was, and what a college or high school stage should be. They represented three entirely different ideas because the purposes and ownership and uses of each were so varied.

There will probably be very few theaters constructed in the next ten years of the kind first pictured — the speculative, commercial theater building. The theater of that sort is dead, except in a few large centers where there are already too many theater buildings. The competition of motion pictures, the cost of railway transportation, the "fleecing" policies of some commercial managers, the inconvenience of traveling to the big stars — these are the pall bearers.

Although this is the prevailing condition of the professional theater, drama is not dead. It is very much alive and vastly improved in quality. The original mass of theater-goers now finds relaxation at the movies. People who patronize the theater go not blindly and casually for something to do, but for the particular purpose of seeing a certain play. This change has raised the standard of the American drama. The theater today is for a smaller number of people, but those few have an exacting, critical

*Assistant Director of the Yale University Theater and Assistant Professor of Play Production.

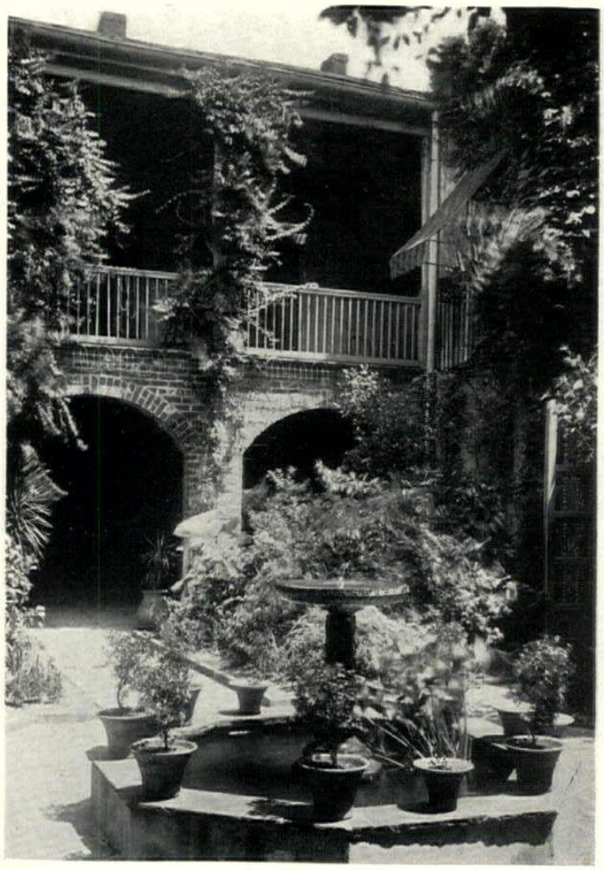
standard of values, a rich background of taste and knowledge of the drama as a form of literature, and an intellectual as well as an emotional criterion of judgment in art values. This has been one of the main reasons for the building of smaller theaters. The mob goes to the movies.

This changed quality of the theater-going public exacted something different from the dramatic production — a new purpose. Not only did this changed audience insist upon the worthwhile drama, but they required it to be produced with added qualities contributed by a stage artist and by a play interpreter. Originally the stage setting and lighting which merely defined place and a rough approximation of time were satisfactory. Now the spirit of the play must be reflected by an artist through style, mood and atmosphere. When Robert Edmond Jones gave us his famous setting in 1915 for "The Man Who Married a Dumb Wife," he established the value of the artist in the theater, working beside and with the director, the actor and the playwright. All this enlargement in purpose of the dramatic performance has made the production of a play an art expression.

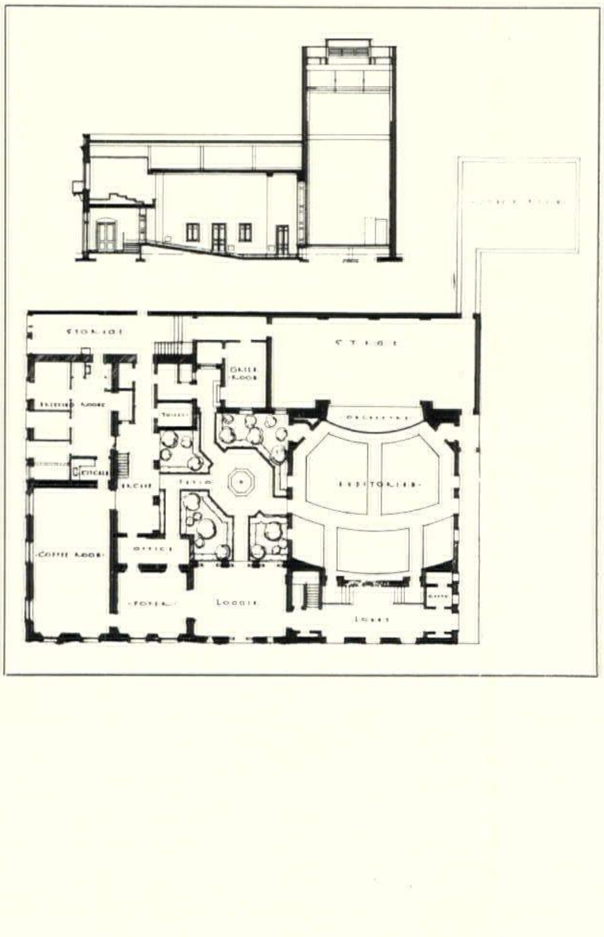
The theater must now be a highly equipped building with complete mechanical rigging for the hanging of scenery and its changes, a huge expanse for an exterior cyclorama, extensive lighting equipment with a large and easily controlled switchboard. This introduction of the artist and his requirements into the theater naturally makes greater demands on the theater architect. The importance of the stage itself has come into its rightful relation to the rest of the building.

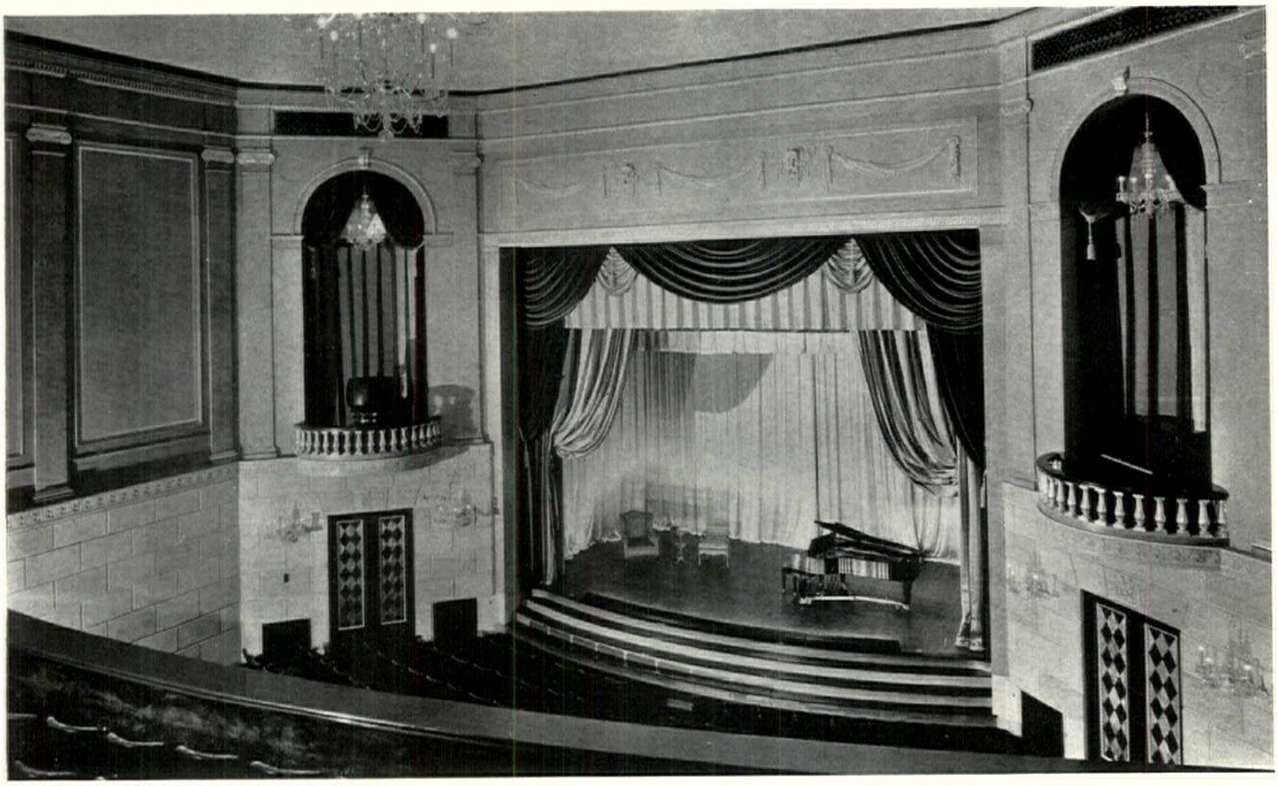
Another change which concerns the architect in planning the relationship between the stage and the auditorium is the more naturalistic style of directing. This is obtained by utilizing a third dimensional element in the stage picture, by using the full stage within the set as a real place, by allowing the actors to play in the extreme upper left and right corners. Lining up the actors in a straight line, choruslike, or in a semicircle, minstrel manner, has given way to a more lifelike picturization, even in the amateur theater. This restricts the auditorium so that it can be little wider than the proscenium arch. A broad-angled auditorium requires the director to keep his actors within the sight lines and forces the use of the center and the two down-stage side areas repeatedly. No director with this limitation can produce a play so as to reflect, by means of his actors, the mood and style values necessary. He must have the full space of the stage, and that space must be made visible to all parts of the auditorium. This has led to the omission of the old side boxes. For this reason also the center aisle is a thing of the past and in its place are the most desirable seats.

The change in manner of directing results in a more intimate and "ensembled" style of produc-



The courtyard of *Le Petit Theatre du Vieux Carre*, New Orleans, La., Armstrong & Koch, Architects. This theater has been developed from the alteration of two old buildings. It was designed to serve an amateur organization, and the social side of theater activities has been emphasized throughout the plan




Richard Averill Smith

The interior of the Civic Auditorium at Kalamazoo, Mich., for which Aymar Embury II was the architect, has been completely equipped for elaborate legitimate performances, and is an outstanding example of a project of this kind

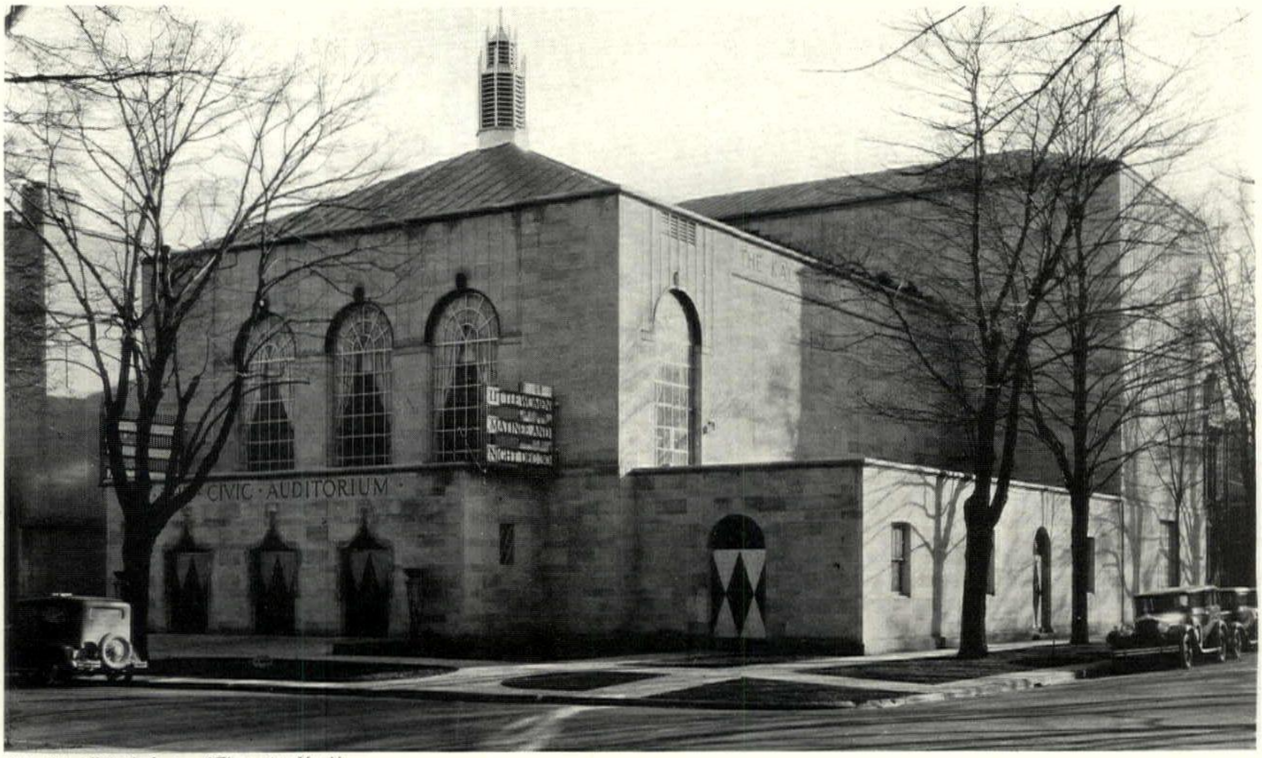
tion. Actors no longer play a rôle to make it an histrionic display but endeavor to show its relation to the other characters and to the idea of the play itself. They no longer "play to the gallery" — there is no gallery to play to. Elocution has gone, and the natural projection of the voice must be heard.

The Little Theater movement has a tremendous influence. Without discussing all of its principles, two important ones concern us here. First, it was amateur insofar as the workers labored for the love of the theater, and, secondly, it immediately incorporated the principles and services of an art director. Influenced by the theories of Gordon Craig, it attempted to produce plays as an artistic unit. For several years these groups were known as Art Theaters because they practiced these new production theories so vigorously.

It was at this time that light became a new and important factor on the stage. Inventions from Europe were quickly adopted by the Little Theaters here. Permanent cycloramas were built into the stage. Footlights were for a time abolished and indirect lighting was adopted. Architectural pieces with an actual third dimension took the place of painted perspective. Steps, ramps and platforms offered new opportunities for the director. The proscenium arch as a fourth wall began to lose its conventional significance, and the actor and the audience came into closer contact. Listing all the changes in the mechanical development of the stage itself is not in order here, but what should be emphasized is that this amateur theater required an intricate technical structure, and from the first practiced this new stagecraft.

Books, magazines and lecturers took up the movement. Courses in universities were given where directors of the Little, the University and School Theaters studied. The larger colleges quickly established their Experimental and Art Theaters as laboratories for this new and rapidly progressing theater. As a matter of interest, it was as an art instructor at Harvard that Mr. Jones began the experimentation of applying the principles of art to stage settings. So it was from the amateur theater in this country that the art director entered the professional theater.

This non-professional theater was developing rapidly just at the time when the professional theater, especially "on the road," was diminishing, and soon many cities had no theatrical performances except those that were produced by the local Little Theater. The directors of the Little Theaters became professional. Stages were built, equipped with the most recent theatrical inventions. Almost without exception the second paid worker was the art director with a full knowledge of the technical



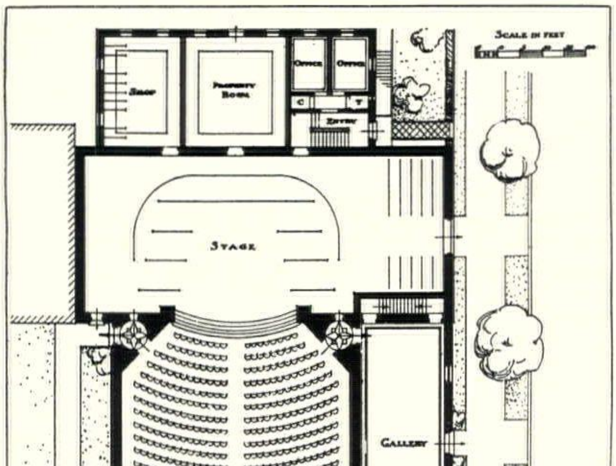
Richard Averill Smith, Courtesy of Theatre Arts Monthly

The exterior of the Civic Auditorium at Kalamazoo. In its simplicity of treatment it typifies the change and development in theater technique which has brought the community theater to its present state of importance

stage. This growth has increased (as the motion picture became more popular and as fewer productions left New York) until today these amateur theaters, with the professional theater now restricted to some dozen cities, are *the* theaters of the United States.

The School Theater is a very important development. Students brought into contact with the university theater influence have become school teachers and have carried the principles of the "new" theater into their productions. Many a town, too small to support even the Little Theater as a separate organization, depends entirely upon the school for its drama, and the school auditorium is its theater. Many are doing significant dramatic productions and using advanced stagecraft.

It has been necessary to trace at length this development in the change of ownership of the modern theater, because few people realize that the things which come to mind on mentioning the non-professional theater of the past are not what they should be today. Far too often they are thought of as places to put on an "amachurr show" or "private theatricals." At times there seems to be an attitude of contempt in feeling that any stage conditions will do. Accordingly, sight lines are ignored; stage floors are laid with hard wood into which no stage screws can be driven, space behind scenes is insuffi-

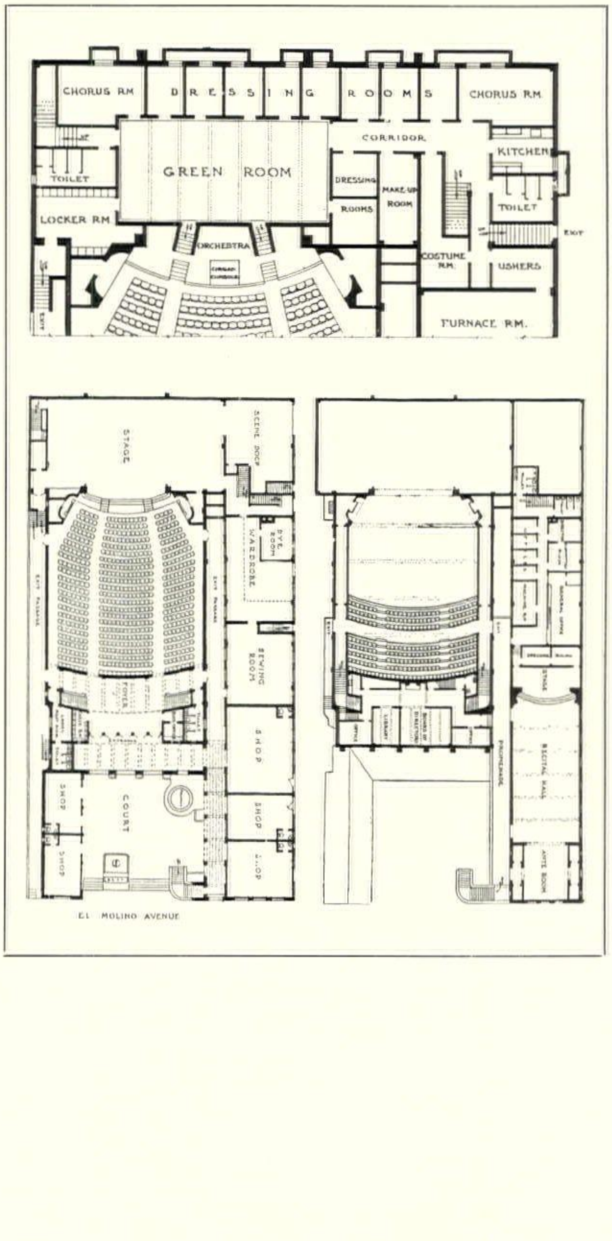


Hiller Photos

The Community Playhouse at Pasadena, Calif., for which Elmer Grey was the architect, is interesting for its emphasis on the social side of theater life. The Green Room, formerly an important part of every theater plan, is regaining its prominence. A view of it is shown above. The illustration below is of the main auditorium

Hiller

The patio of the Community Playhouse at Pasadena, California, is an important exterior feature, for it serves the double purpose of a lounging terrace and a central entrance to the small shops on either side



cient for the stacking of scenery and properties for three acts; doors to the stage are built too narrow to carry on the furniture; a huge apron to the stage is allowed to cut down the playing space; and the gridiron is not included.

Especially in the university theaters has there appeared a gross lack of consideration for the requirements of a modern stage production. It is essential that the university authorities ascertain the requirements and technical needs through the Director of Dramatics and that they bring about his full collaboration with the architect. Working together to solve their mutual problems the architect and director can produce the best result — working independently always ends unsatisfactorily.

The non-professional theater in its building is demanding more from the architect than it did when the drama was solely a commercial proposition. The Little Theater is a part of, and belongs to, the community. Although now privately owned, it is a civic institution. Its uses are increasing in number and scope. Its building is a matter of local pride and it has become a distinct landmark in the community. It is no longer part of a city block, but an entity by itself. The community theater does not depend upon the passerby for its patronage, and consequently does not need to be in a commercial center. It does need parking space and a proper and a beautiful setting. This change of the theater into a complete entity offers greater opportunities to the architect.

However, since it is the home of productions, the theater must have much larger working spaces and be more thoroughly equipped than the old professional theater which housed only the already rehearsed and assembled productions. It must have several rehearsal rooms. In addition, it should contain a small, experimental theater, especially if connected with the university. For the university there must be lecture and seminar rooms and offices for the faculty. Several productions in rehearsal at the same time further require more dressing rooms. There must be large storage space for scenery, lighting equipment, properties both large and small, and costumes. Adequate business offices should adjoin the box office. The Green Room as a social center for the actors has returned to the theater.

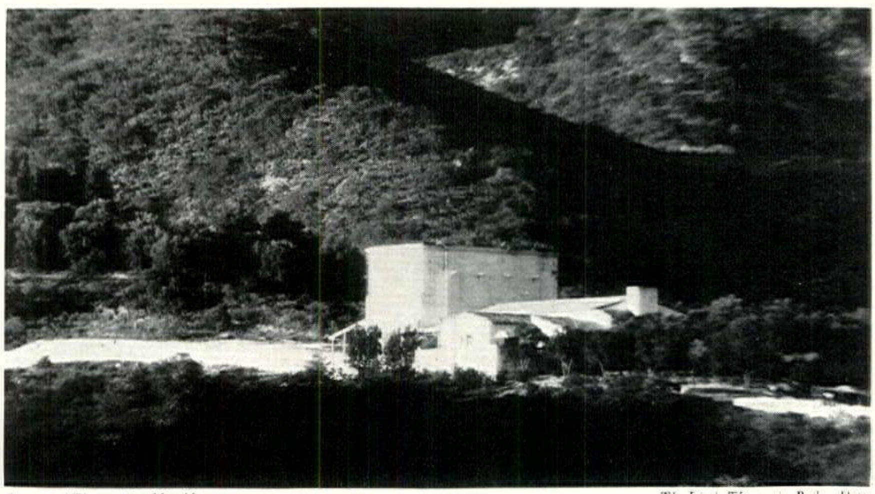
Another result of this change in ownership of the theater and in the development of its civic nature is its use for purposes other than dramatic performances. Many a Little Theater is being used for the housing of art collections and exhibitions. Certainly its foyer and lounges, if not especially planned rooms, should be designed for this purpose.

The auditorium is often used for concerts, lectures and community dramatic productions. This necessitates complete soundproof rehearsal rooms and workshops so that the work on the next production does not have to stop when the auditorium is being used for other attractions. It cannot be stressed too strongly that the working space for productions must be safeguarded against interruption when the auditorium is in use. The community theaters are taking on the aspect of the true art center and their officers are learning that the more uses an auditorium can have, the less of a financial burden it is for the theater corporation.

In the community theater the number of professional workers is increasing to include not only paid business managers and production assistants but even paid actors. This policy requires adequate rehearsal and workshop space. This future development should certainly be considered by the architect. It is not hard to imagine the day when these theaters will house those few first-class professional productions that dare to brave the road.

The community theaters frequently include the unusual motion picture in their activities. Pictures for children which have no place in the commercial picture theaters often form a Saturday morning series. Accordingly, the sound and sight equipment for motion pictures is becoming a required part of a community theater.

Changes in the purposes, the ownership, and the uses of the theater have produced a new theater, and the stage of the amateur *is* the theater of the present day America. These are the theaters which the architects are going to be engaged to design during the next twenty years. The Community, University and School Theaters must be thought of as places to house performances which will be produced with the highest standards of scenery and lighting and directing, and for which a general public will pay its hard-earned money. They require a stage and an equipment which are visualized as belonging to a first-class professional theater. In fact, they require much more because of their increased activities and uses. In the adjustment of the architectural design to the most exacting physical demands lies the architect's path to success.



Courtesy of Theatre Arts Monthly

The Little Theater in Padua Hills

RECENT EUROPEAN THEATERS

All photos by Herbert Felton

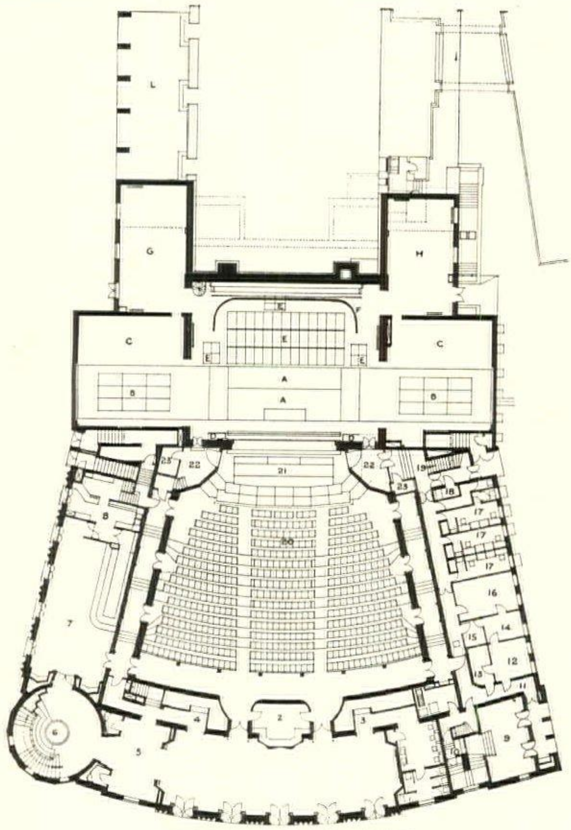
THE ENTRANCE FROM ACROSS THE AVON

SHAKESPEARE MEMORIAL THEATER

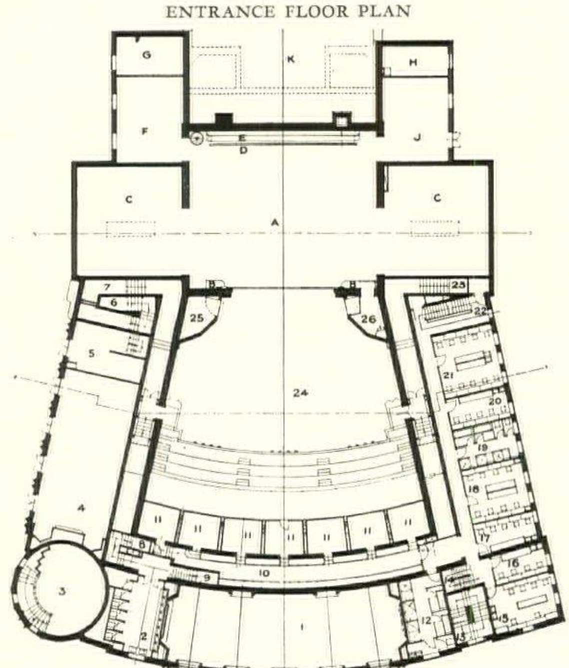
STRATFORD-ON-AVON, ENGLAND

SCOTT, CHESTERTON & SHEPHERD, ARCHITECTS

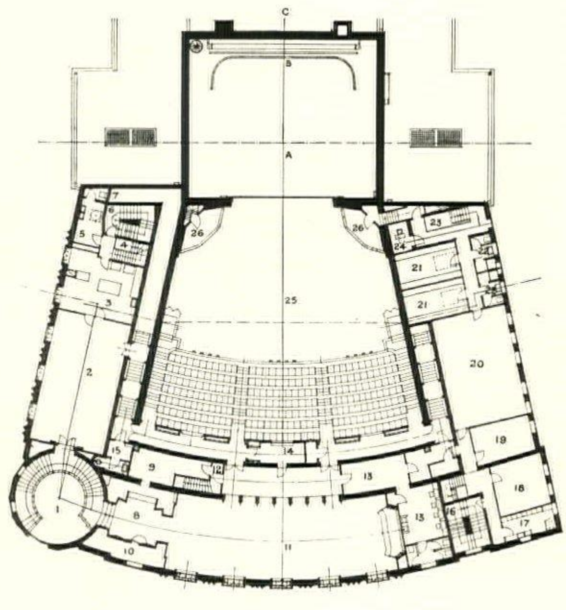
THE international competition for the Shakespeare Memorial Theater was won by Miss Elizabeth Scott in 1928. H.R.H., the Prince of Wales, opened the theater in April of this year. The theater is truly functional and expresses its balance admirably in its exterior masses. It is modern in its forms but classical in its simplicity and directness. The walls are of solid brick and the decoration is likewise carried out in the same material on the exterior. The interior walls of the entrance foyer and circular staircase hall are lined with a cream colored brick. The cantilevered marquee and entrance doors shown on the opposite page are finished with aluminum alloy and bronze. Blue Hornton stone is used for the window reveal lining. The theater has been made flexible for any type of Shakespearean production or for repertory, light opera or music. The plans are practically self-explanatory in their simplicity and directness. The stage lifts and the two rolling stages provide for the setting of three complete scenes in advance, with changes taking only 25 seconds. The proscenium is 30 ft. wide, and the stage lifts occupy the whole acting area. These lifts are suspended and counterweighed



ENTRANCE FLOOR PLAN



MEZZANINE PLAN



DRESS CIRCLE PLAN

SHAKESPEARE MEMORIAL THEATER

STRATFORD-ON-AVON, ENGLAND

SCOTT, CHESTERTON & SHEPHERD, ARCHITECTS

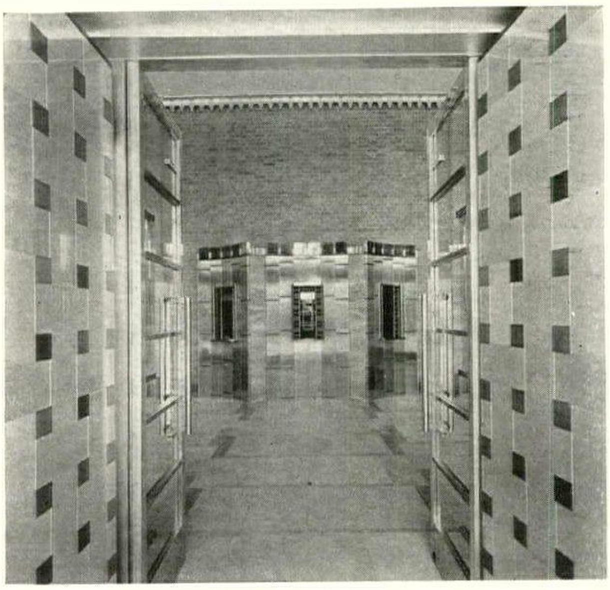
NORTH ENTRANCE AND MARQUEE

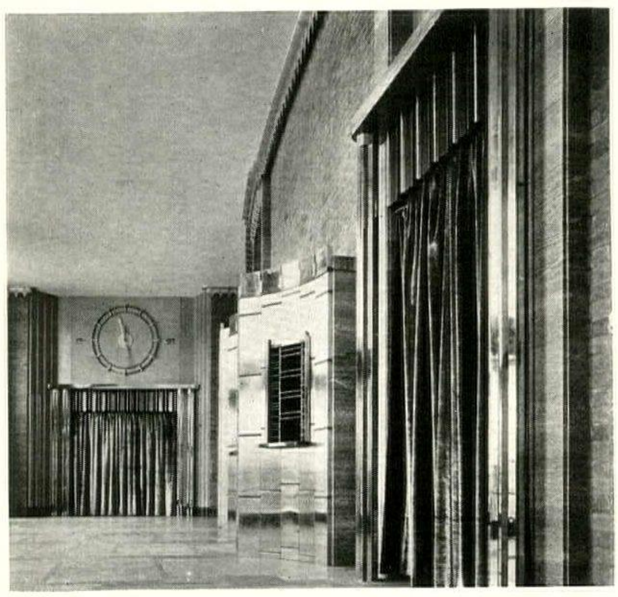
SHAKESPEARE MEMORIAL THEATER

STRATFORD-ON-AVON, ENGLAND

SCOTT, CHESTERTON & SHEPHERD, ARCHITECTS

THE ENTRANCE FOYER

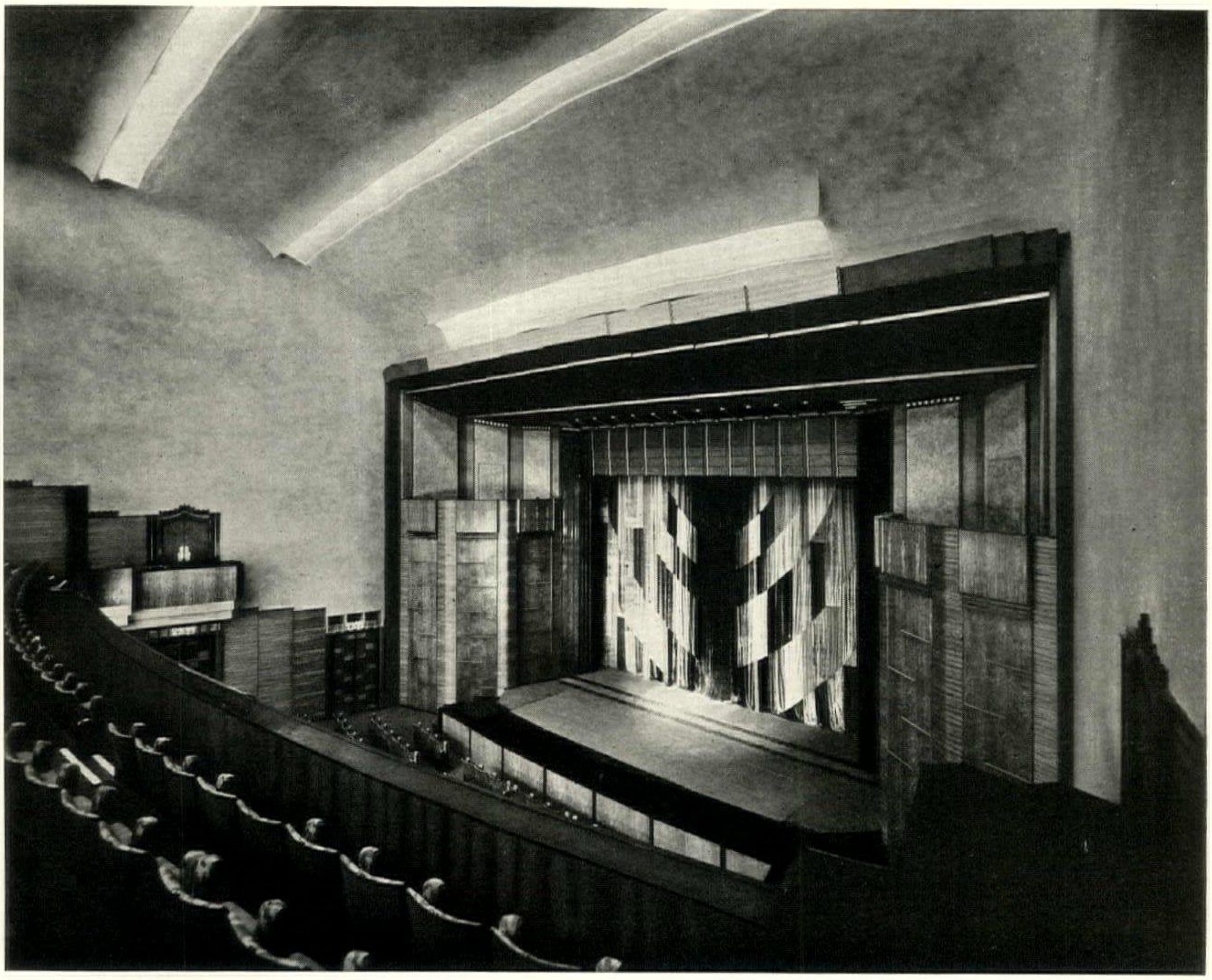




SHAKESPEARE MEMORIAL THEATER

STRATFORD-ON-AVON, ENGLAND

SCOTT, CHESTERTON & SHEPHERD, ARCHITECTS



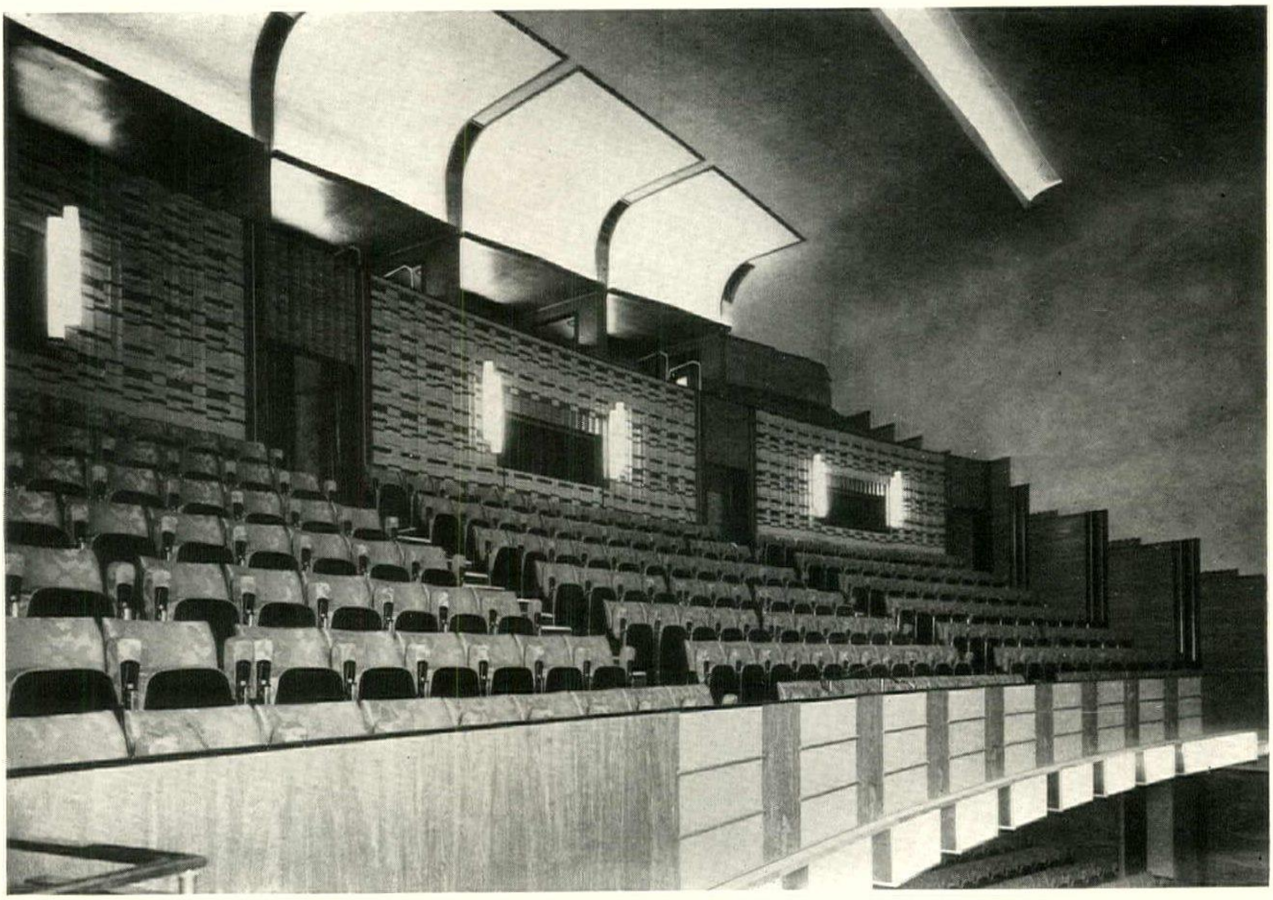
THE STAGE FROM THE MEZZANINE

THE entrance foyer doors are surrounded with Swedish-green marble and stainless steel. Throughout the building new materials, metals and wood are used in their natural state because of their fitness to function rather than as novelties, and reduction of maintenance cost was a factor in their selection. The "pay-box" or ticket booth is faced with stainless steel and horizontal strips of bronze. The splayed front to the assemblies adjoining the forestage, shown above, is faced with stained gray sycamore and projecting fillets of Andaman padauk. The horizontal proscenium splay is of painted mahogany with gold leaf. The curtain, designed by Walpole Champneys, is in black, crimson, gold, silver and white velvet. The auditorium walls and ceiling are painted mottled blue and white which appears neutral gray under artificial lighting. Cellulose lacquer was used as the finish for most of the woodwork and doors. The chair seats have no springs but are stuffed with specially aerated rubber and the arms of the chairs tip with the seats. The general lighting is almost entirely indirect and is controlled by a master switchboard and motor-driven dimmers. There is a central vacuum cleaning plant. The ventilating, on the basis of 1,000 cu. ft. per person per hour, is accomplished by direct fresh air from ground level drawn through a preheater, water-spray washer, and secondary heater, to the main fan at basement level. The building is heated by a panel radiant heating system, the steel pipe coils being cast in the soffits of ceilings and covered with plaster. Fire protection is provided by automatic sprinklers, fire hydrants and chemical extinguishers . . . The illustrations have been reproduced here through the courtesy of The Architectural Review, of London

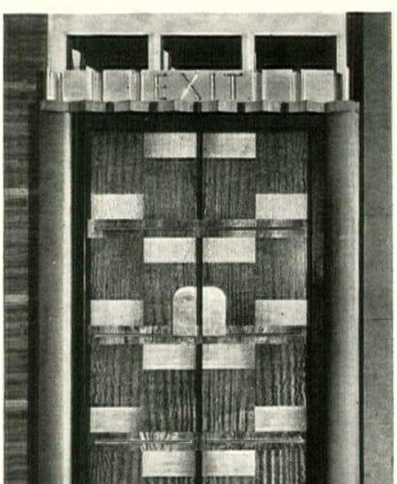
SHAKESPEARE MEMORIAL THEATER

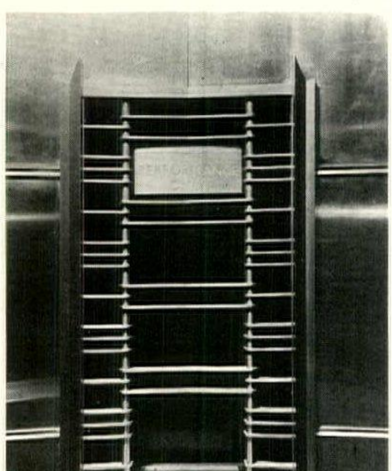
STRATFORD-ON-AVON, ENGLAND

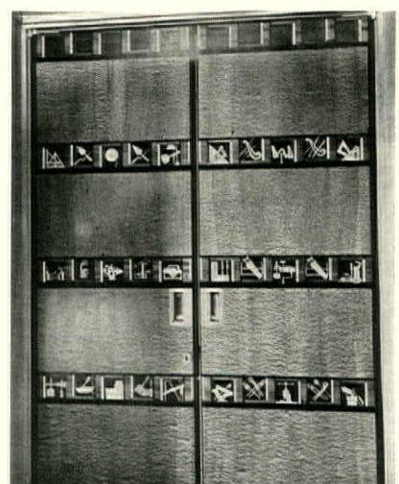
SCOTT, CHESTERTON & SHEPHERD, ARCHITECTS



The vertical face of the dress circle, shown above, is covered with pleated fabric for acoustical purposes. The doors below are combinations of inlaid wood, the large panels being of mahogany. The ticket office wicket grille is of stainless steel and bronze



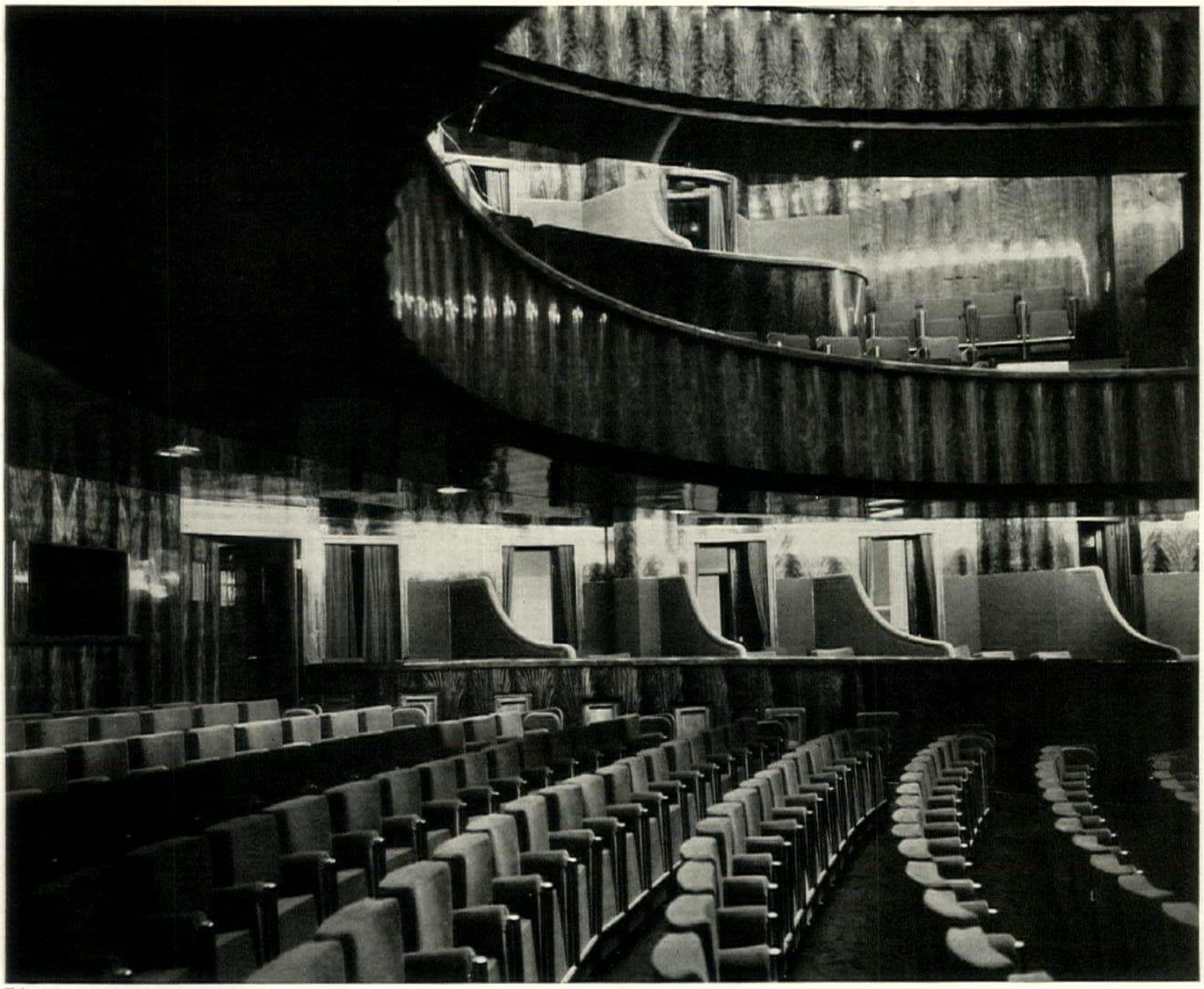




SHAKESPEARE MEMORIAL THEATER

STRATFORD-ON-AVON, ENGLAND

SCOTT, CHESTERTON & SHEPHERD, ARCHITECTS



Tabaro

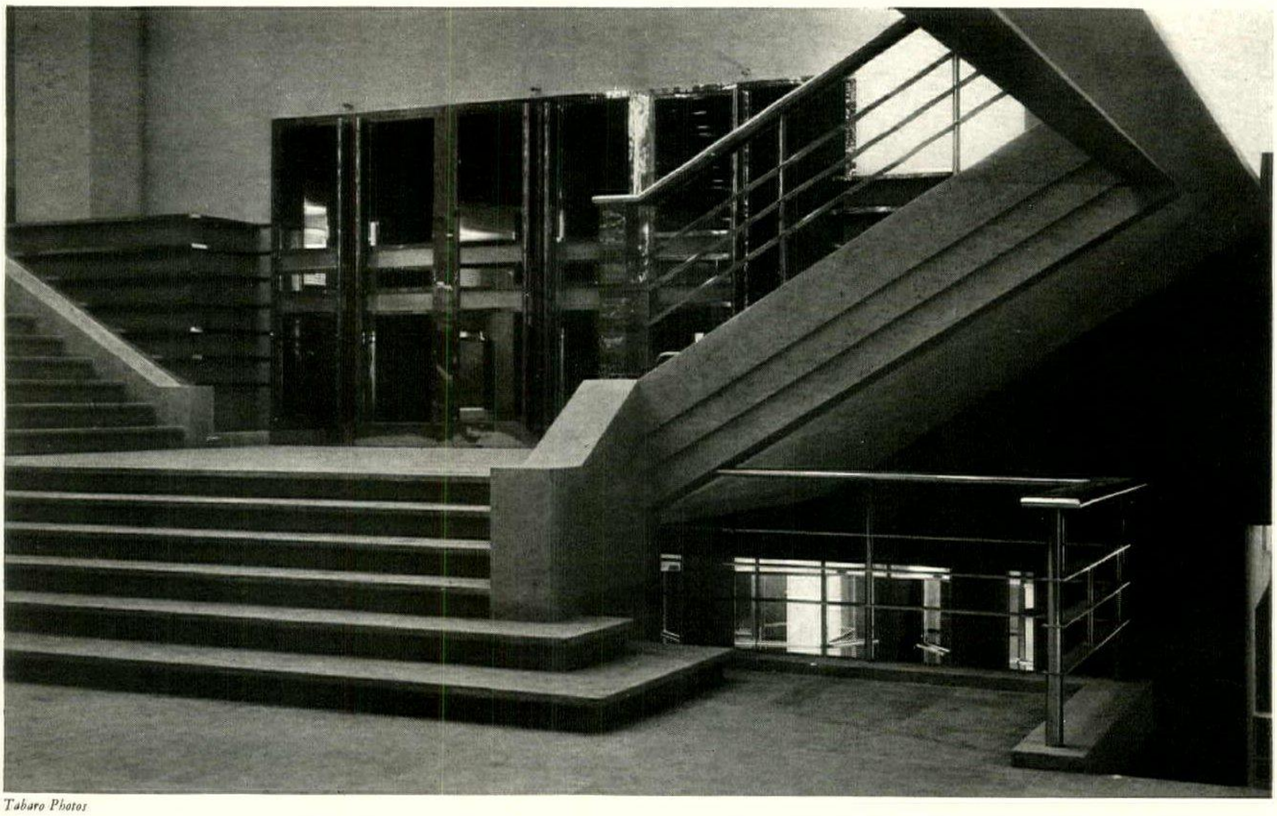
THE Pigalle Theater is one of the most elaborately equipped theaters in Europe. It is intended to provide the utmost flexibility in answering the technical requirements of any type of production. The stage equipment is as interesting as the architecture. Four complete sets can be changed with the minimum of time, due to the division of the stage into four parts, arranged in two sets, one above the other, which move vertically and horizontally. They can be hoisted into the fly gallery and dropped into position. The interior is severe in its simplicity but rich in its materials. The auditorium is completely paneled in a fireproof burl mahogany and the curtain is of rich red velvet. Chrome nickel is used decoratively throughout the theater and is used as a striking *tour de force* in the monumental tubular screen separating the staircase hall from the auditorium entrances. Lights of varying colors play on these reflecting tubes. The electrical installation is exceedingly complete, and the lighting effects can be controlled from one electrical organ, having some 228 keys, for remote control of color and intensity of light. The theater structure is of reinforced concrete except for some partitions and minor features. The heating is accomplished by an automatic oil burner thermostatically regulated. Ventilation is provided by eight changes of air per hour, the air from the outside being filtered and warmed in winter and cooled in summer. Cooling is accomplished by passing the air through a water spray at 50° F. The temperature of the water is constant due to its source, a well some 80 meters deep dug under the theater

PIGALLE THEATER

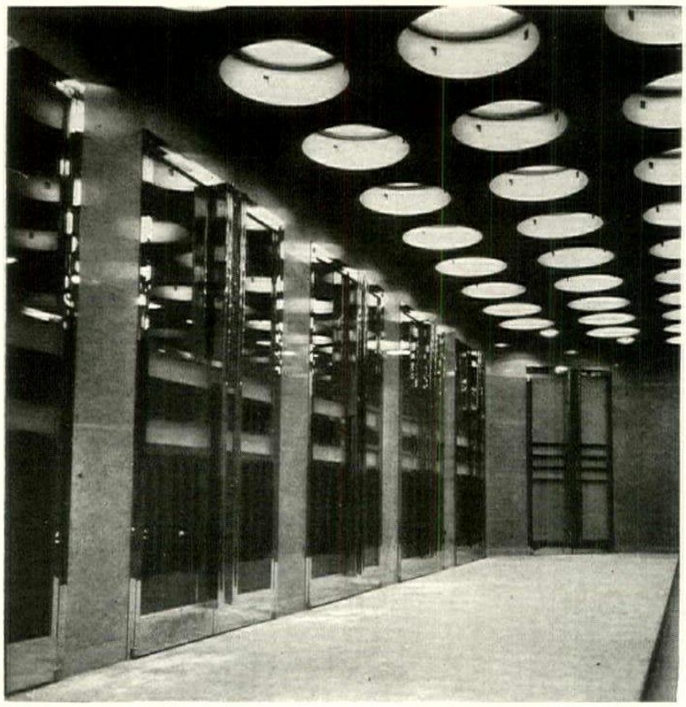
PARIS, FRANCE

CHARLES SICLIS, ARCHITECT

HENRI JUST AND PIERRE BLUM, ASSOCIATED ARCHITECTS



Tabaro Photos



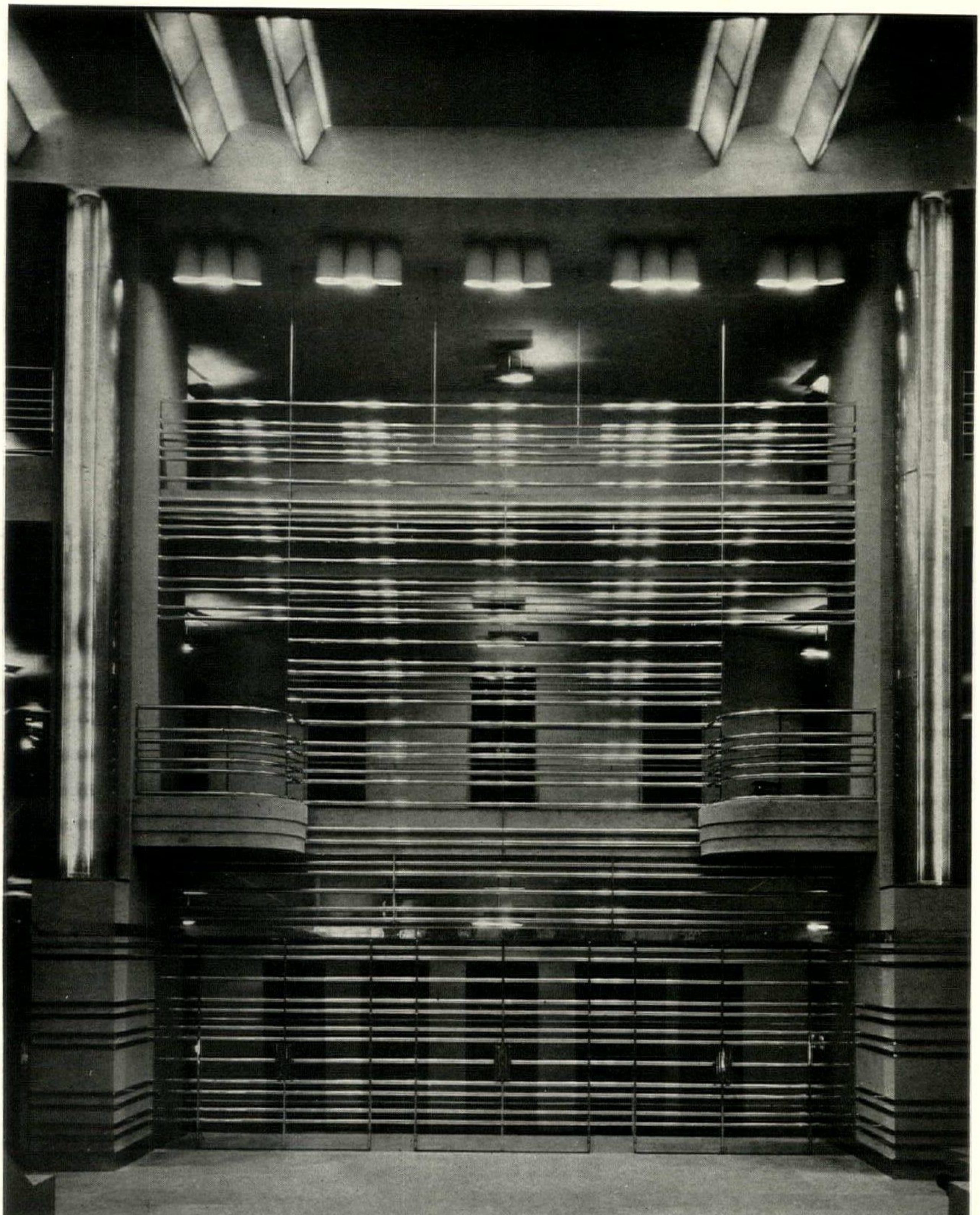
THE simplicity and straightforwardness of the design are illustrated in the double staircase illustrated above. This staircase leads from the staircase hall and is directly opposite the chrome nickel tubular screen which is pictured on the opposite page. The lower doors of this screen give access to the doors to the auditorium and boxes and the auditorium proper. The stairway leads to the mezzanine and galleries. At the left is shown the interesting and brilliantly lighted open vestibule where one can find shelter before entering the ticket office or the vestibule proper. On the following page is shown the ceiling which depends for its effect so largely upon light and light changes. The plan of the first floor also appears on page 238

PIGALLE THEATER

PARIS, FRANCE

CHARLES SICLIS, ARCHITECT

HENRI JUST AND PIERRE BLUM, ASSOCIATED ARCHITECTS



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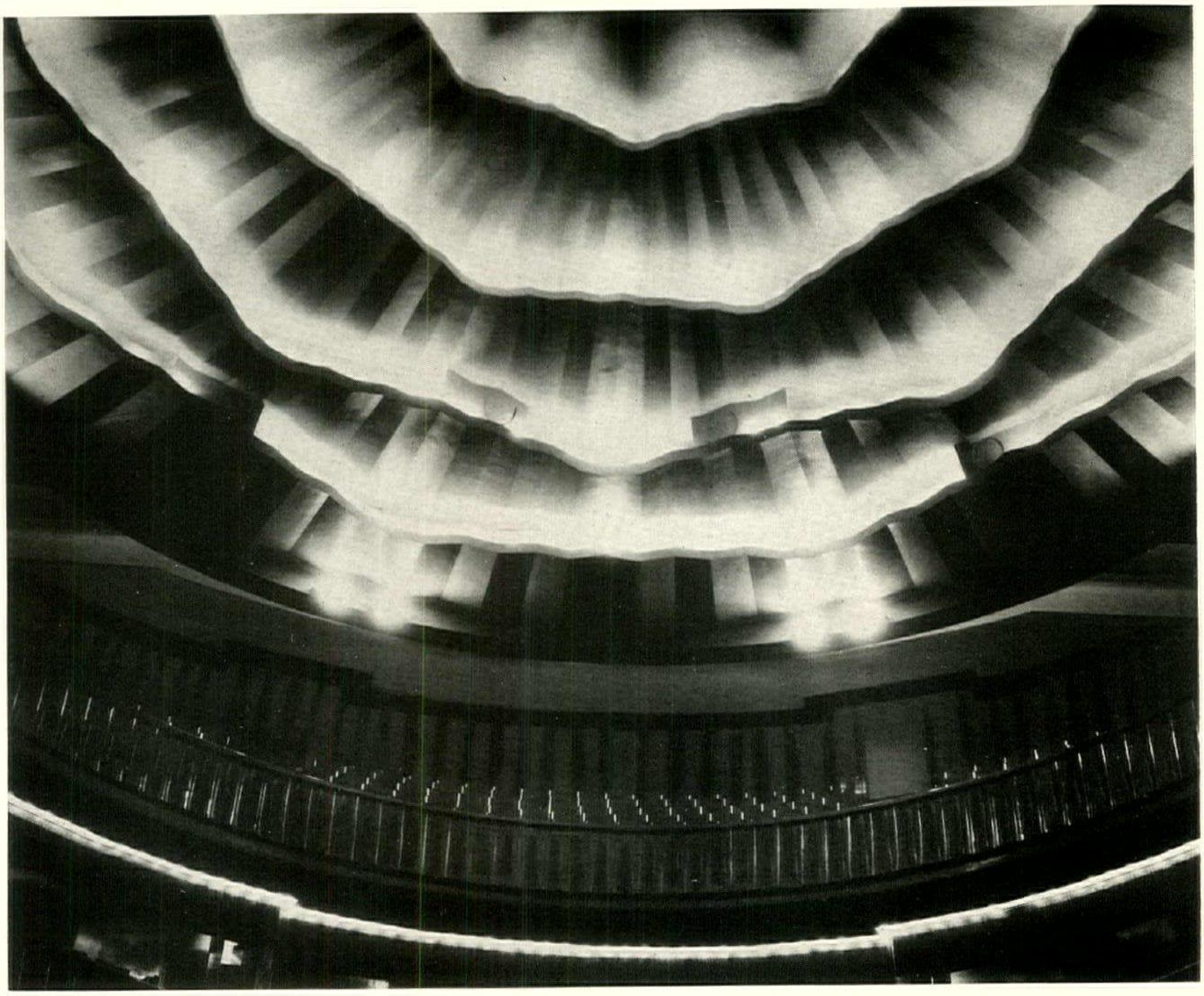
PIGALLE THEATER

PARIS, FRANCE

CHARLES SICLIS, ARCHITECT

HENRI JUST AND PIERRE BLUM, ASSOCIATED ARCHITECTS



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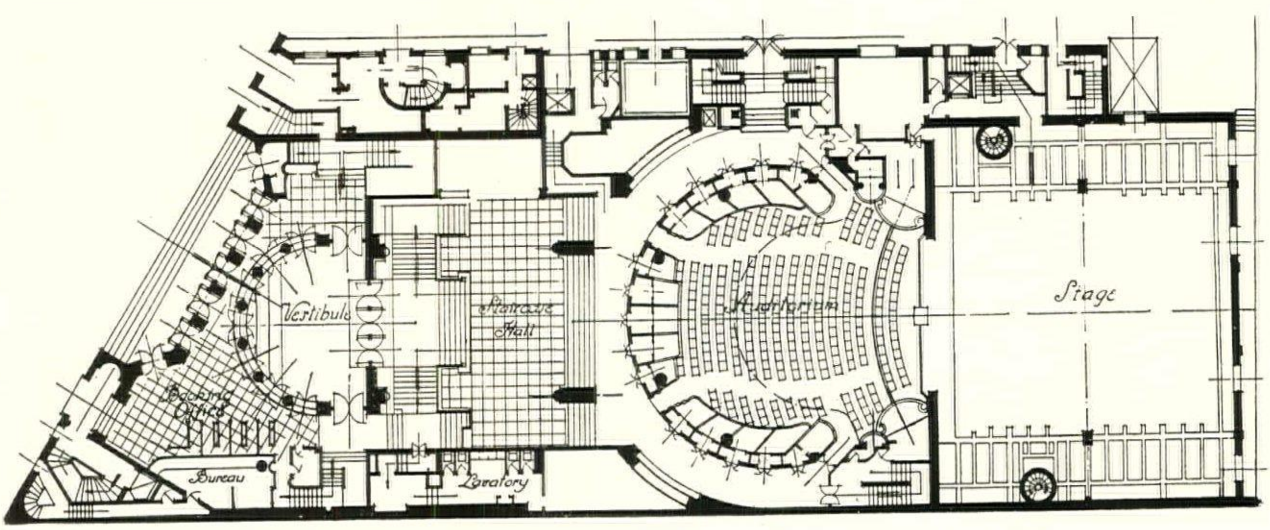
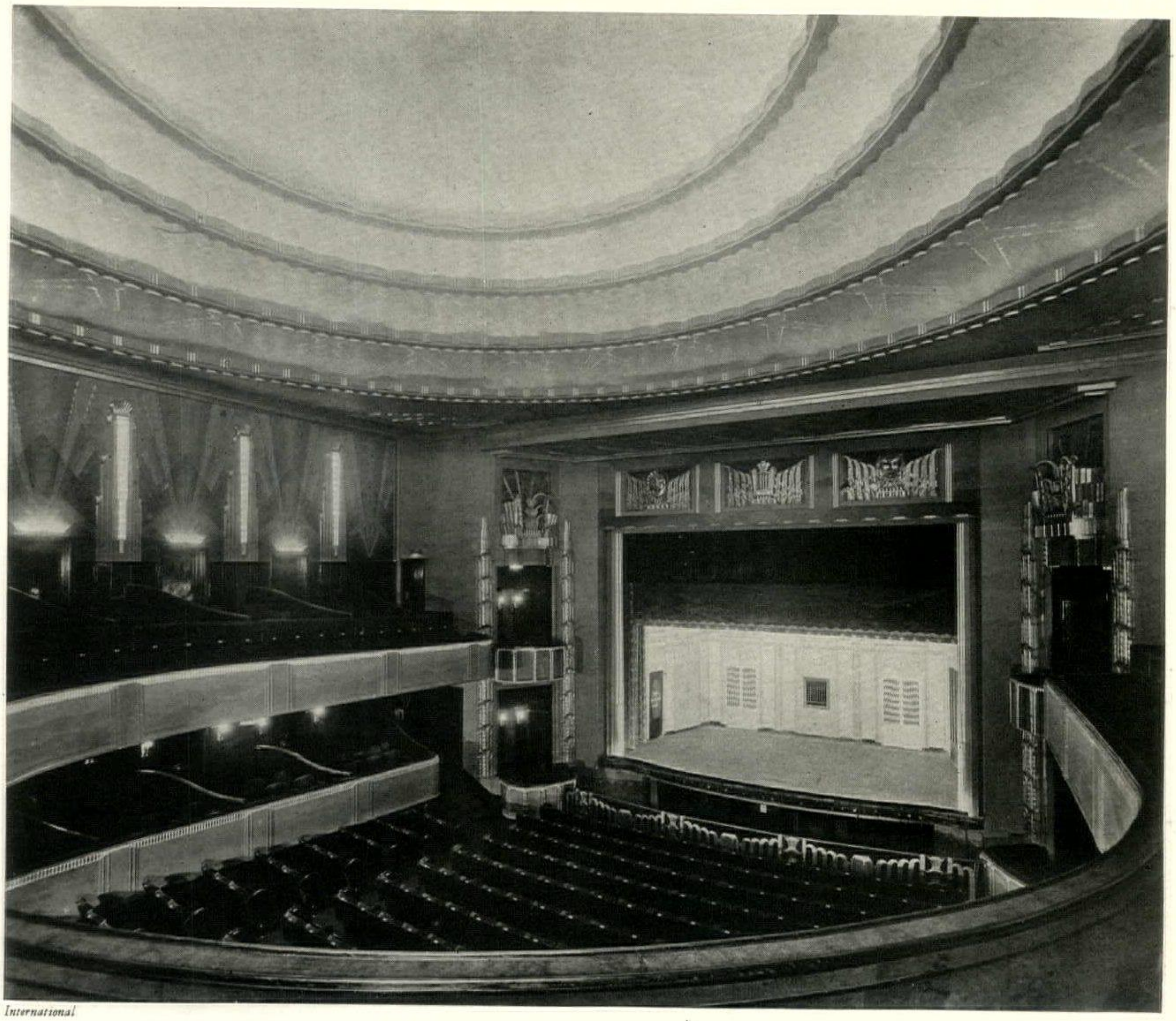


PIGALLE THEATER

PARIS, FRANCE

CHARLES SICLIS, ARCHITECT

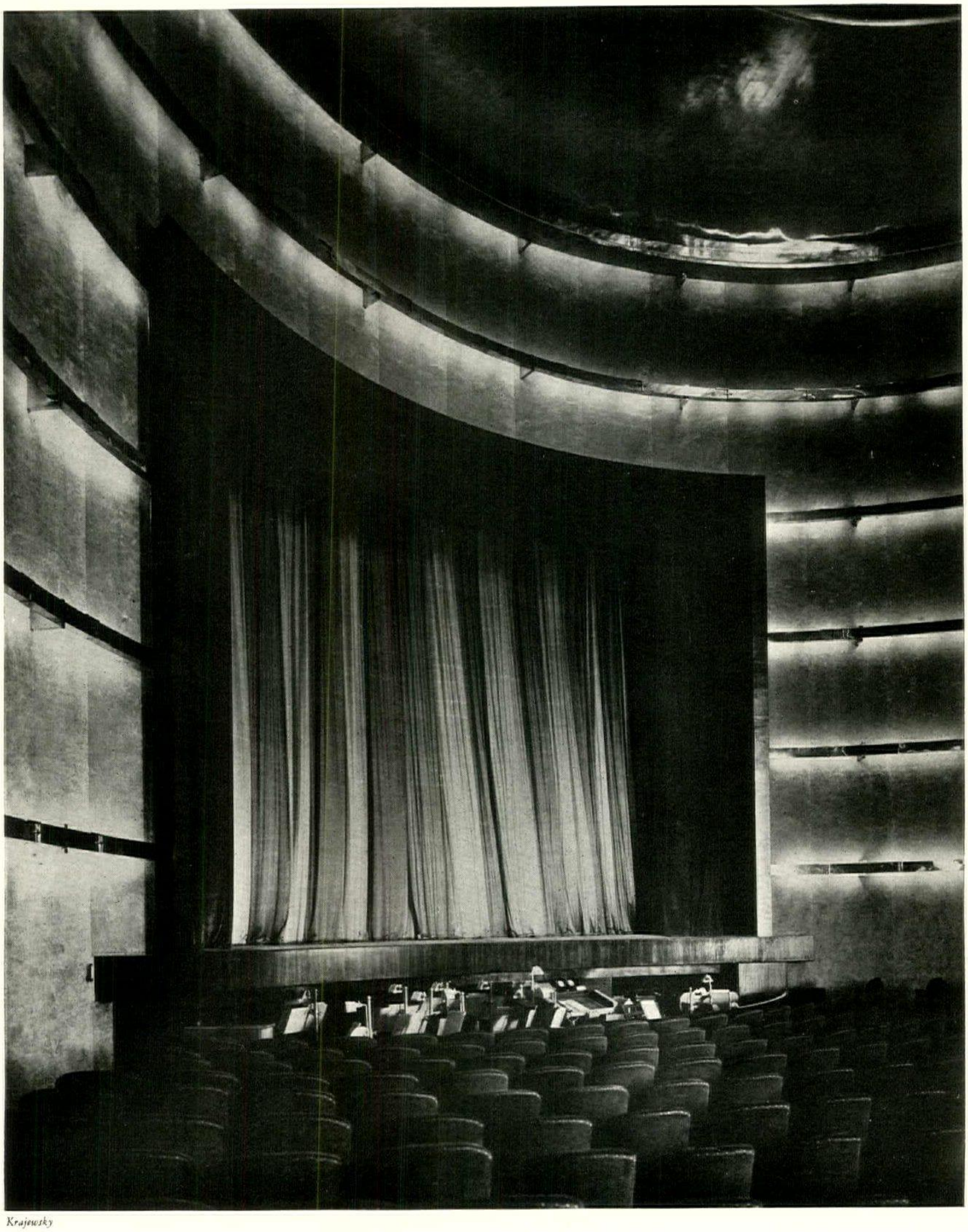
HENRI JUST AND PIERRE BLUM, ASSOCIATED ARCHITECTS



International

THE CASINO

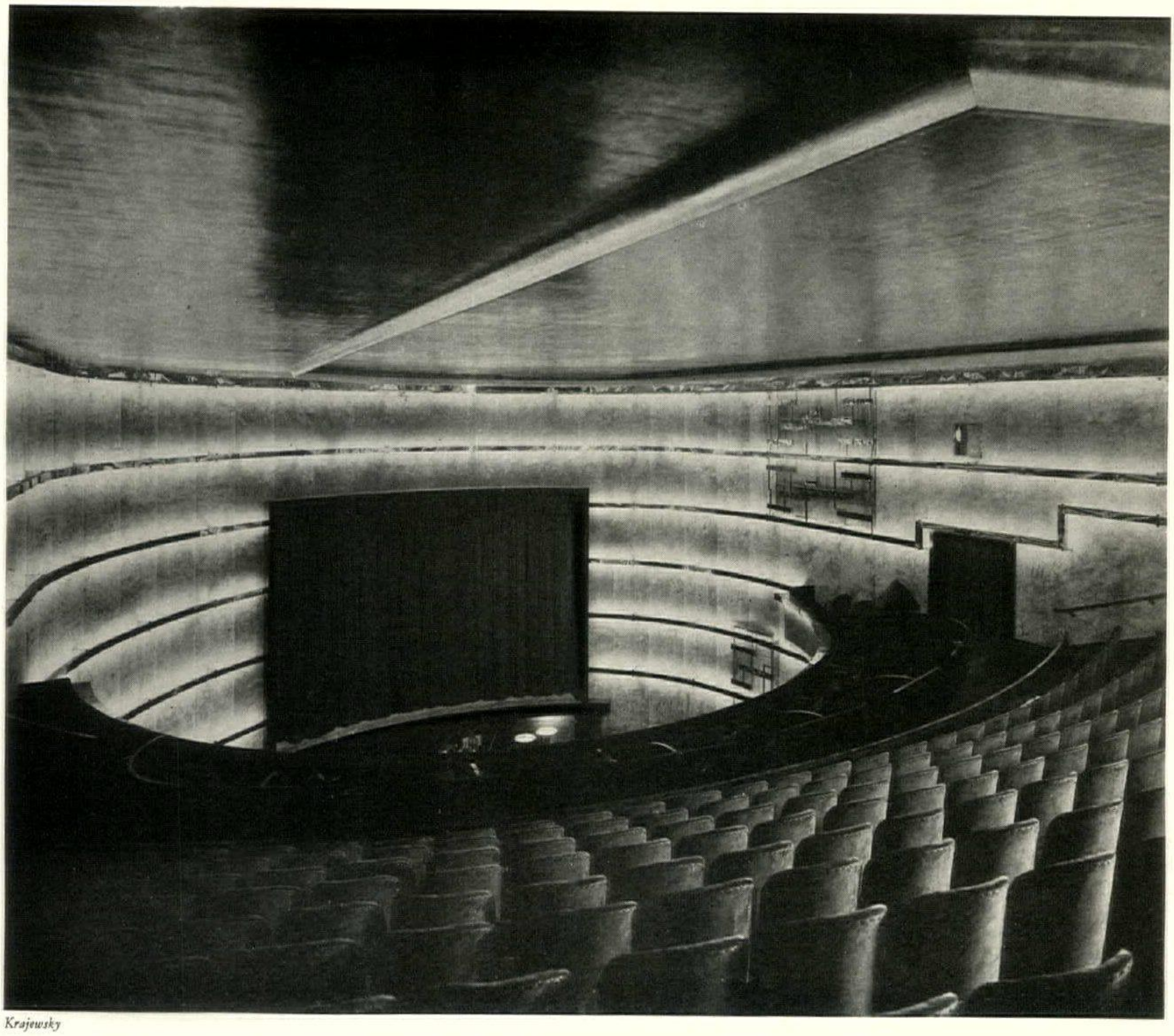
NICE, FRANCE



Krajewsky

KAMMERLICHTSPIELE, BERLIN

CARL STAHL-URACH, ARCHITECT

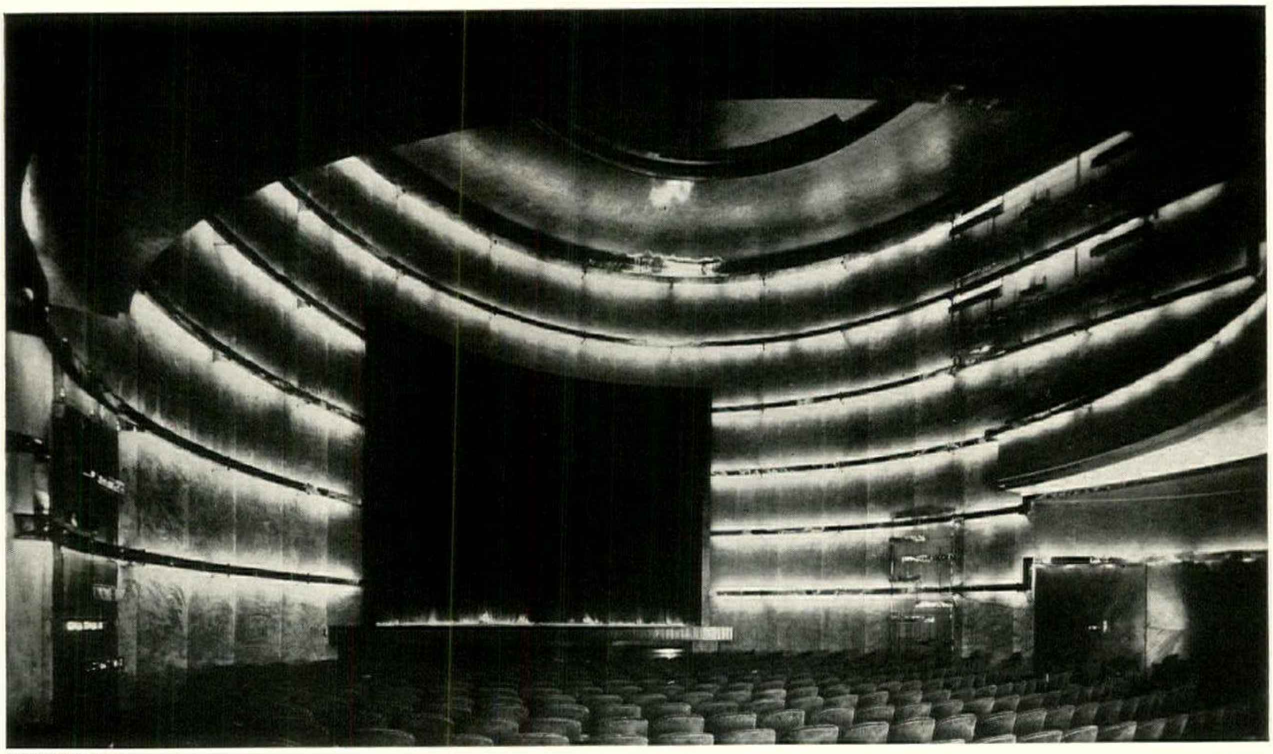


Krajewsky

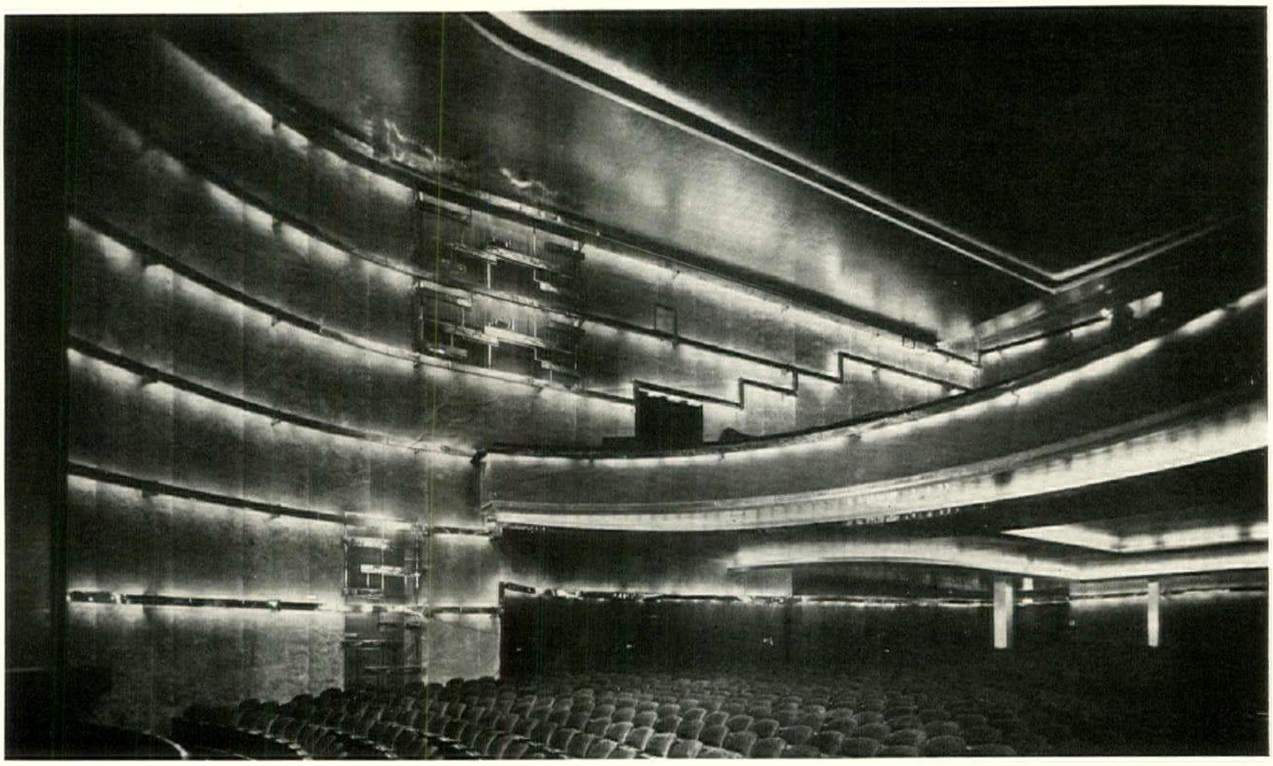
THE Kammerlichtspiele in Haus Vaterland, Potsdamer Platz, Berlin, is a striking example of effective simplicity in theater auditorium design. The walls are covered with velours of an old gold tone which is rich and yet neutral and of a splendid surface for light reception from the horizontal lighting bands. The general illumination is provided by these highly polished brass reflector bands of individual pattern, the light being concealed from the audience. There is also a lighting trough on the ceiling which is seen in the illustration above. The ceiling itself is covered with gold leaf. The illumination is variable in four colors (green, red, amber and blue), so that the proper lighting effect can be obtained in keeping with the mood of the performance. The main stage curtain is black and the floor is of dark green carpet. The seats are of dark gray-green leather

KAMMERLICHTSPIELE, BERLIN

CARL STAHL-URACH, ARCHITECT

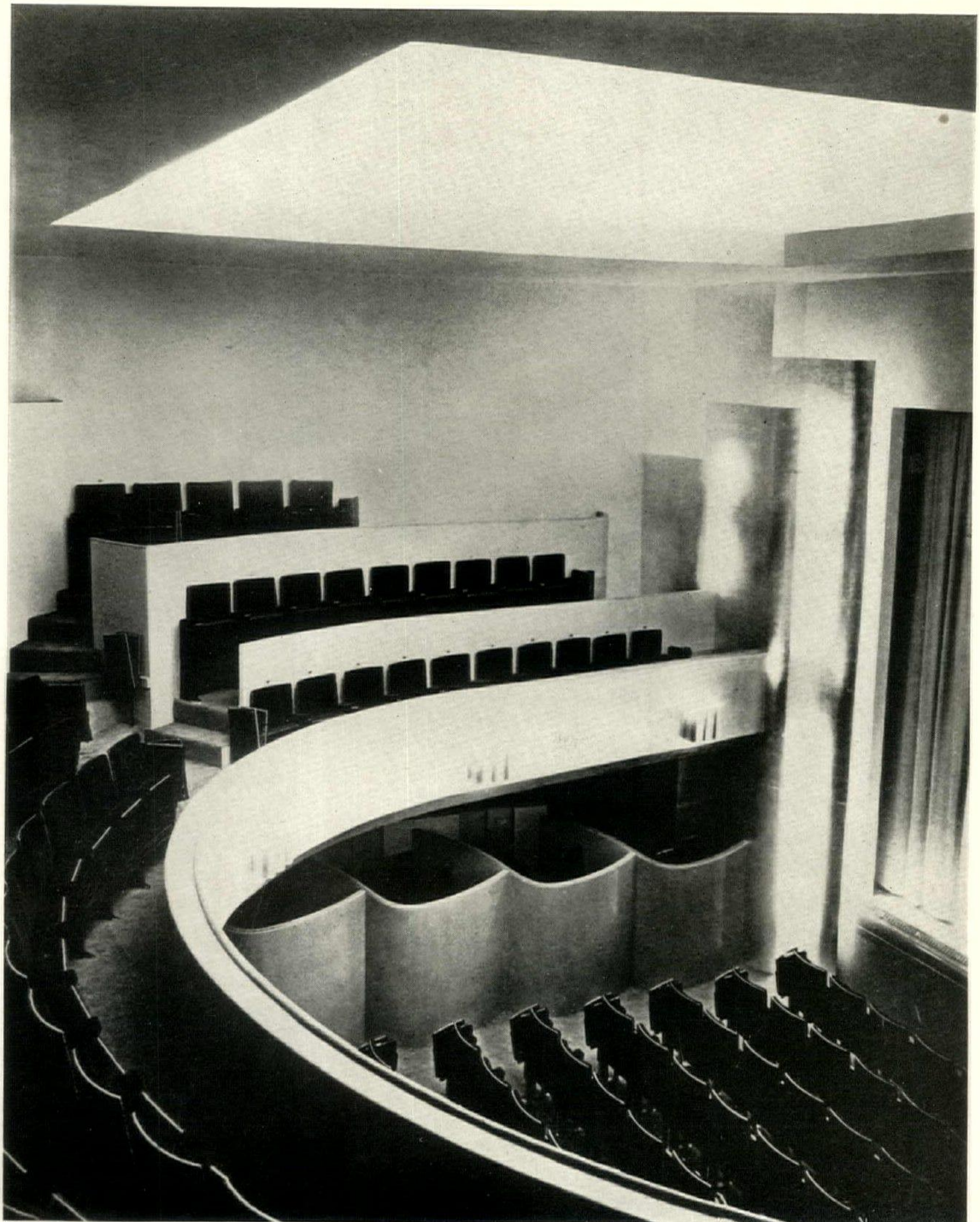


Krajewsky Photos



KAMMERLICHTSPIELE, BERLIN

CARL STAHL-URACH, ARCHITECT

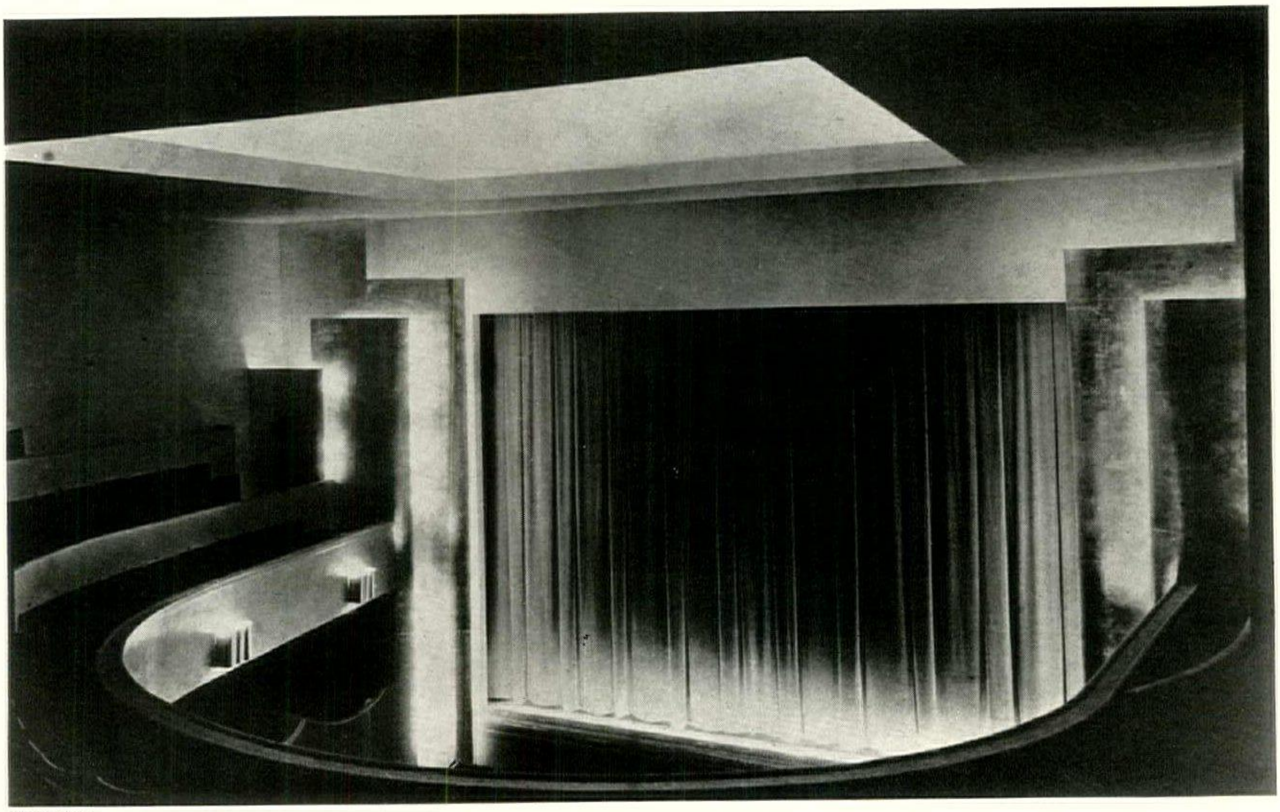


Bonney

ST. GEORGES THEATER

PARIS, FRANCE

CHARLES SICLIS, ARCHITECT



Bonney Photos

IN THE St. Georges Theater the lighting is the dominant feature, being called upon to interpret psychologically the mood of the play. The curtain is a deep red velvet while on either side of the proscenium are vertical strips of sheet iron finished in silver Duco which reflect the tonality of the lights which they shield. The dominant colors are silver, red and deep brown, with bright steel trimmings on the furniture. The stairs shown at the left lead from the entrance vestibule and the steps are of ochre with red center bands. The railings are of tubular iron

ST. GEORGES THEATER

PARIS, FRANCE

CHARLES SICLIS, ARCHITECT

DEVELOPMENT OF THE AUDITORIUM

In the design of a successful theater auditorium is included the subtle relationship between actors and audience in which the elements of psychological comfort play an important part. This article explains how this factor was assured in the development of the Philadelphia Auditorium by the analysis of ten different theater schemes

BY

PERRY COKE SMITH

OF THE OFFICE OF

VOORHEES, GMELIN & WALKER

MR. PENN lives and works in a large Eastern city. Tonight he is going to the opera. He really wants to go to the opera. Strangely for Mr. Penn and thousands of other Mr. Penns in that city, the ancient art of dramatized music, so long scorned, has become fascinating. As he leaves his office the elevator hall in all its blaze of Renaissance glory — or is it "Modern"? (Mr. Penn does not know) — makes little impression on his tired senses. The bank, the office building, all the streets of vying facades are even less than obnoxious to Mr. Penn — they are ignored.

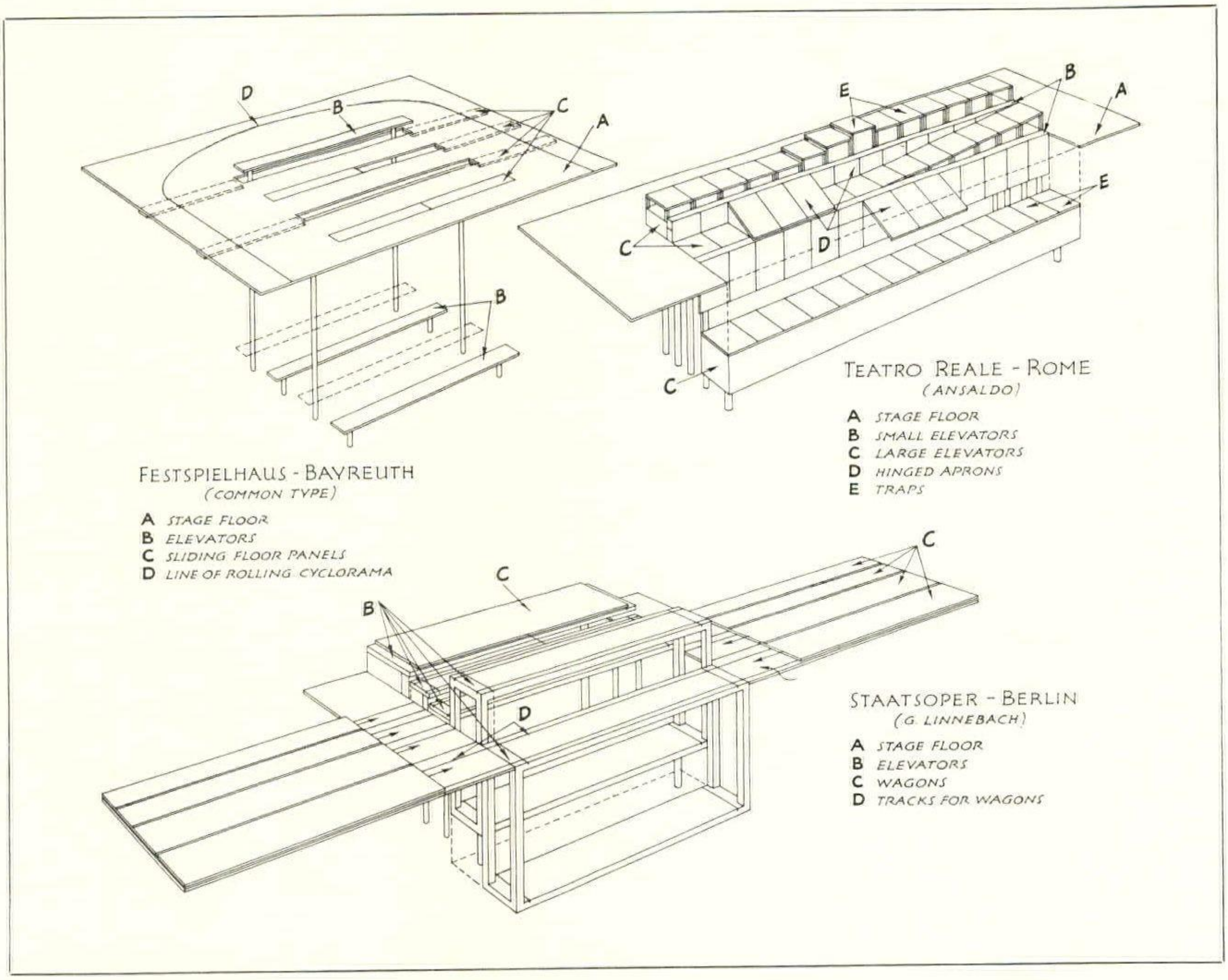
At home he arrays himself in his "purple and fine linen" and goes off with Mrs. Penn. He is now a different man. His actions and his reactions are no longer affected by the exigencies of bread-winning. He likes music better than statistics and, regrettably, illusion better than reality. The city has become a different city. True, the night and the lights have changed it, but in Mr. Penn himself is the real difference. He approaches the great building which houses the opera with other theatrical enterprises, and its smallest detail has meaning to him. His appetite for the food of the senses is awake. And Mrs. Penn — she too has left her realities of soiled dishes and children's clothes and is entering with him this evening a world of illusion. This is the grist for the art of the theater, material ripe and ready for the architect, the author and composer, the scene designer and the director.

All this is an attempt to illustrate an interesting difference between the design problem of the theater and most other architectural problems. The theater deals with the human functions of pleasure, rather than those of bodily necessity. Its quality must be wholly emotional and illusory, for that is what its patrons demand. It is true that other minor functions crop out. Any gathering tends to satisfy the gregariousness in us and the desire to exhibit ourselves. But these functions may be taken in stride to the main objective of conditioning a space where all the senses may be most aware and responsive to the art of illusion.

The statement of the problem for a theater, omitting all the mass of accessory functions and spaces, becomes relatively simple. It is to provide a stage and audience chamber where the conditions of seeing and hearing and feeling, both for performers and audience, may approach the ideal. The solution of the problem, far more difficult, lies in discovering the characteristics of these spaces. It is a description of this laborious process applied to the Philadelphia Auditorium which follows. This, of course, is a somewhat idealized statement. It goes without saying that location and size of community and lot, kind of financing and ownership and all the other things affecting any architectural problem apply. But these things are solved more or less well in the natural course of study and need not in this discussion interest us.

The first step in this problem was the gathering of data. Perhaps the most noteworthy thing about this was that practically none of it came from books, or for that matter, from magazine articles! The process, in Ralph Walker's words, was picking the minds of men and women active in all branches of the theater and music. Nothing was taken for granted, but everything was respected. This building is to house the Philadelphia Orchestra, the Philadelphia Opera Company and to include a smaller house for drama, so that its activities include symphonic music, grand and light opera, drama, dance, pageants, vocal, instrumental and choral concerts, forum, addresses, and whatever the present and future may hold in electrically reproduced sound and light. In fact, what the future may be in any of the above things is one of its gravest problems. So the field for mind picking was broad and varied.

Conferences were held with some thirty people both in this country and abroad. This group represented all phases of the theater; producing, state direction, technical direction, acting, composing, conducting, business management, scene design, lighting and acoustics. From each of these individuals we tried to get a pattern of his desired theater. Superimposing these patterns, so to speak, we gained



The diagrams on this and the opposite page are indicative of the research into matters of technical production which was undertaken by the architects of the Philadelphia Opera House. Every conceivable type of stage was studied and the possibility of utilizing its principles in whole or in part was seriously considered in the development of the problem at Philadelphia

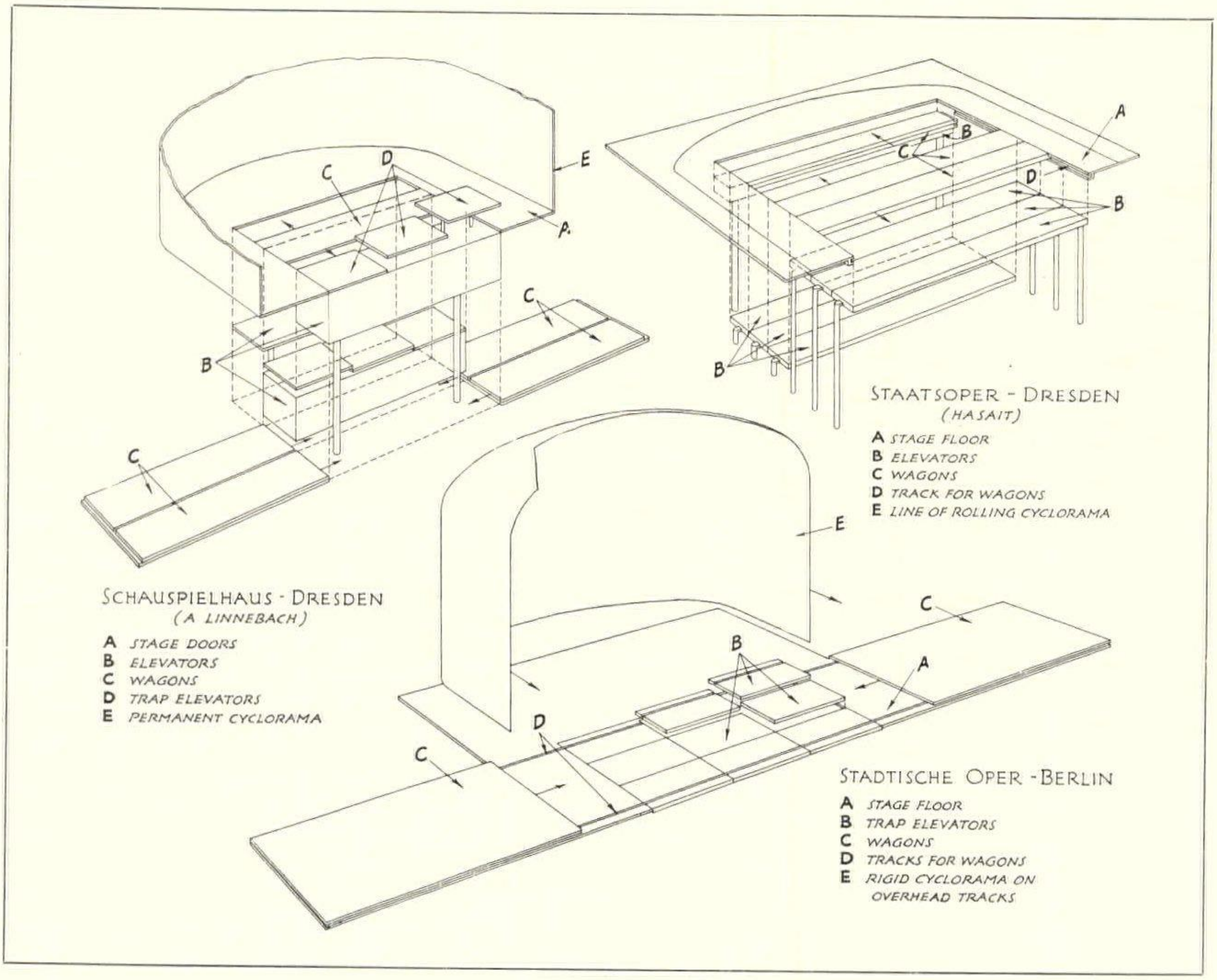
a solid nucleus of thought surrounded by a fringe of varying ideas. It remained then to correlate the fringe and nucleus into a master pattern, which has become our program. The consulting service of these experts continues as a check on this program and on our interpretation of its design.

During the time of gathering this information, covering a period of nine months, we proceeded with the design of ten auditoriums of greatly varying characteristics as to arrangement of seating. At the same time we investigated various chairs and spacing by setting up actual examples and taking a vote for comfort from a range of physical types. Scale models were made of the more characteristic of these houses. It must be understood that this was an attempt at the arrangement of the human units of the audience. Disposition of walls and ceiling was considered as a further step depending upon the ultimate solution of seating and modified by acoustics, lighting and many other factors yet to be discovered. Four of the seating plans and scale models are illustrated here, together with sight line diagrams and an interesting section diagram for determining the proportion of faces to architecture which the performer sees on facing the audience. In the preamble to the section of a report to the owners, in which these diagrams were included, is the following explanation of the analysis of each scheme:

A comparative analysis of the characteristics of each theater, based on an arbitrary system of numbers. The points considered in rating the characteristics are as follows:

1. *Hearing.* Projecting balconies; proportion audience to structure presented to the sound source. (Distance from the stage is not considered within the dimensions of these theaters.)

2. *Seeing.* Horizontal sight angles; vertical sight angles. (Distance from the stage is not considered within the dimensions of these theaters.)



During the preliminary part of the design conferences were held with representatives of all phases of the theater. From each individual an effort was made to obtain a pattern of an ideal theater. The superimposition of these ideas led to the ultimate correlation of many ideas into a master pattern which became the actual program for the Philadelphia Auditorium design

3. *Feeling* (as the appearance of the auditorium affects the audience). Unity of the seating surface; projecting balconies; width of auditorium.

4. *Feeling* (as the appearance of the auditorium affects the performer). Unity of seating surface; proportion of audience to structure presented to the performer.

5. *Comfort* (as regards slope of auditorium).

6. *Flexibility* (as regards the changing art of the theater). Horizontal sight lines; unity of seating surface.

Characteristics applying particularly to boxholders:

7. *Hearing.* Projecting balconies; proportion audience to structure presented to the sound source. (Distance from the stage is not considered within the dimensions of these theaters.)

8. *Seeing.* Horizontal sight angles; vertical sight angles. (Distance from the stage is not considered within the dimensions of these theaters.)

9. *Comfort.* The position of the seat in relation to the direction of the stage.

10. *Privacy.* Privacy of seating in the auditorium.

These schemes are intended to cover the field of possibilities for auditoriums of between 3,000 and 4,000 seats.

You will observe that Mr. Penn's emotional comfort has been principally considered. He must hear and see and he must feel. Not only must he actually hear and see but he must feel that he hears and sees, and that all his neighbors do. Much of the enjoyment of the theater comes from contagion — mob psychology, if you will. Only the most rare ascetic may enjoy an emotion in private. There is much evidence for this and we accept it as a fact as definite as sight lines and the behavior of sound waves. Hence, we can say that it is better to have the audience as closely related, unit to unit, as possible. Again, the width of the auditorium has a definite

ANALYSIS OF TEN THEATER AUDITORIUM SCHEMES	1	2	3	4	5	6	7	8	8-A	9
CAPACITY	3675	3100	3400	3800	3250	3900	4535	3600	3389	3478
1. HEARING	90	85	85	90	80	85	55	65	75	90
2. SEEING	90	85	85	90	85	90	80	75	75	90
3. FEELING As appearance of auditorium affects the audience	90	90	75	75	60	65	40	50	65	85
4. FEELING As appearance of auditorium affects performer	90	90	70	70	50	50	35	45	45	90
5. COMFORT As regards slope of auditorium	50	90	75	70	70	70	65	75	75	75
6. FLEXIBILITY As regards the changing art of the theater	90	85	80	75	60	55	45	40	45	90
Boxholders										
7. HEARING	90	85	90	85	90	85	85	85	85	90
8. SEEING	90	85	90	85	90	85	85	75	75	90
9. COMFORT	90	80	80	90	80	90	80	65	65	90
10. PRIVACY	40	40	75	75	90	90	90	90	90	75

This chart shows the results by a rating of arbitrary percentages of ten tests which were put to ten variations in auditorium layout. They were used in conjunction with models, several of which are shown in the following pages

effect upon the audience in producing a feeling of uniform participation in the performance. There can be no doubt that the soffit of a balcony overhead mars the enjoyment of a performance, and that those seated in a balcony feel separation from those seated on the floor below. So much then, for the effect of the main characteristics of the audience chamber upon the feelings of the audience.

To the performer the identical holds. He wants his audience before him as a unit, a single sea of faces. His gesture, his word or his note should include all of them at once, and he wishes their response as a whole.

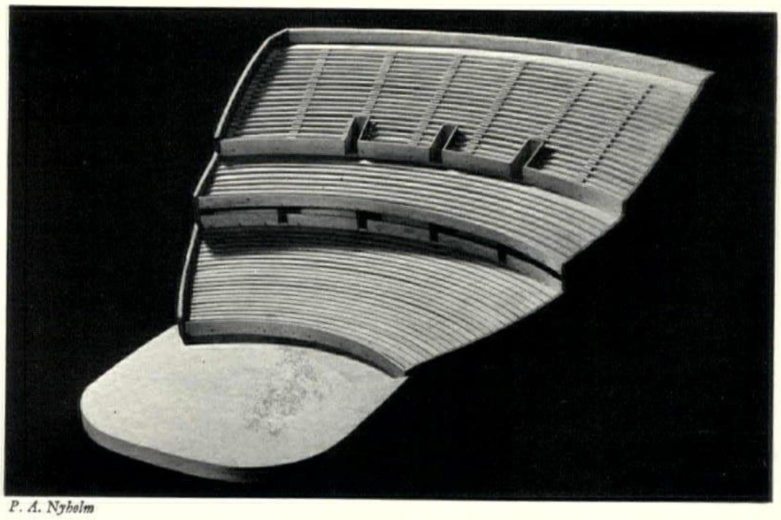
Projecting balconies destroy much of the brilliancy of sound for those seated under them. All of the possible direct sound may be received, but most of the enrichment of reverberation which particularly enhances orchestral music is lost. Sounds generated from the stage of a theater are mainly directional. The voice and the instrument pour most of their sound energy into a 90° cone. Hence, the greater proportion of that cone section occupied by ears, the less will be lost on structure.

In considering seeing, the most obvious factor is obstruction. This may be definitely controlled by horizontal and vertical sight lines. Obviously, our friend must see over the heads of those in front, and regardless of where his seat is he must see what takes place upon the acting area behind the proscenium frame. The seeing diagrams illustrated with the four theaters show a method of actually determining their characteristics in this respect.

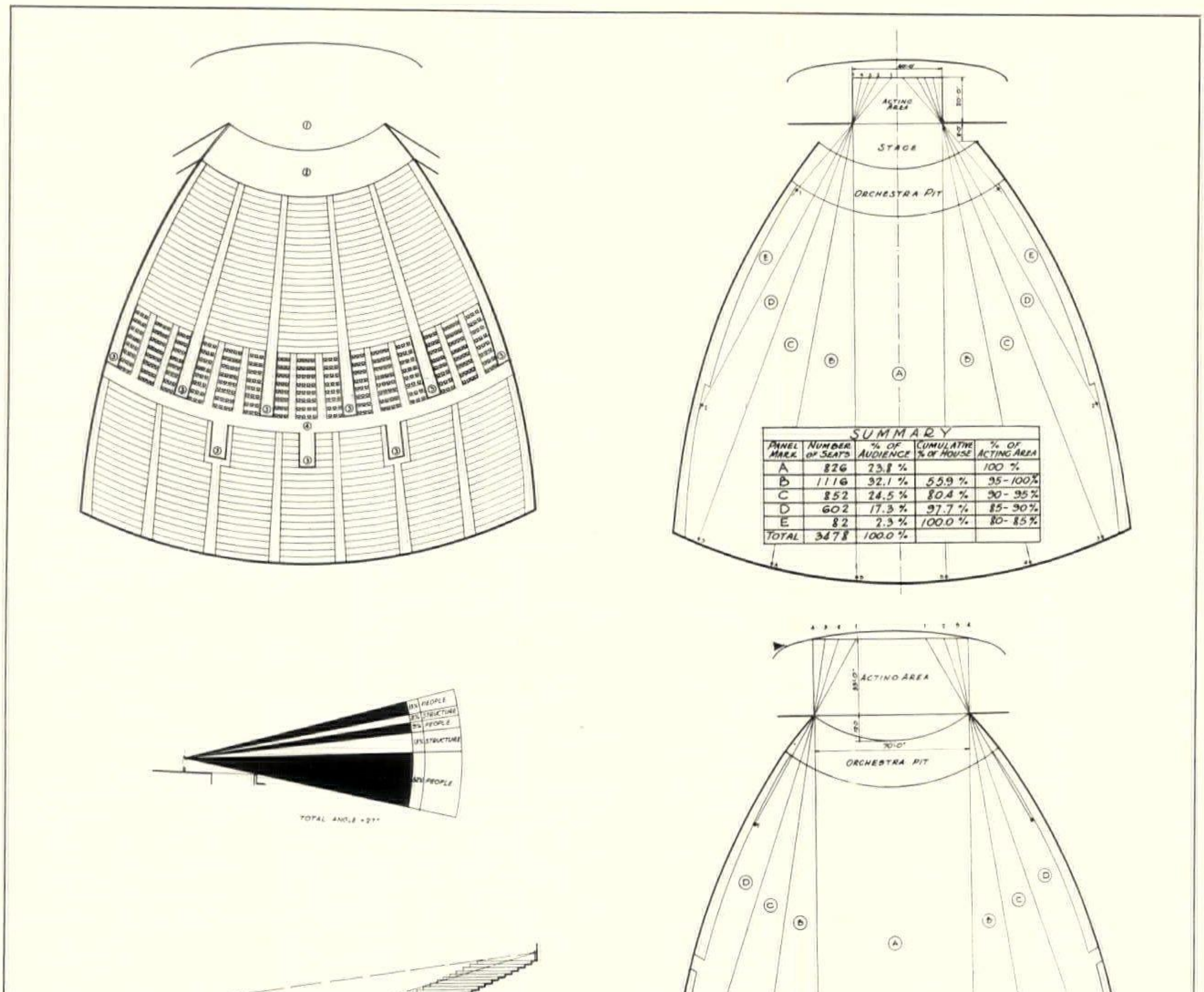
But merely seeing what takes place on the stage is not the whole story. *How* it is seen is of great importance to the full enjoyment of the performance. The stage designer, being limited by so many things, designs his set to produce the effect he wishes from the normal point of view of the orchestra level. Often when a set is seen from above, at a steep vertical angle, much of its value is lost. The two sketches of stage sets illustrate this idea. The human figure is generally more noble when seen normally. Even a prima donna is better in elevation than in plan. This is particularly true of dancing which so often depends on background for its effect. When the background becomes the stage floor, and the body is fore-shortened, an otherwise beautiful performance may become even ridiculous.

All this, then, led us to the conclusion that we must have no balconies in our house; that we must keep the vertical sight lines as low as possible consistent with good head clearance over the seats in front; and that we must confine our seating to as narrow a horizontal angle as possible.

Scheme A. Modified amphitheater type with a narrow sight angle and loge boxes on a separate level. Seating capacity 3,478, gross area 27,500 sq. ft., width of auditorium and rear 208 ft., width of proscenium 70 ft., expanded width of proscenium 95 ft., number of boxes 60, space occupied per person 7.9 sq. ft. The arrangement of the boxes is non-traditional and the scheme is a possible one in relation to the lot. The scheme is designated in the chart on page 248 as No. 9

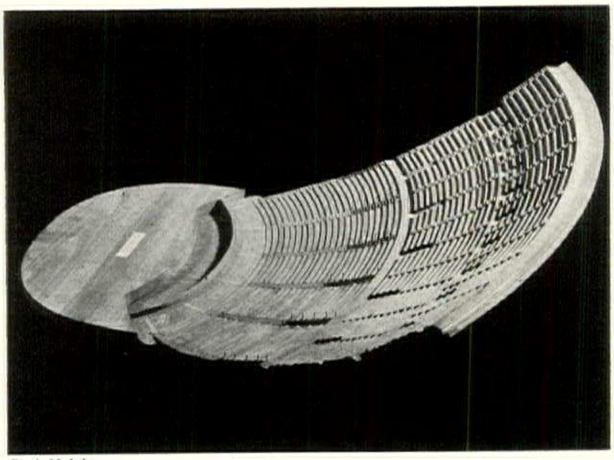


P. A. Nyholm



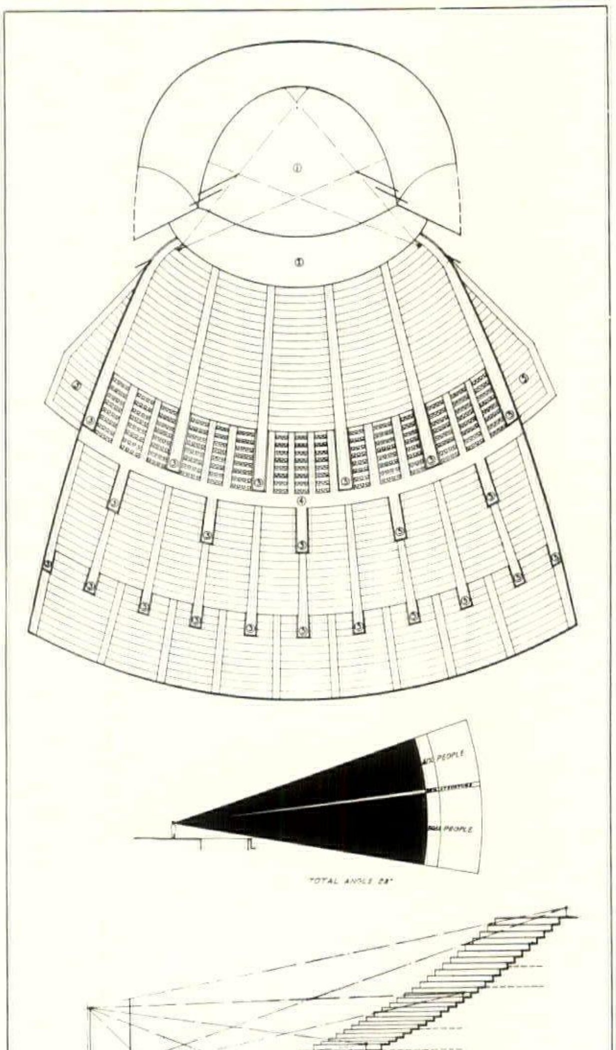
PANEL MARK	NUMBER OF SEATS	% OF AUDIENCE	CUMULATIVE % OF HOUSE	% OF ACTING AREA
A	826	23.8 %		100 %
B	1116	32.1 %	55.9 %	95-100%
C	852	24.5 %	80.4 %	90-95%
D	602	17.3 %	97.7 %	85-90%
E	82	2.3 %	100.0 %	80-85%
TOTAL	3478	100.0 %		

PANEL MARK	NUMBER OF SEATS	% OF AUDIENCE	CUMULATIVE % OF HOUSE	% OF ACTING AREA
A	1206	34.1%		100%
B	812	23.8%	59.4%	94-100%
C	732	12.3%	77.7%	88-94%
D	490	17.0%	94.7%	82-88%
E	180	5.3%	100%	76-82%
TOTAL	3420	100%		



P. A. Nyholm

Scheme B. Designated on the analysis chart on page 248 as Theater No. 1



You will note that no mention has yet been made of distance from the stage to the rear seats, nor of the volume of the house. This naturally concerned us, especially since there is an old tradition in theater design that no seat should be more than 125 ft. from the curtain line, and no house should contain more than one million cubic feet, the first rule relating to seeing and hearing and the second to hearing.

Experts both in the science and æsthetics of sound agree that for music brilliancy is essential for its full enjoyment. Good brilliancy is reverberation under control. In order to have reverberation, either the walls or ceiling, or both, must in some degree reflect sound. Our experts have shown us how we may shape the ceiling of our auditorium so that the directed and conditioned reflected sound may compensate, in the rear half of the house, for distance from the stage. We find by theory and practice, that the volume of an audience chamber has no effect within very wide limits on its acoustics. This, we believe, disposes of the problem of distance from the stage as affecting hearing, gives us brilliancy and, in addition, a handsome ceiling to shelter our friend Mr. Penn.

As to the effect of distance on seeing, we have distinctly made a trade. For the benefits of a low vertical sight angle already discussed we have exchanged nearness to the stage, believing that to see the stage and the performers in normal relationship one to the other and the audience is better seeing than mere nearness gives. It is also thought that the gradual decrease in scale given by the audience in a single surface from the spectator in a rear seat to the stage will tend to make more human the scale of those on the stage than if seen, suddenly diminished, across the gap beyond the balcony rail.

These considerations of the auditorium cannot be separated from the stage, whose physical characteristics are much affected by those of the audience chamber. But we shall consider here only the most important and delicate part of the whole theater as affecting performance; that plane or surface, or even void, which separates the actor from the

Scheme B. Amphitheater type with a narrow sight angle and with loge boxes. The seating capacity is 3,675; the gross area 29,500 sq. ft.; width of the auditorium at rear 220 ft.; width of proscenium 80 ft.; expanded width of proscenium 114 ft.; number of boxes 60. The space occupied per person is 8 sq. ft. The arrangement of boxes is non-traditional. In relation to the lot the scheme is too large in plan in all dimensions. The height of risers exceeds the legal limit audience. This — the proscenium zone and the horizontal surface upon which the actor performs and the seating surface of the audience — forms the physical whole upon which the entire imagery of the theater is hung. All the rest is mechanics and devices, the machinery of illusion, if you will, whose excellence, nevertheless, must be high.

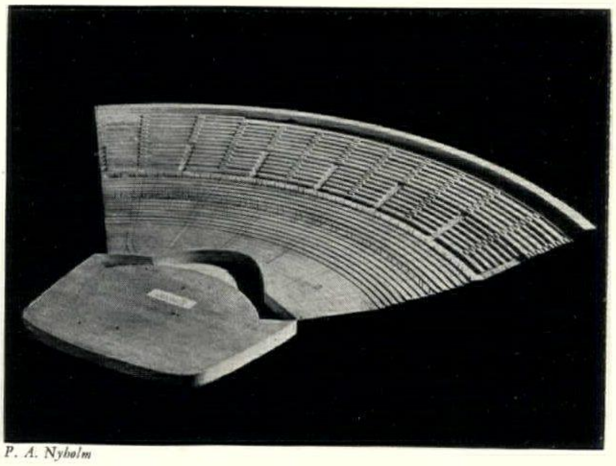
Taking these three things, proscenium, stage and audience, then, as applied to the problem of the Philadelphia Auditorium, we have chosen to make the last inflexible and as fine as our study permits, and to make the first two as flexible as possible, and garnished with only the gadgets within the realm of possible use. The so-called "Total Theater" of Walter Gropius, and others, to a certain extent reverses this, making the audience flexible to the possible injury of the flexibility of the stage. This idea was considered in this project and discarded not only for æsthetic reasons but also for its inherent mechanical difficulties.

A quotation from an office memorandum on the subject of the stage may give an idea of what we consider flexibility:

"— The tools with which we should provide the designer and regisseur of genius are these: An acting area of very large dimensions, or as small as he chooses. . . . With this it must be possible either to eliminate the sense of a proscenium opening or exaggerate it. . . . It must be possible to change easily the levels of the stage. . . . Entrances to the stage for the actors must be as many as possible — from the sides, from the rear, both at the stage level and from beneath it, from the audience and from beneath the audience. . . . It must be possible to stage a production on the apron, either wholly or in part. . . . Naturally, every facility for lighting must be provided, as well as adequate means of shifting what we now know as scenery."

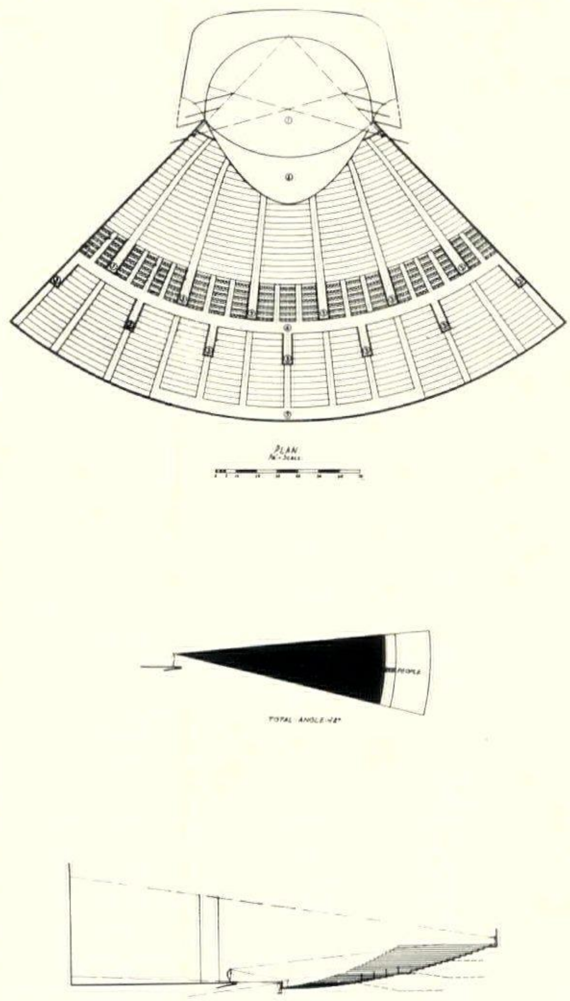
And so we have Mr. and Mrs. Penn hearing, seeing and feeling, as intensely as we know how to make them, the imagery evoked from an instrument flexible enough for the manipulation of a genius. We hope they will enjoy the performance.

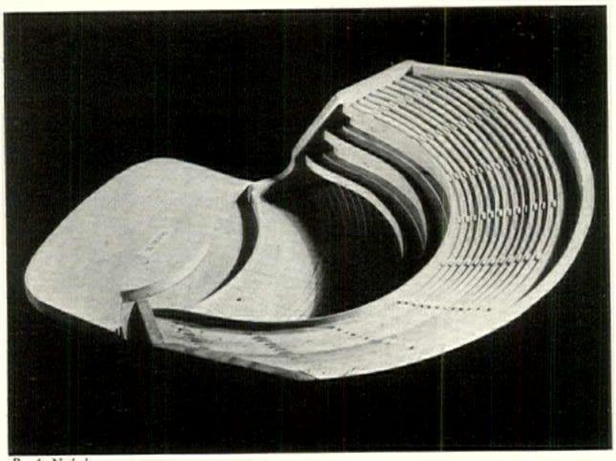
Scheme C. Amphitheater type with a wide sight angle and loge boxes. The seating capacity is 3,100, the gross area 23,000 sq. ft., the width of the auditorium at rear 266 ft., the width of the proscenium 80 ft., expanded width of proscenium 108 ft., the number of boxes 60, and the space occupied per person 7.4 sq. ft. The arrangement of the boxes is non-traditional. In relation to the lot this scheme is too wide in plan. If placed in other direction it would be necessary to raise the auditorium above the street to make space for lobbies. The stage would still be too small



P. A. Nyholm

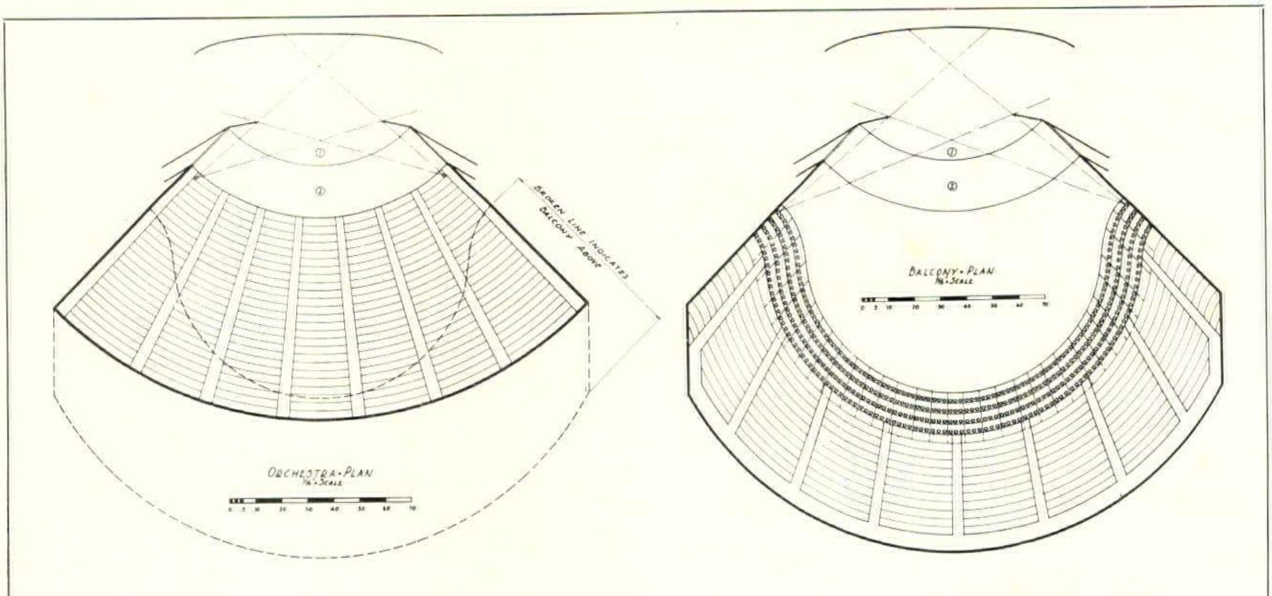
Scheme C. Designated on the analysis chart on page 248 as Theater No. 2





P. A. Nyholm

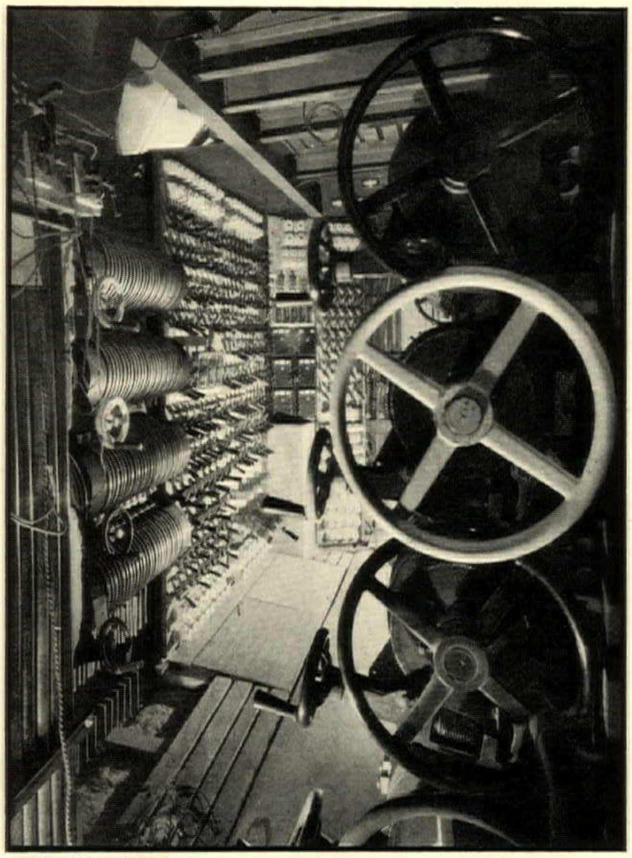
Scheme D. Designated in the chart on page 248 as Theater No. 8. It is a horseshoe type with a wide sight angle with opera boxes in two levels and a widely projecting balcony at the sides. Seating capacity in the orchestra 1,840, seating capacity in the balcony 1,760. The gross area of the orchestra is 12,800 sq. ft. The gross area of the balcony 16,000 sq. ft. Width of orchestra at rear 205 ft., width of proscenium 70 ft., expanded width of proscenium 100 ft. The number of boxes is 62 and the space occupied per person 8 sq. ft. The arrangement of the boxes is traditional and the scheme is a possible one in relation to the lot



SUMMARY

PANEL MARK	NUMBER OF SEATS	% OF AUDIENCE	CUMULATIVE % OF HOUSE	% OF ACTING AREA
A	1206	34.1%		100%
B	812	25.3%	59.4%	94-100%
C	732	18.3%	77.7%	88-94%
D	490	17.0%	94.7%	82-88%
E	180	5.3%	100%	76-82%
TOTAL	3420	100%		

ENGINEERING & BUSINESS



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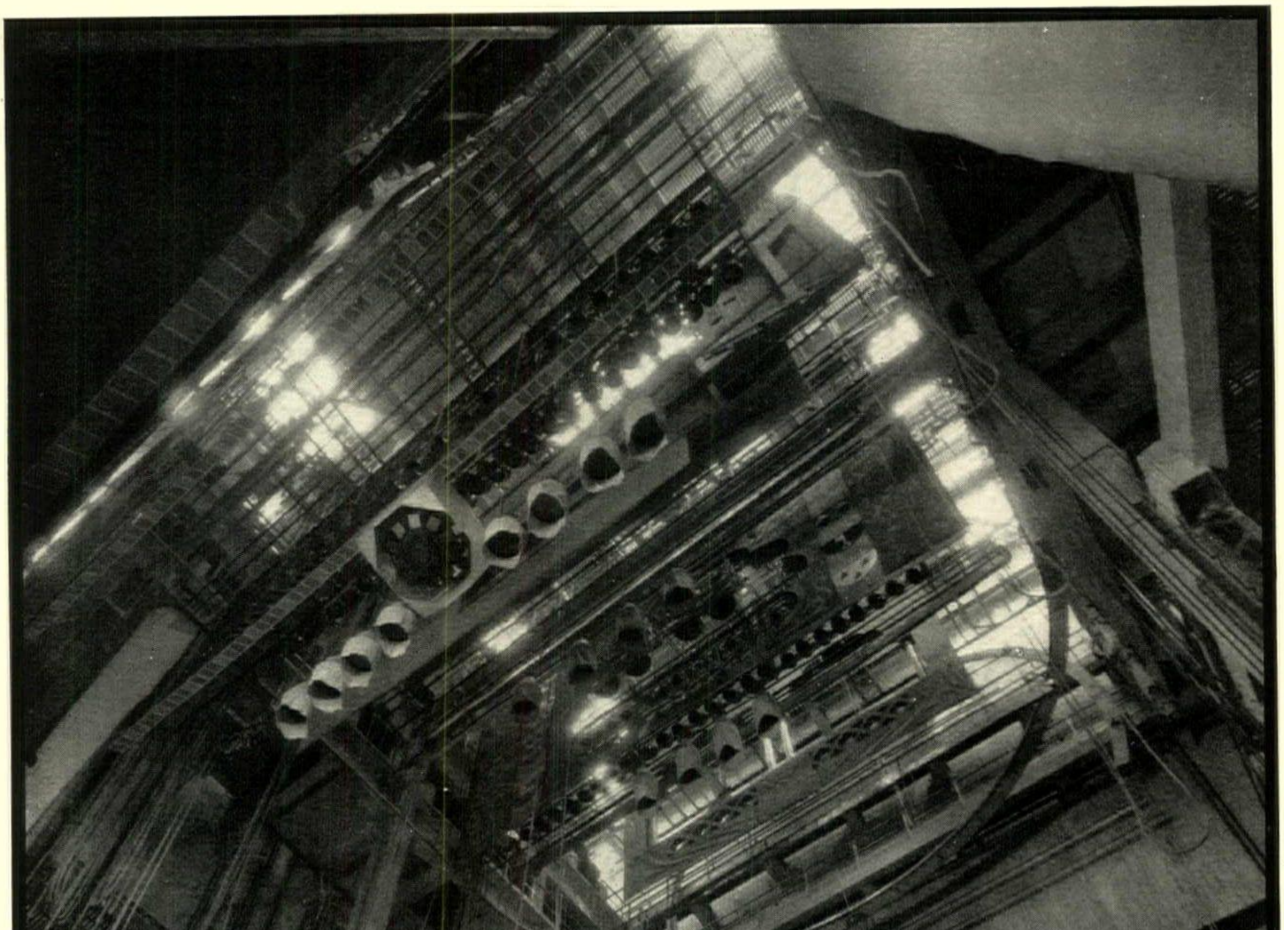
NEW THEATERS FOR THE CINEMA . . . THE PROBLEM OF ACOUSTICS . . . STAGE DESIGN AND EQUIPMENT . . . LIGHTING THE LEGITIMATE THEATER . . . AIR CONDITIONING THE AUDITORIUM . . . AN OUTLINE CHECK LIST . . . ARCHITECTURAL FORUM DATA AND DETAILS OF STAGE CONSTRUCTION AND EQUIPMENT



Courtesy of Draeger Imp., Paris

PARAPHERNALIA OF ILLUSION

PIGALLE THEATER, PARIS, FRANCE

NEW THEATERS FOR THE CINEMA

BY

BEN SCHLANGER *

THE motion picture as a form of entertainment has made notable strides in recent years. It is the dominant instrument which brings to the masses, in remote as well as in centralized locations, an effective theater art, heretofore out of reach. It is only in the past few years that the motion picture has, due to many technical developments, proved itself a form of the theater arts that is worthy of a home or structure specially designed for its needs.

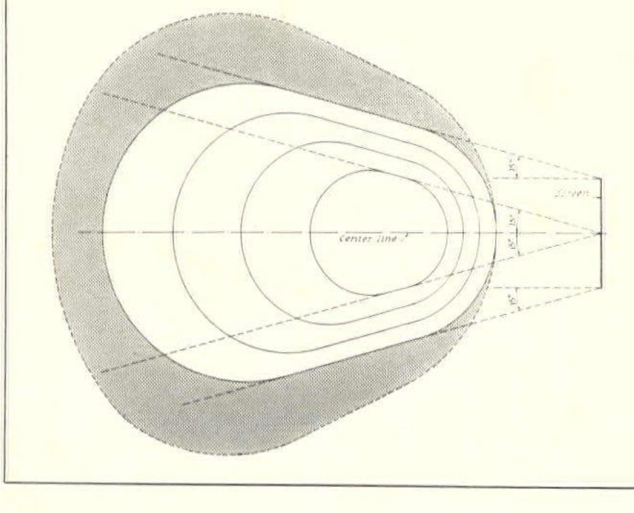
A survey of the policies of theaters now in use would probably show that most of them are devoted to the exhibition of motion pictures exclusively. Many of them at one time housed a combined entertainment of legitimate stage performance and the motion picture. The feeling that the motion picture was merely an added attraction may explain why theater structures today are unsuited for proper motion picture exhibition.

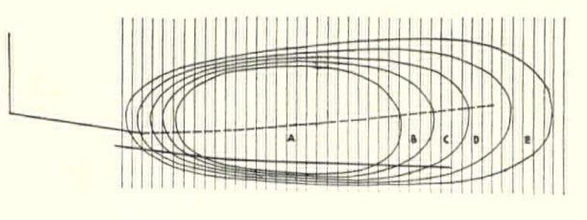
Although the requirements of vision, of acoustics, and of the comfort of the patron are important in the planning of the legitimate theater, it will be found that these requirements are subject to a more precise adjustment in the case of the motion picture theater. The sounds and dialogue, now part of the motion picture, have a broader range of frequencies and volume than can ever emanate from a legitimate stage performance. This makes the problem of acoustics in the cinema a relatively more complex one and requires a more delicate adjustment of the form and treatment of the theater interior.

Basically, however, the acoustical requirements of the cinema and of the legitimate theater are similar, differing only in degree. It is the requirements of proper vision of the screen in the cinema which differ entirely from the requirements of vision of the legitimate performance. If necessary, acoustics in the legitimate theater could be improved to accommodate the audible screen performance, but in the matter of proper vision the very form of the legitimate theater structure is basically unsuited for, and difficult to adapt to motion picture presentation.

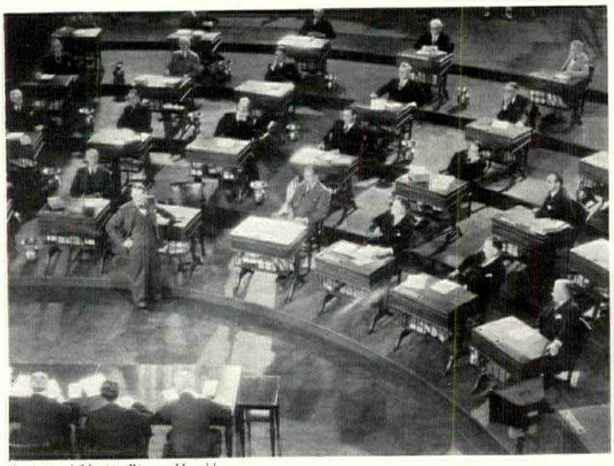
Viewing a stage performance is similar to observing images, backgrounds, etc., in real life. The performance, or that which is being viewed, holds a particular position and the spectator may be in any arbitrary position in relation to that which is being viewed. In any one of a variety of locations, the spectator receives his own particular perspective view of the performance. One view may be different from or better than another, but each still has its interest and value for the viewer. In the cinema, the camera becomes the many eyes of the spectators;

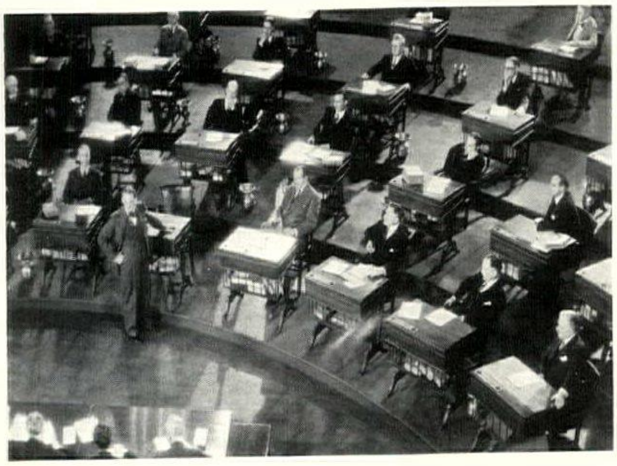
* EDITOR'S NOTE: Mr. Schlanger is an architect, a member of the Society of Motion Picture Engineers and has done much individual research on the problem of proper vision for the motion picture theater. The parabolic reverse floor system was developed by him. Although application has been made for a patent on the system, Mr. Schlanger is generous in offering any assistance that he may be able to give in the development of better planned cinemas.





These two charts illustrate graphically the usable areas for proper vision in a motion picture theater. Chart No. 1, at the left, determines the usable areas in a horizontal sense (plan view). The shaded portion indicates areas commonly used but affording poor seating positions. Chart No. 2, above, determines the usable areas in the vertical sense





Courtesy of Motion Picture Herald

These two scenes from a motion picture, "The Washington Masquerade," illustrate (at the left) a direct view and (at the right) a distortion of the same scene if viewed from a position outside an area 15° to a perpendicular erected at the edge of the screen. A similar distortion takes place above the 15° vertical maximum for good vision

it commands not only one perspective view of the performance, but many more impossible for the spectators of a stage, and transposes them on to a two-dimensional surface, the motion picture screen.

The spectator's position for viewing the screen performance is not an arbitrary one, as it may be in the legitimate theater. He must be seated within a confined area suitable for viewing the two-dimensional screen surface. The view obtained by each spectator of the screen is a similar one, for the perspective effects that would be seen from different vantage points in real life or on the legitimate stage have already been achieved by the moving eye of the camera. This means that the spectator's view of the screen images already thrown into perspective must not be additionally foreshortened or converged. A distorted view of the two-dimensional picture surface with images and background already thrown into perspective is very disturbing to ocular and physical comfort.

The author has developed two charts indicating the areas in the motion picture theater which are usable for proper vision of the motion picture screen. Chart No. 1 determines the usable areas in the horizontal sense (plan view). Chart No. 2 determines the usable areas in the vertical sense, representing a longitudinal section taken through a motion picture auditorium. The shaded portions in both charts indicate areas which are commonly used in many theaters but afford only very poor seating positions from which spectators obtain a distorted view of the screen image.

Figure No. 1 shows how a distorted view of a human figure results from the poor position of the spectator in relation to the screen. Dimension A is the full width of the human figure (plan view). Dimension B shows the foreshortening of Distance A due to the particular perspective view the motion picture camera has obtained — a view similar to that obtained by the spectator in a similar position in the legitimate theater. Distance C represents Distance A decreased, first, by a natural foreshortening (due to the camera angle) and, secondly, by the poor position of the spectator in relation to the motion picture screen. It is easily seen that if Distance C must represent Distance A, the result can be only a distortion of the image.

Distorted views of forms and background on the screen are accented most when the forms of back-

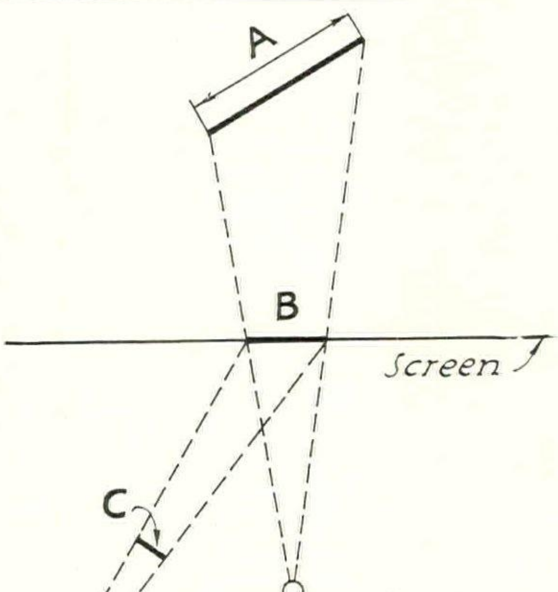


Figure 1

This diagram explains graphically the distortion apparent by comparing the two illustrations at the top of the page ground appear in sharp perspective. A view taken in sharp perspective in motion picture work is one of the most forceful and effective instruments of the motion picture art. Thus, it is necessary that the means of exhibiting must be allied with the production of the motion picture itself.

The comfort of the patron also requires more careful attention in the cinema than in the legitimate theater. The spectator in the cinema must be at ease and must feel neither bodily nor ocular discomfort. This is essential to help complete the illusion of realism desired, despite the fact that the images on the screen have technically only two dimensions.

The comfort of the patron depends upon the seating arrangement, which involves chair spacings, aisle arrangements, and the floor slopes and the balcony pitches. Chair spacing and aisle arrangements are largely controlled by the local building ordinances and the economies of space utilization for each individual project. But a more important and heretofore neglected consideration is the seating arrangement as it is affected by the needs of ocular and bodily comfort. A scientific adjustment of the floor slopes, balcony pitches, sightlines and individual chair back pitches is needed to insure the patron's comfort.

The floor that slopes up from the stage has been commonly used to gain unobstructed vision and has served its purposes so far as the needs of the stage performance were concerned. However, this type of floor is not efficient for the cinema; first, because it does not allow for the designing of the seating areas within the confines from which the screen may be properly viewed, and, secondly, because it does not permit the use of proper seats and chair back angles needed for the spectator's

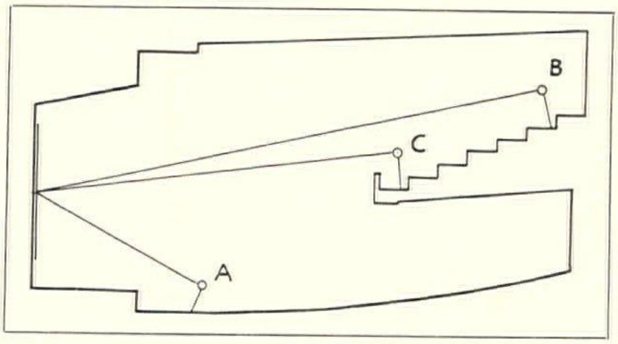


Figure 2. A diagram of the typical theater with the usual sloping floor and high balcony. Spectator "A" must tilt his head backward in order to view the upper portion of the screen. The steep angle of the balcony makes it necessary for "B" and "C" to lean forward in order to view the screen

comfort while viewing the entire height of the motion picture screen.

On the orchestra floor level, the present arrangement of floor slope requires (except at the extreme rear of the auditorium) that the spectator tilt his head backward to see the upper portions of the screen, in some cases to a somewhat painful degree. In the balcony the steep angle makes it necessary for the patron to pitch his body forward away from the support of the back of his chair in order to view the screen which, in most cases, is at a level below that of a greater part of the balcony or balconies.

The parabolic reversed floor system corrects all of the faults which become evident when the present type of theater structure is used for motion picture exhibition. This new system brings the high point instead of the low point of the floor nearest the screen. This permits a systematic tilting of the backs

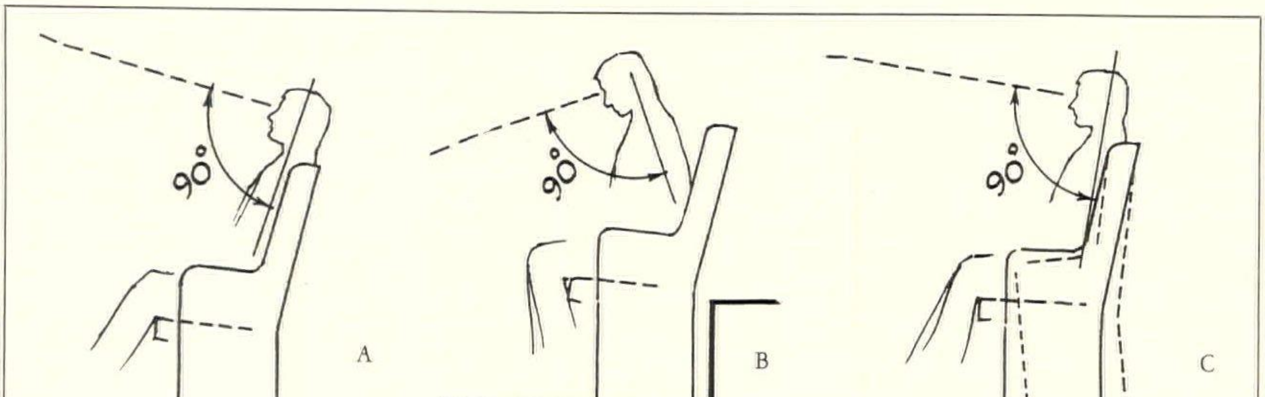
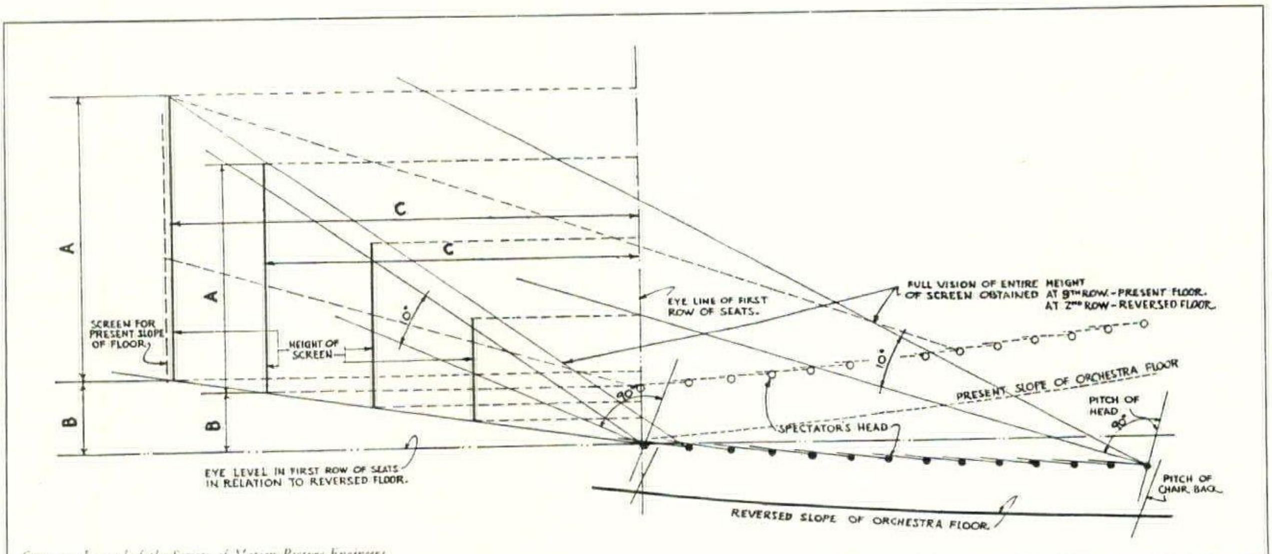
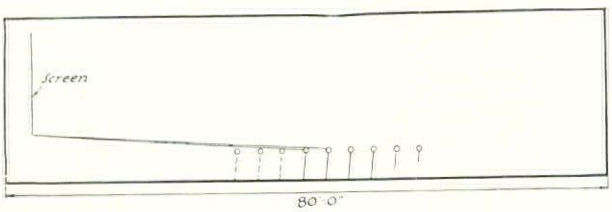


Figure 3. Scientific adjustment of the floor slopes, balcony pitches and individual chair back pitches is needed to insure the patron comfort. In "A," the spectator is forced to assume an unnatural head tilt in the orchestra. In "B," his position is uncomfortably reversed in the balcony. "C" illustrates the comfortable position assumed on a horizontal floor with a reversed pitch



Courtesy, Journal of the Society of Motion Picture Engineers

Figure 4, above, is a diagram for determining the screen level, sightlines, distances, slope of floor and pitch of seats. When the distance "C" is from 0 to 15 ft., $\frac{A}{X} = B$; when "C" is from 15 to 30 ft., $\frac{A}{Y} = B$; when "C" is from 30 to 50 ft., $\frac{A}{Z} = B$. In the diagram "C" = the distance from the first eye to the screen, "B" = the distance from the first row eye level to the bottom edge of screen; "A" = the height of the screen. Figure 5, below, shows that for proper screen vision approximately only half of a flat auditorium floor may be used to advantage



of the chairs on the reversed orchestra floor slope. By tilting the body backward to a specified pitch in each row and permitting the higher part of the floor in front of the seat to support the feet, a natural and comfortable position is assumed which allows the spectator to obtain a complete view of the screen without having to raise his head from its natural position. Seats on the orchestra level more remote from the screen require less tilt.

The angle of tilt in each case is perpendicular to a line of sight drawn from the eye level to a point on the screen about one-half its height from the lower edge. This is the area of maximum action where the spectator's eyes are most usually focused. The angle formed between the back of the chair and the seat is 98°. This is a constant for every chair, because it has been found most conducive to a correct and restful posture. Heretofore, only the position of the seats and the screen were taken into consideration in determining sightlines, the matter of posture being entirely disregarded. The screen itself is raised to a prescribed height above the level of the eye line of the first row of seats nearest it. The reverse slope of the orchestra floor permits establishing a definite relation between the inclination of the floor and that of the seat and the position of the screen. It would be impossible to apply this system of tilting to the present slope of the orchestra floor because the proper angle of the seat with respect to the back of the chair could not be maintained without leaving the feet unsupported. Sightlines from the orchestra level cannot, therefore, be improved for screen entertainment unless the slope of the orchestra floor is reversed.

While this arrangement distinctly improves the orchestra seating, it also serves as a means by which the complete form of the theater may be revised to suit the requirements of the screen performance. The faults of the present orchestra seating are greatly magnified when the enlarged screen is used because the spectator then has to tilt his head backward even further than it is now necessary with the small screen. And so the enlarged screen has also served as an important agent in determining a new form for the theater structure.

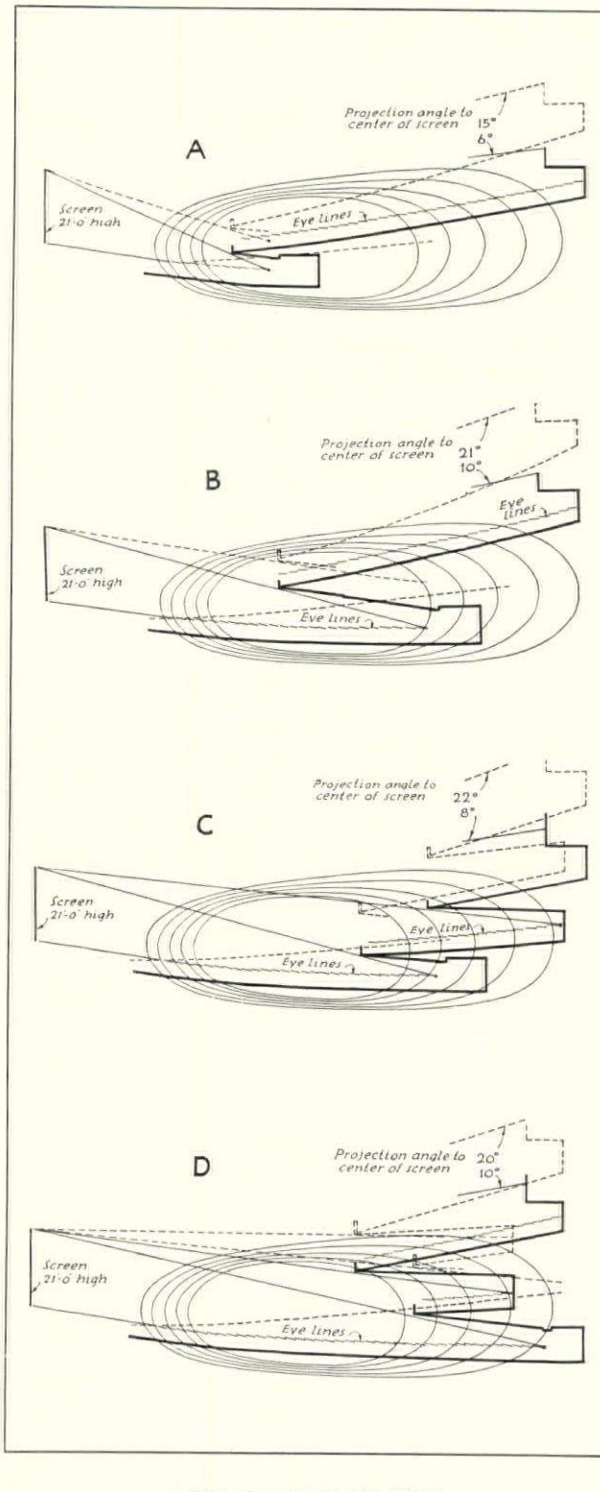
Reversing the slope of the orchestra floor also brings many decided advantages to the balcony, which can now be kept low and of a slight pitch, made possible by the low point of the rear of the reversed orchestra floor. The balcony thus becomes more desirable for two reasons: (1) due to the fact that the level of the screen is very much the same as that of the balcony, the sightlines are greatly improved, and (2) direct and easy access to the balcony from the street level is provided, the difference in levels being surprisingly small, compared to the difference in these levels to the usual theater.

A complete analysis of bodily posture has been made in connection with the parabolic reverse floor principle; the maximum and minimum angles at which the spectator may comfortably repose in seats placed on the different portions of the orchestra floor and on the balcony and yet maintain ocular comfort. It is of no value to be seated comfortably if the eye must be strained to see an image placed out of the normal range of vision. To avoid this fault in seating design, the author has correlated the factors of the normal range of vision and good bodily posture.

The Flat Floor and Its Relation to the Reverse Floor. The problem of exhibiting motion pictures in an auditorium having a flat floor presents itself when an auditorium (in institutional and non-commercial structures) is designed for multiple uses. While it is possible to exhibit motion pictures under such conditions, it can be properly accomplished only by a highly inefficient use of floor area. For example, in a room 30 x 80 ft., with a screen placed 4 ft. away from the end wall for the amplifying horn, only about one-half of the depth of the room is usable for proper seating. To make these seats usable, it is necessary to raise the position of the screen sufficiently to allow vision of the bottom edge of the screen from all seats. This renders the front half of the room near the screen unusable for seats, due to the high position of the screen which produces distorted screen images in relation to the low level of the floor at the screen end.

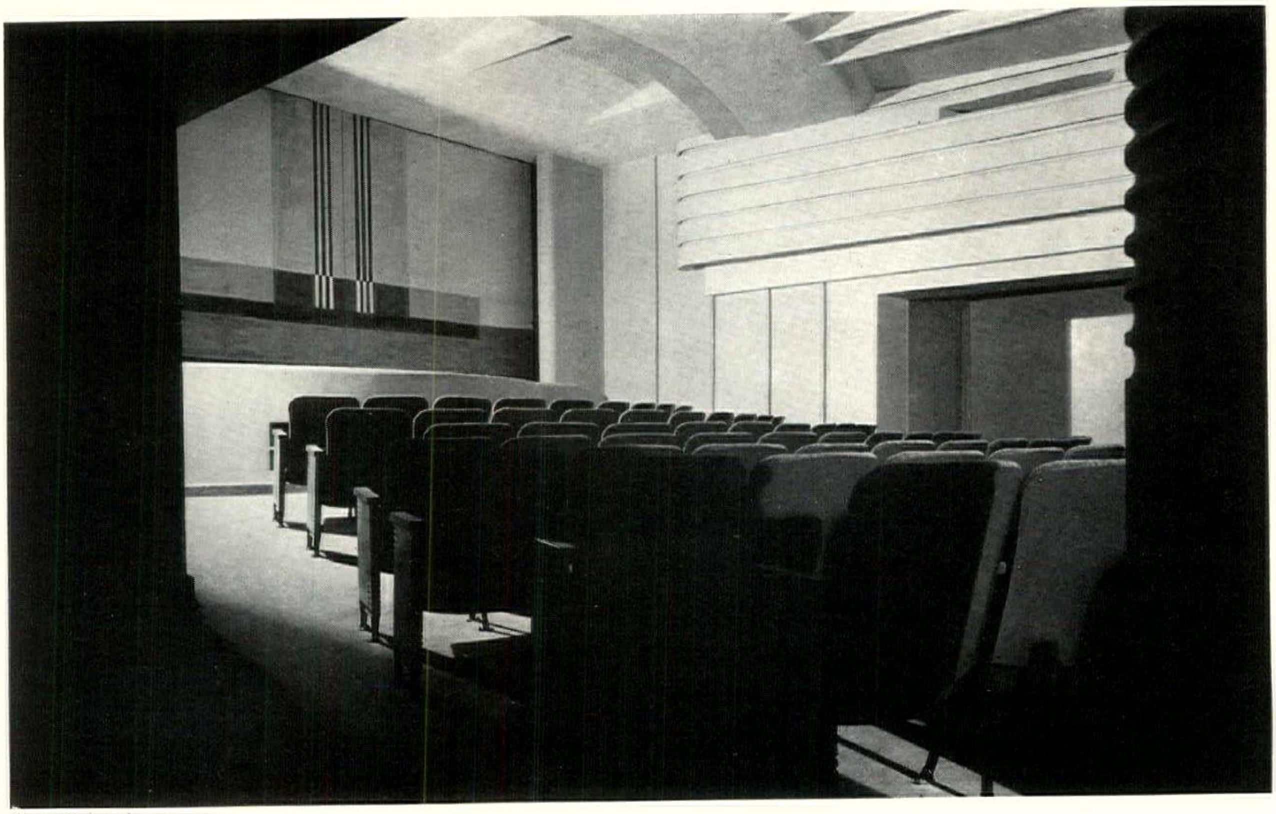
The reverse floor principle is an evolution of this factor of gain in the vertical range of vision due to increased distance from the screen and it is therefore an evolution of the flat floor rather than an improvement of the commonly sloped orchestra floor. The basic foundation of the parabolic reverse floor principle is the position of the screen in relation to the gain in the vertical vision due to distance from the screen. The position of the screen and degree of the reverse slope (which controls the angle of chair back tilt) can be determined, however, only from a thorough analysis of all the factors involved. (See Figure 6.)

Screen Size, Proportion and Third Dimension. The screen is the motion picture stage. It is the nucleus of the whole theater design, the point around which the whole theater should be built. The dramatic effect of the screen performance on the spectator has yet to be thoroughly analyzed. The screen as it is presented in today's cinema is still an obviously framed picture instead of a space into which we peer, seeing the projected other world of the cinema. To achieve this much-desired effect, the scientific development of the third dimension effect on the screen is a primary necessity. This, however, implies many technical difficulties, and

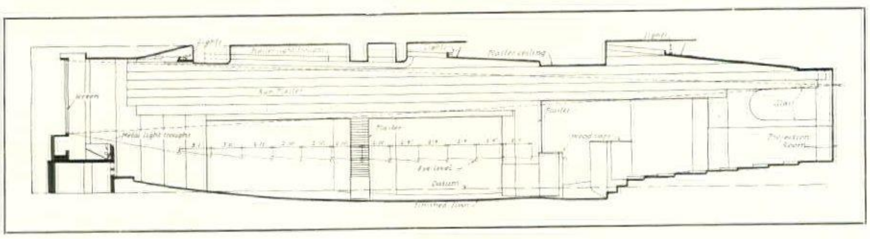


APPLICATION OF THE PARABOLIC REVERSE FLOOR

Figure 6. These four diagrams illustrate the economy of space which may be achieved by utilizing the parabolic reverse floor system. The dotted section lines show the orchestra and balcony floors of four common types of motion picture houses. The heavy lines show that with the parabolic reverse floor the capacity of the theater may be maintained, the visual efficiency raised and the comfort of all spectators greatly increased



Keystone-Underwood



At the left is a section of the Thalia Theater, New York, Ben Schlanger and R. Irrera, Architects, and above is a view of the orchestra in the Thalia Theater which illustrates the practical application of the parabolic reverse floor system

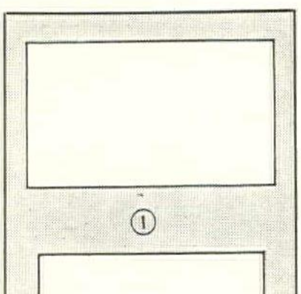


Figure 7. Three proportions for moving picture screens. No. 1 has a proportion of 1 to 1.8 and accents the horizontal direction. No. 2, having a proportion of 1 to 1.67, permits both the vertical and horizontal directions to be well balanced for picture composition and may be modified to achieve any desired shape. No. 3, the present screen, accents the vertical direction. No. 1 and No. 3 are not susceptible to changes in shape, because a modification would result in too great a reduction in the picture size

until they are overcome, other means at present more available must be used to increase the screen illusion of space reality. Upon these means, namely, the proper size, proportion and framing of the screen, depends the effective delivery of the performance to the spectator.

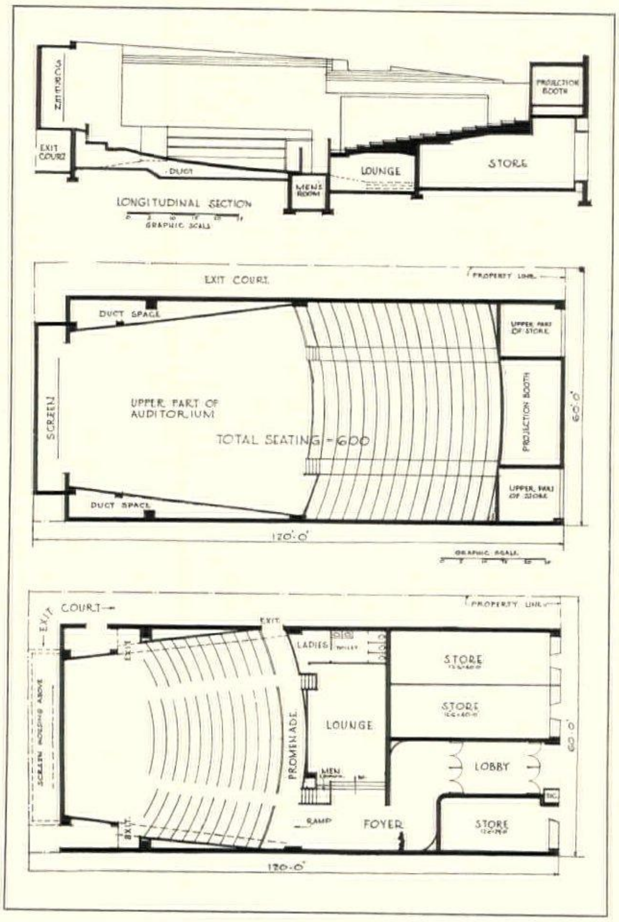
A maximum size screen is desirable. It should, if possible, dominate the whole forward portion of the auditorium. The spectator can thereby be made to feel that he is actually encompassed in the action which he views. The maximum size screen also enlarges the scale of images and backgrounds in relation to the spectator, thereby heightening the dramatic effect.

The size of the screen is dependent upon (1) the width and depth of the auditorium; (2) distance sacrificed between the screen and the first row of seats; (3) distance from the screen to the row of seats furthest from the screen; (4) the location of the balcony facia or facias fixes the maximum height of the screen (the usual large overhanging balcony limits the height of the screen); (5) the shape of the screen; (6) the width of the motion picture film (at present 35 mm.; a 50 mm. width is now being considered); (7) projection lens size; (8) length of throw from projector to screen.

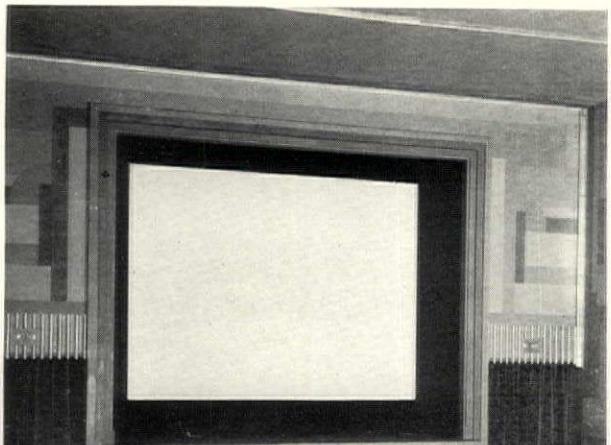
The present type of theater structure cannot accommodate a large screen. There may be sufficient space in the proscenium opening, but balcony obstructions and unsuitable floor slopes afford vision characteristics which are adaptable only to the smaller screen now in use. A maximum size screen is very readily usable in a theater with reverse slope floor.

The proportion of the screen is an important factor in cinema design inasmuch as it controls the size of the screen. For example, the height of the screen should determine the slope and position of the floors and balconies, the shape of the auditorium, the location of the projection booth, the seating arrangement, and the chair back pitches. The width of the screen determines distances B and C shown on Chart No. 1. It is therefore necessary to investigate screen proportions before planning the cinema auditorium.

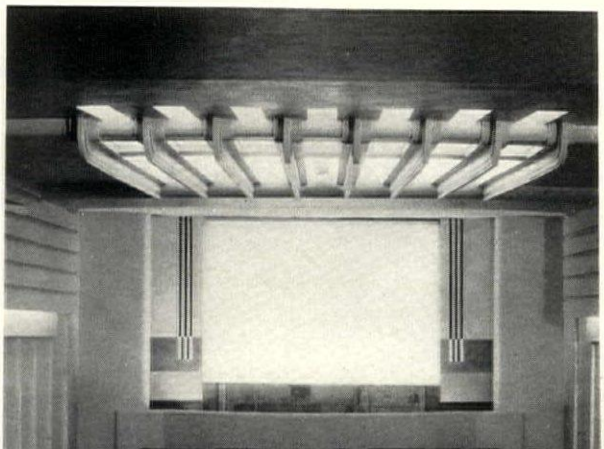
Screen Framing. Motion picture screens are commonly framed with a black velvet masking placed directly in front of the white sheet to insure a steady, sharp edge for the picture. The fuzzy edge of a magnified light source and the slight shifting of the picture due to vibration in the projection machine is invisible to the spectator because the black masking absorbs a few inches of spilled light all around the screen. However, because of contrast, the eye is always somewhat conscious of the frame, instead of the picture image only. The result



Plans and a section of the projected theater employing the reverse floor principle. Due to the location of the balcony, the capacity is more than usual in a small house, and the space under the balcony may be put to commercial use



Folger



Keystone-Underwood

At the left is a screen masked with a typical frame of black velvet used to insure a steady, sharp edge of the picture. At the right is the screen in the Thalia Theater which shows an even tone of light stretching from wall to wall. An obvious architectural frame is lacking and the screen image blends naturally into its surroundings is distraction and eye fatigue. In addition, the obvious frame of this type of masking destroys the illusion of space realism so much desired.

The illuminated screen and its surrounding surfaces should appear as an even tone of light stretching from side wall to side wall. The screen image in effect should blend into the side walls and ceiling, for the obvious architectural proscenium frame is useless and detrimental to the screen performance. This portion of the cinema is subject as yet to some important study relative to the transition between the audience and the performance.

A recessed masking was employed by the author in the design of the Thalia Theater, in New York, to decrease the sharp contrast heretofore mentioned. A haze of light around the screen projected from the side wings was used.

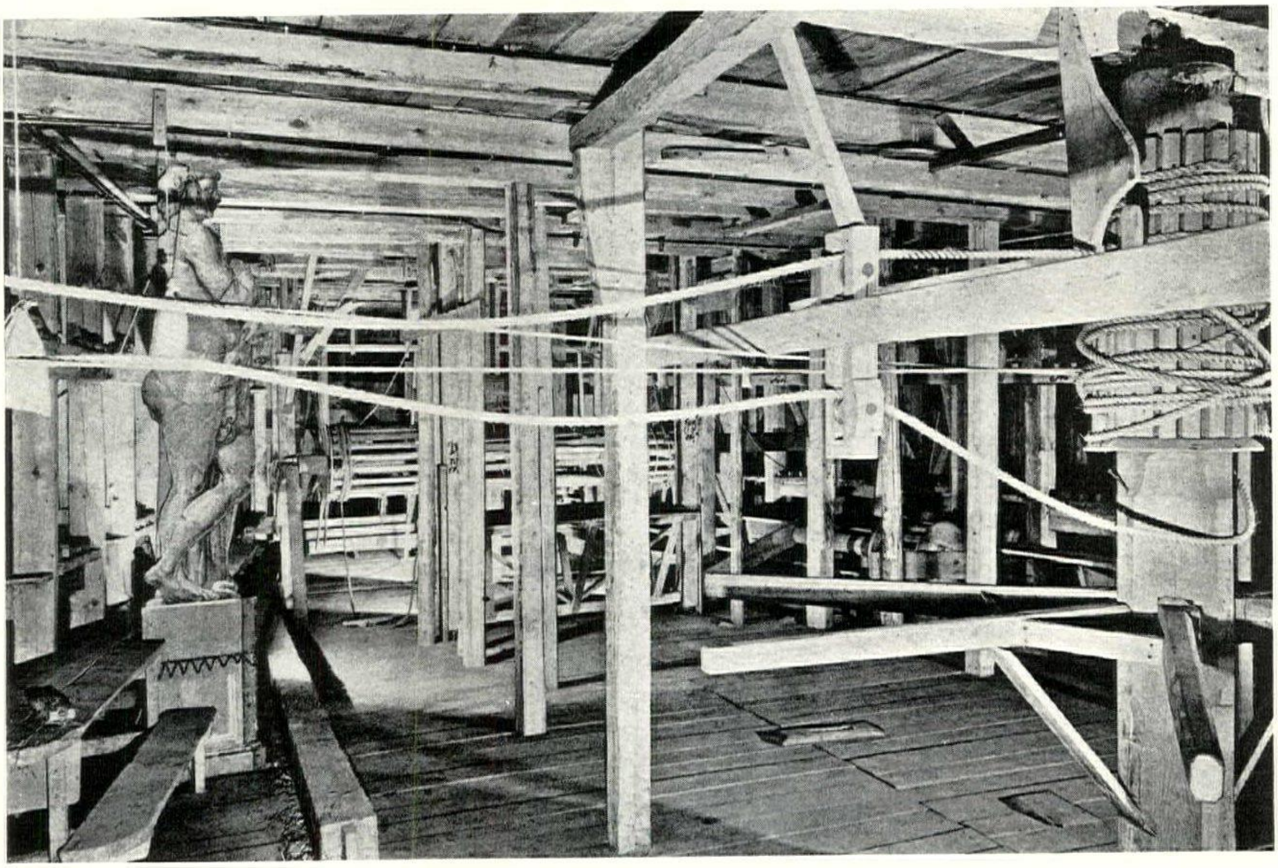
Projection and Projection Booth. In the placing and planning of the projection room, the following factors are important:

1. The projection angle due to the position of the booth in relation to the screen. Most booths are placed at a level over the top of the high point of a balcony. This implies excessive projection angles which produce distorted screen images. A projection angle of 18° taken from the lens center of the projection machine to a midway point on the height of the screen is suggested as a maximum angle to avoid distortion.

2. Projection room layout and equipment. (See typical plan on page 276.) The leading projection equipment manufacturer should be consulted for information relating to the necessary wiring, piping, etc., in connection with booth equipment.

3. Projection booth enclosure construction. The projection booth should be constructed so as to be soundproof, in order to eliminate from the auditorium all machinery noises, vibrations and the sound-recording monitor horn in the booth used by the operators for checking the sound in the auditorium. (See United States Government bulletin for information on sound-proof wall construction.)

EDITOR'S NOTE: Complementing Mr. Schlanger's article from the standpoint of technical projection and sound equipment, there will be in the October issue an article on the installation of motion picture equipment by Harry B. Braun of the Photophone Division of the Radio Corporation of America.



The theater in Drottningholm, Sweden, was built in the year 1766 and contains many stage properties and costumes from the time of Gustav III. The illustration above showing part of the stage equipment is particularly interesting in contrast with the many highly mechanized devices which are a necessity to the theater stage of today

ACOUSTICS IN THEATER DESIGN

BY

PAUL E. SABINE

DIRECTOR, RIVERBANK LABORATORIES

THE securing of good hearing conditions does not impose any very hard and fast demands that must be met at the sacrifice of other desirable features of design. Rooms are rendered acoustically good through the absence of defects rather than by the possession of positive virtues. As evidence of this may be cited the fact that in the older theaters of conventional types, with one or two balconies and seating less than 1,200 people, the acoustic properties are generally quite excellent. As exceptions, one calls to mind certain outstanding examples in which in response to the client's demand for something novel and striking, the architect has resorted to new and untried forms, with unfortunate acoustical results. Limitations as to size, the necessity of keeping distances from the stage small enough that the most remote seats will come within the range of the unaided speaking voice, tend to obviate acoustical defects.

With the advent of talking motion pictures, and of satisfactory means of sound amplification, these limitations have been removed. The present trend toward much larger houses, intended for widely diversified uses, including vaudeville numbers, sound films, and orchestral performances, makes acoustics a much more important element of the designer's problem. Viewed from the standpoint of utility only, this problem is simply to provide seats for a large number of people so that all may see and hear clearly what transpires on the stage. It is the purpose of this article to deal briefly with the conditions necessary for good hearing.

There are a few simple rules which may be followed in design that will go far toward insuring satisfactory hearing conditions. They may be enumerated as follows:

1. Side walls and ceiling in the front of the room should reflect the sound at nearly glancing angles to the sides and rear of the room.
2. Extended curved wall or ceiling surfaces, particularly those with curvature in two planes, should not have centers or axes of curvatures that fall either on the stage or near any portion of the audience.
3. The average ceiling height should be determined by the number of seats, so that the cubic contents per seat is not greater than about 200.
4. The total sound-absorbing power should be such that with the average audience present the reverberation time computed by the reverberation formula will fall within the range of acceptable values for a room having the volume of the proposed room.
5. Upholstered seats should be specified in rooms in which frequent small audience use is to be expected.

The reason for Rule 1 is obvious enough. From the standpoint of hearing, as well as of seeing, seats in the center and near the front are more desirable than those at the sides and rear. Proper design under this rule will materially lessen the undesirability of the side rear seats. The operation of the rule will in general lead to a fan-shaped or spatulate plan, and a ceiling which slopes upward from the stage opening. Both these features of theater design are desirable for other than acoustical reasons. The fan-shaped plan is good by virtue of the fact that the angle between the line of vision from seats at the side to the stage does not become excessive, while the sloping ceiling is a natural means of taking care of the greater height at the rear required by the balconies. The tolerances that are allowable under our first rule in the particular contours employed still leave considerable leeway for individuality in any particular case.

Attempts to direct sound to specified points by precise design of contours are to be discouraged. The fact that the sound in a theatrical performance does not originate at a fixed point on the stage makes this impossible. One is satisfied to know the general direction which the reflected sound will take and this can be determined by the simple law that the direct sound and the reflected sound make equal angles with the normal to the reflecting surface. An easy geometrical construction for determining the direction in which sound will be reflected from a surface is shown in Figure 1. If sound originates at S and is reflected from the surface MN, pass a perpendicular to MN (extended if necessary) through S. Locate S′ on this perpendicular so that S′ and S are equally distant from MN. S′M and S′N will mark the boundaries of the reflected beam. In this way one can easily determine the general direction which sound will take after reflection from any given surface. This construction will prove useful in determining the proper angle between the side walls and the curtain line, as well as the upward slope of the proscenium and of the ceiling from the proscenium opening.

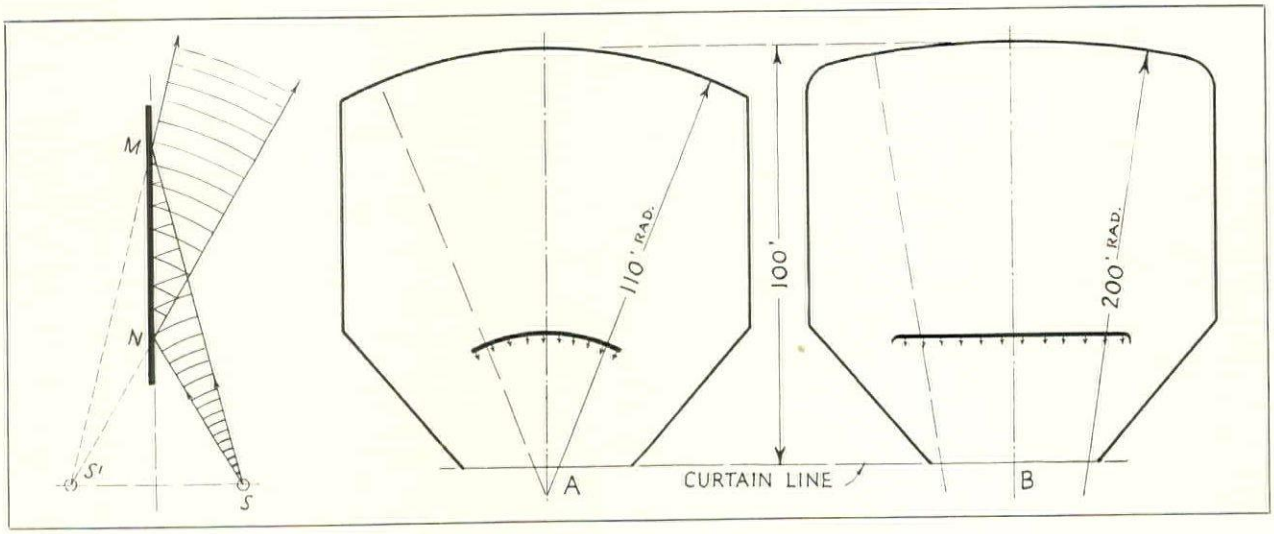


Figure 1, above at the left, shows the construction for determining the direction of sound reflected from a given surface. The two plans at the right constitute Figure 2. In A the curved rear wall with center of curvature on the front focuses reflected sound at the point of origin. In B the focus effect is reduced by increasing the radius of curvature to twice the distance from curtain line to rear wall

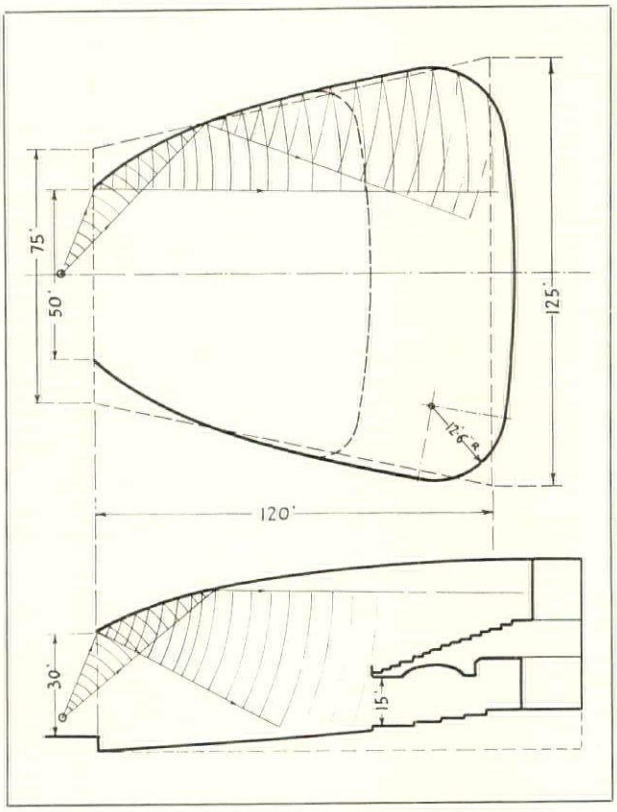


Figure 3. A suggested plan and section for a theater with one balcony, seating 2,400 persons. It illustrates a design conforming to the rules enumerated on page 261

The second rule calls for careful scrutiny of the curvature of rear walls, particularly in talking motion picture houses. It prohibits the use of domed or vaulted main ceilings, centering at or near the head level of the main floor audience and calls in general for careful examination of the effects of extended curved shapes. One frequently meets plan designs for large houses, in which the seating and the rear walls are circular and centering near the curtain line. This arrangement accentuates the rear wall echoes that to a greater or less degree may be detected in the forward half of almost all large theaters. In Figure 2, the curved rear wall centering on the stage shown in A, focusses the sound which it reflects to the point of origin with an annoying "back slap" for the performers and the auditors in the front of the house. In B, the main curvature is flattened out to a radius of curvature twice the distance from curtain line to rear wall, with a corresponding reduction in the concentration. The same rule applies to the curvature in transverse section of ceiling vaults. A cylindrical vault of uniform curvature whose axis falls within the room will result in undesirable concentrations of ceiling-reflected sound, whereas a slightly curved main portion with coved sides is innocuous.

The application of all the principles of good acoustical design can perhaps be best illustrated by taking a specific case and noting the points at which acoustic demands enter into the development of the plans. We will suppose that we have to design a theater with only one balcony and 2,400 seats. It is specified that the most distant seat on the main floor shall not be more than 130 ft. from the stage. Varied types of entertainment, including vaudeville numbers, musical shows, talking motion pictures and orchestral performances, are contemplated. Approximately two-thirds of the seats are to be on the main floor. Hearing conditions are to be good with only two-thirds of the seats filled.

The horizontal dimensions are fixed by the number of seats that have to be provided. Allowing 7 sq. ft. per seat, including aisle space, the 1,700 main floor seats call for an area of 1,700 × 7 = 11,900 sq. ft. The requirement of a maximum distance of 130 ft. will allow a depth of 120 ft., let us say, so that the average width must be 11,900 ÷ 120 = 99 ft. Suppose we adopt a trapezoidal plan as likely to provide useful side wall reflections of sound. With a 50 ft. stage, and with an allowance of 12½ ft. on either side of the proscenium opening, we have a width of 75 ft. at the stage end of the trapezoid. For an average width of approximately 100 ft., the width required at the rear is then 125 ft. Roughly, the plan would be that indicated in the dotted lines of Figure 3. In the solid lines there is suggested a natural development of this floor plan. The radius of curvature of the main portion of the rear wall is twice the depth, thus minimizing the possibility of concentrated rear wall reflections. The coved corners at the rear will not produce any undesirable effect since the time lag between direct and reflected sound will be extremely short at points where the concentration due to these surfaces will occur. Using the construction already described, we find that the side walls reflect sound originating on the stage to the sides of the room at the rear, thus meeting the requirements of our first rule.

The requirement of 700 balcony seats with a spacing of 6 sq. ft. per seat calls for 4,200 sq. ft. of balcony seating space. Stepping the rear line of the balcony 5 ft. back of the rear line of the main floor we have a balcony overhang of 37 ft., not an excessive amount if we provide ample height of the under-balcony ceiling. The height of the balcony opening should be not less than one-third the under-balcony depth to insure an ample supply of sound to the rear main floor seats. Making a liberal allowance on this score, we shall call for a height of 15 ft. from the main floor to the under side of the balcony front.

In developing the sections from the plan we get the average ceiling height that is acoustically desirable from the application of our third rule. Two hundred cubic feet per seat calls for a total cubical content of 2,400 × 200 = 480,000 cu. ft. With a plan area of approximately 12,000 sq. ft., the average ceiling height should be about 40 ft. A suggested longitudinal section is shown in Figure 3, on which it will be noted that the forward portion of the main ceiling reflects sound usefully to the seats at the rear of the main floor and throughout the entire balcony. The curvature of the ceiling in longitudinal section is so slight as to produce no appreciable concentration of the reflected sound.

The curved contours in plan and longitudinal section suggest curved transverse sections. To avoid the possibility of focusing in the transverse plane, a flat elliptical arched ceiling is suggested. The main

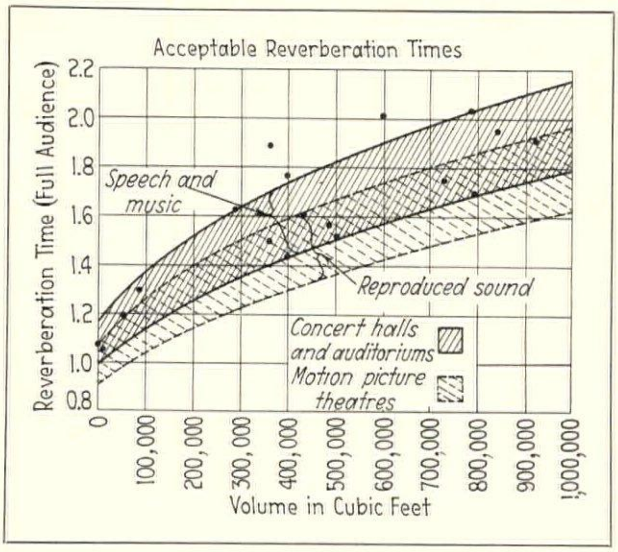
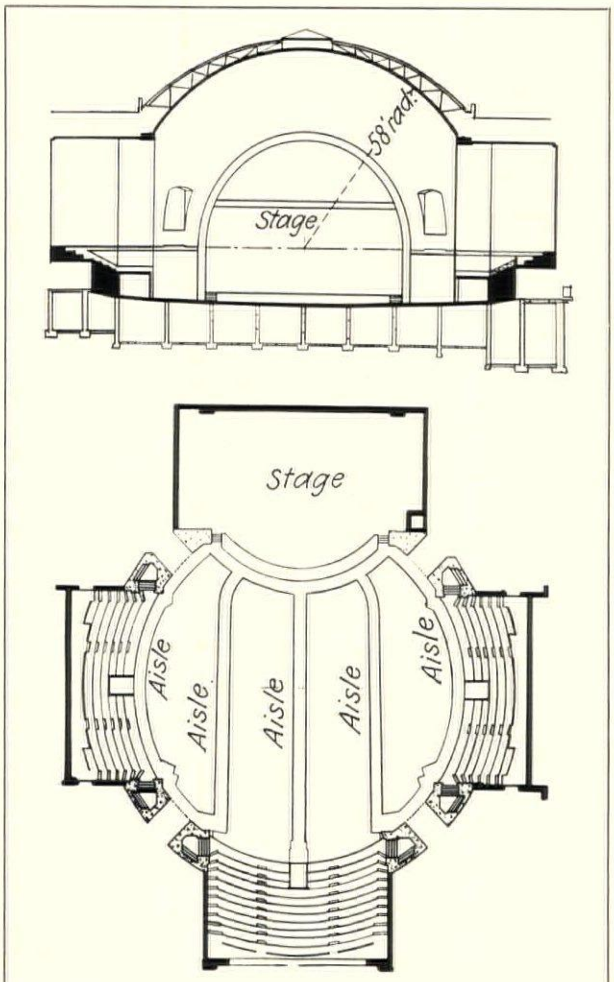


Figure 4, above, shows the acceptable reverberation times for rooms of different sizes and uses. In Figure 5, below, the focused echoes from ceiling dome and cylindrical walls rendered this room acoustically intolerable



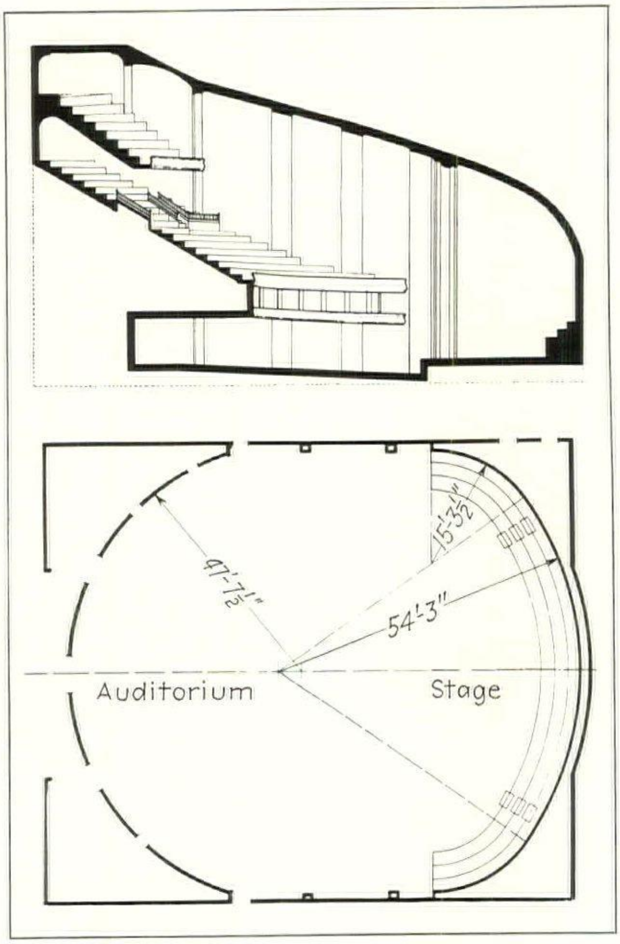


Figure 6. Good ceiling design renders hearing in balconies excellent, but the curved stage and rear walls give unsatisfactory acoustical conditions on the stage and at the front of the main floor

central portion should have a radius of approximately 80 ft., with sharply coved portions at the side. The development of these sections may call for one or more architectural breaks in wall and ceiling lines. These are acoustically quite unobjectionable. Moreover, acoustical considerations impose no limitations upon the relief of wall and ceiling surfaces by architectural ornamentation.

In the foregoing, our design was developed with the requirements for good hearing primarily in mind. We arrive at a result that shows no marked evidence of its acoustical motivation. We have used curved forms without running the risk of acoustical difficulties and have provided for a nearly equal distribution of sound intensity throughout the room. It only remains to consider the proper reverberation time in view of the varied uses to which the room is to be put. In Figure 4, the range of reverberation times, which experience has shown to give good hearing conditions in rooms of different volumes, are plotted as a function of the volume in cubic feet. We note lower values for reproduced sound than in rooms intended for speech and music. Since in the case considered, various uses are contemplated, we shall take the middle of the range that covers all uses and we find that for a room of 480,000 cu. ft., a reverberation time of 1.5 seconds is acceptable. This is computed by the well-known formula $T = .05\ V/a$, in which V is the volume in cubic feet and a the total sound-absorbing power of the room. We compute the total absorbing power needed to give a reverberation time of 1.5 seconds as follows:

$$1.5 = .05 \times \frac{480{,}000}{a}$$

from which $a = 16{,}000$ units.

Assuming that all the seats are heavily upholstered, and that the aisles and open spaces are carpeted, we can estimate the total absorbing power of the room, by multiplying the area of each surface exposed to sound by its known coefficient of absorption. Such an estimate shows that with 1,600 people present, the total absorption is approximately 13,000 units. Therefore, to reduce the reverberation time to the desired value, 3,000 additional units have to be supplied by the application of commercial absorbents of one sort or another. The choice and location of the material employed for the purpose will be to some extent determined by circumstances. It is good practice to reduce rear wall reflection as much as possible. To effect this we should treat the rear walls both below and above the balcony with a highly absorbent material. Various materials with coefficients of more than 0.75 are now on the market. The area available in our example is about 2,600 sq. ft. which, with a coefficient of 0.75 gives 1,950 of the required total of 3,000 units. In the present instance, the remainder of the requirement for additional absorption could be secured by the use of a sound-absorbent plaster with a coefficient of about 0.30 on the 4,500 sq. ft. of ceiling above the balcony. So treated we have for the total absorbing power:

Room and audience	13,000
Rear walls 2,600 × .75	1,950
Balcony ceiling 4,500 × .30	1,350
	16,300

This will give a reverberation time of

$$T = \frac{.05 \times 480{,}000}{16{,}300} = 1.48$$

It should be said that all we have tried to show by the preceding example is that the demand for good hearing conditions does not call for any special features of design. The solution given is by no means the only solution, and probably not the best one. We have simply shown that starting with a conventional seating plan, and proceeding along natural lines, but with acoustical considerations in mind, we arrive at a design that needs very little doctoring to make it acoustically acceptable for almost any type of performance. Had the program called for 3,000 or 3,200 seats, the addition of a second balcony with a corresponding increase in the average ceiling height to 60 or 65 ft. would be found to meet good hearing requirements excellently. Had we been designing a hall for opera with a seating capacity of only 2,400, the addition of boxes would necessitate a greater ceiling height, suggesting a second balcony and somewhat reduced floor plan dimensions.

In this connection a comment on the acoustics of the so-called "atmospheric theaters," somewhat in vogue at the present time, may not be out of place. In these heavy architectural relief ornamentation of side walls simulate an out-of-doors scene with a plain vaulted ceiling representing the overarching sky. To get the effect a great ceiling height is required with a correspondingly large ratio of volume to seating capacity. This will result in an increased natural reverberation, necessitating a liberal use of artificial absorbents, in order to reduce reverberation to a desirable figure. Moreover, the beneficial results of ceiling reflection to the rear of the room are lost. With amplified sound, the latter are not essential, so that with proper control of reverberation, and with care in the design of the transverse sections of the ceiling arch, this type of room may be made quite acceptable for talking motion pictures. It does not, however, lend itself readily to the acoustical requirements of the varied uses to which most large theaters are put nowadays.

Figure 5 shows a design which meets none of the requirements for good acoustics, except that of proper reverberation. Here the architect made the mistake of assuming that if the reverberation is right the acoustic properties will be good. Focused echoes from the spherical dome centering only 10 ft. above head level on the main floor, and from the cylindrical walls make hearing extremely difficult and annoying. It may be said that, acoustics aside, there are several points open to serious criticism on the score of auditorium design. It is beautiful architecture, but a poor auditorium. It is now in process of complete remodeling.

Figure 6 shows the plan and section of Orchestra Hall in Chicago. Hearing in the balconies is excellent. The unfortunate curvatures of the main floor and stage walls produce trying conditions for the performers on the stage and auditors in the front of the room.

Figure 7 shows in longitudinal section the series of expanding flat elliptical ceiling arches of the Auditorium Theater of Chicago. This room was designed some forty years ago, and its lines were probably dictated by other than acoustical requirements, yet we see in the splayed side walls near the stage and the general trend of the ceiling line upward from the proscenium acoustically good features of design. Two rows of boxes with fabric and upholstery furnishings, and heavily upholstered seats provide sufficient natural absorption to give a computed reverberation time of 1.9 seconds, a desirable value for a room of this size, nearly 1,000,000 cu. ft., intended primarily for opera.

In conclusion, it may be said that ordinarily theater design presents the least difficult of acoustical problems. The requirement of getting the maximum number of people into the minimum space, and the observance of the simple rules here set forth do not leave much chance for serious error in the usual case. When, however, as sometimes happens, special conditions call for a room of monumental proportions or for the use of new and untried shapes, the architect should be well advised while his plans are still in the sketch stage of development.

*The accompanying figures taken from "Architecture and Acoustics" are published with the kind permission of the McGraw-Hill Book Company.

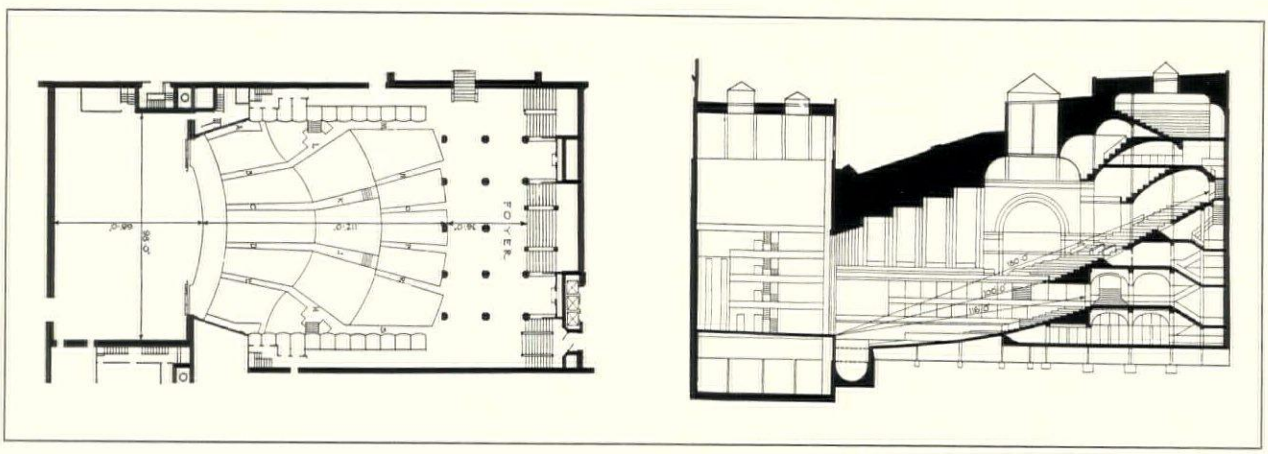
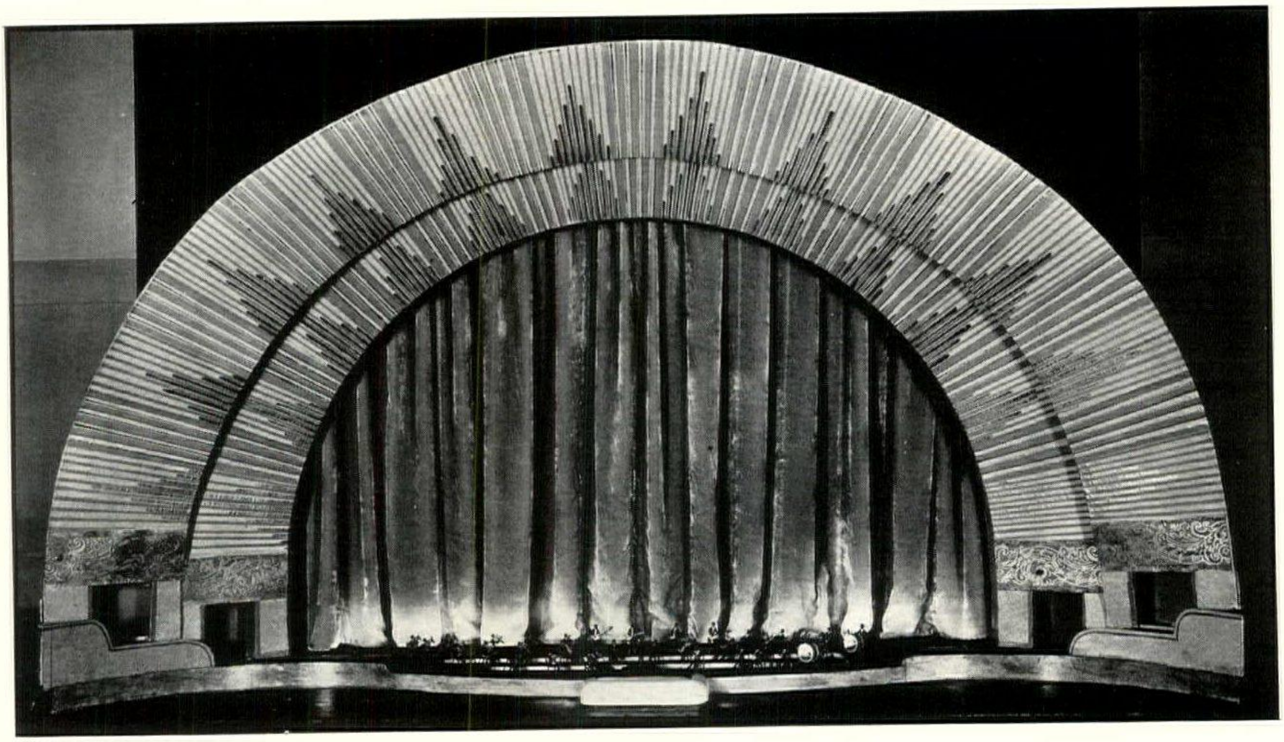


Figure 7. The plan and section of the Auditorium Theater, Chicago, Ill., an acoustically excellent room. Splayed side walls, a sloping ceiling and proper reverberation are contributing causes



Keystone

BEHIND THE SCENES

BY

PETER CLARK

PRESIDENT, PETER CLARK, INC.

THE design and equipment of a stage for the rapid, economical and smooth-running presentation of a production is at once a science and an art, far more complex than it appears either to the audience or to the architect who has had little experience in theater design. This is a highly specialized branch of architecture, for the design of a modern theater extends beyond the planning and construction periods into the actual operation of the stage, long after the building itself has been finished. It is in this last phase — the practical operation — that the skill of the architect, judged from a commercial viewpoint, will be most apparent.

A theater may have an imposing facade, an impressive foyer and an auditorium with decorative treatment that will impress the audience to the point of subjection, yet if the design and equipment of the stage have not been given the necessary study in the light of past experience and present technical possibilities, they mean little. Operating costs will soar and the audience, sensing the lack of efficiency, will be conscious of confusion behind the scenes.

These difficulties must be met and overcome in their natural sequence from the inception of the theater project. Restricted plot areas often give rise to intricate problems of stage design which can be solved adequately only by the collaboration of architect, producer and equipment engineer.

The word "theater" embraces so many types and sizes, ranging from the neighborhood motion picture house to the imposing "cathedral," adapted to both motion picture and stage presentations, that it is impossible to lay down any set of rules or detail any specific information until the type, available plot and desired seating capacity are known. While the stage equipment engineer is not directly concerned with the seating capacity, it is, however, a factor in stage size and thus has a direct bearing upon the equipment problem.

For the small picture house, with a fixed screen, the equipment requirements are at a minimum and may consist of a picture sheet frame with a suitable draw curtain and masking located downstage to mask effectively the offstage ends of the frame and also the top. The amplifying horns in a house of this size are usually permanently attached to the rear of the picture sheet frame or are mounted on fixed locations on the stage floor. The draw curtain is operated by an electrically driven machine, controlled from the projection booth, thus eliminating the necessity for backstage labor.

Making a rough general division, the so-called legitimate theater for dramatic production is next to be considered, for, as a type, it utilizes stage equipment of a class quite different from that common to the motion picture theater.

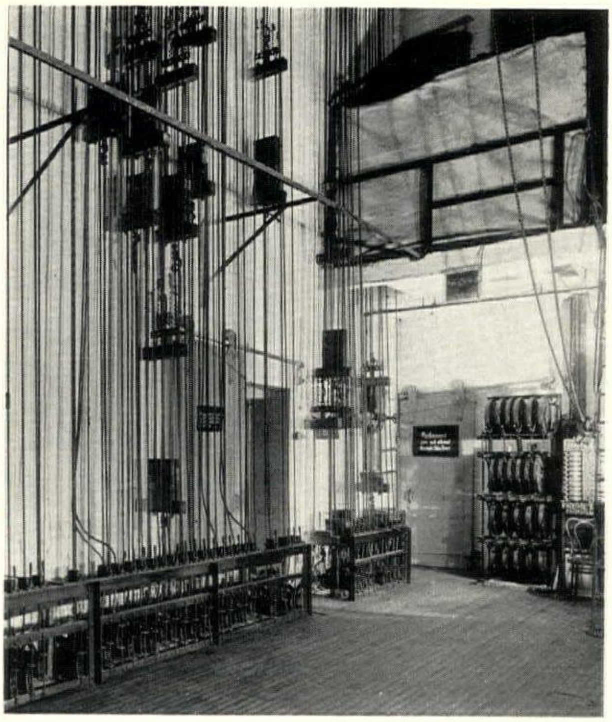
Dramatic productions require the utilization of a number of drops, borders and maskings which are suspended from suitable lines and cables and are capable of being quickly raised or lowered as the scenes are shifted. The modern way of rigging a stage to accomplish this implies a suitable loft floor or gridiron above the stage floor, located at a height in proportion to the proscenium opening, desired sightlines, etc. The gridiron, as constructed today, is a part of the structural framing of the building and consists of structural channels and I-beams, with small channels laid flat and spaced on about 6 in. centers on the structural channels and I-beams, to form a working floor. The gridiron beams may be framed into adjacent columns or made wallbearing into the front and back walls of the stage-house. The gridiron is usually further supported by running tension hangers from the gridiron up to the stage roof beams.

The space between the gridiron and the roof beams should be a minimum of 5 ft., although a greater distance, if not acquired at a sacrifice of gridiron height, is desirable.

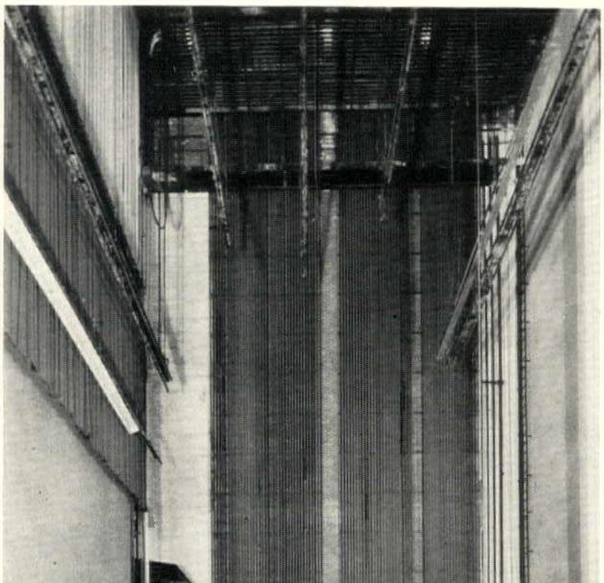
The gridiron is provided with continuous slots or openings running up and down stage for the passage of the lines and cables from their sheaves to the battens on which the drops are hung. The cross-stage spacing of these openings depends primarily on the width of the proscenium opening. Thus, a stage with a 35 ft. opening would have three slots for three lines, which would be termed a "three-line set," while an opening of 55 ft. would have five slots to accommodate a "five-line set."

If the stage under consideration does not include a gridiron, it is possible to achieve a great measure of workability by so spacing the roof beams that sheaves can be clamped to the bottom flanges and the lines run directly to the battens. Some of the most modern stages have both the gridiron and beam construction, to which are attached the underhung sheaves. This type has certain definite advantages, from the standpoint of rigging the stage.

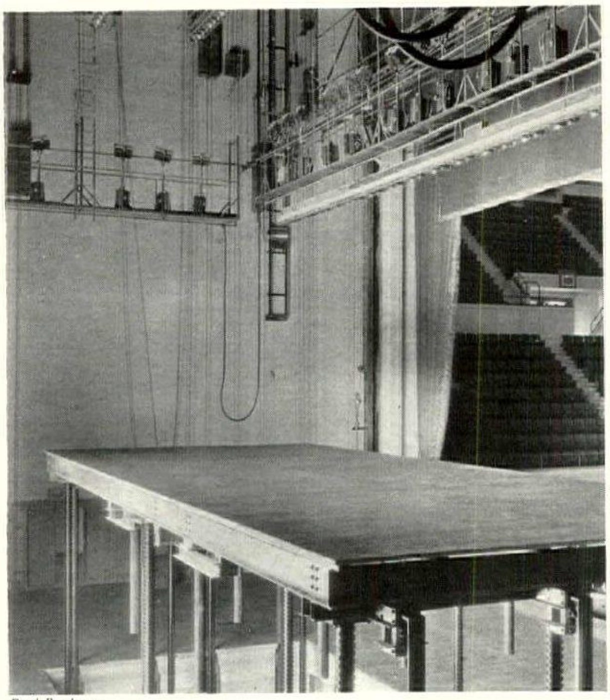
The lines are led off to the operating side of the stage to a "head-block" of the counterweight system so that all lines operate together and with a maximum of speed and minimum of effort, due to the modern counterweight system. Provision must



The illustration above shows an old type of counterweight system and pin rail. The counterweights are set in wire guides. Below is a more modern system in which the counterweights are guided by a system of T-bars. It is part of the stage equipment for the Forest Theater, Philadelphia, Pa., Herbert J. Krapp, Architect



Bond Brothers



Bond Brothers

A view of the stage elevator and lights in the Philadelphia Convention Hall, for which Lockwood, Greene & Co. and Cook & Blount were the architects

be made on the architectural plans and structural drawings for a loading platform and also for heavy head-block beams running up and down stage. The loading platform is used as a loading station to add to or take off counterweight blocks to balance the weight of the drop being hung.

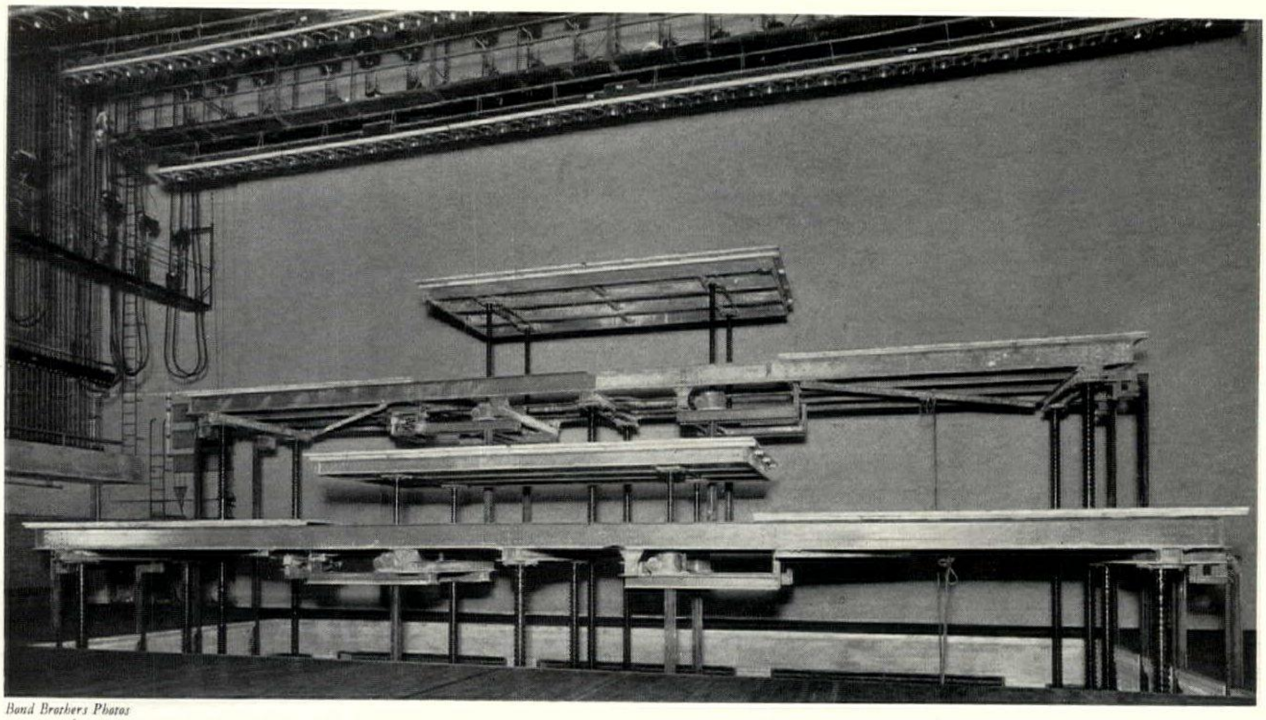
Depending on local building ordinances, the projected theater may or may not have to be equipped with an asbestos curtain. Such a curtain, whether required by law or not, always effects a material reduction in insurance rates and affords greater security to the theater patrons. Asbestos curtains are of two general types: the single curtain, made of asbestos cloth, the offstage ends of which are enclosed in smoke pockets, or the double type, which is a light structural steel frame covered on both sides with asbestos cloth and having the ends also enclosed in smoke pockets. Provision is often made for either fastening the smoke pocket brackets to the proscenium columns or for building the brackets in the brick work.

The vaudeville house is usually built with a combination of equipment as it must serve as a motion picture house as well as for the production of plays and sketches. Therefore, what has been said about the small picture house would apply here, except that the picture sheet frame should be rigged to the counterweight system and some measures taken to clear the amplifying horns for the working space of the stage when pictures are not being shown. If the horns are attached to the back of the picture sheet frame the problem is solved, but if they are of a type that does not lend itself to this mounting, they must be mounted on an overhead trolley, which in turn is rigged to the counterweight system, and run offstage on the trolley. Another method that has found favor in some recent houses is to mount the horns on a stage elevator which rises directly back of the picture sheet. The horns are mounted in the structural framework of the elevator, the top of which forms a portion of the stage floor when not in use as a horn elevator.

Considering the largest type theater, the type classed as the "presentation house," we find a challenge to the equipment engineer's ingenuity. Here, playing to audiences as large as 6,000 people, the show must proceed with clocklike precision. Picture sheets of mammoth size are required to screen the various forms of enlarged pictures such as Grandeur, Spoor or Magnascope. A somewhat recent development, born of the necessity for providing a large screen surface, yet capable of reducing it at will to accommodate standard sized pictures, is the screen adjuster. This is an ingenious device which controls the movement and position of the side and top maskings, running them out and up to maximum size for large pictures or running them in and down for the small or standard picture. This movement is controlled by two motor-driven mechanisms mounted on the rear of the picture sheet frame. Machines are available which will mask the sheet for as many as four different sized pictures. When the sizes of the pictures required are decided, the mechanisms of the machines are set and locked for the predetermined sizes. When this is once done, the only effort required, upon the part of the projectionist for changing his picture sheet size, is to press the control button in the booth for the size desired.

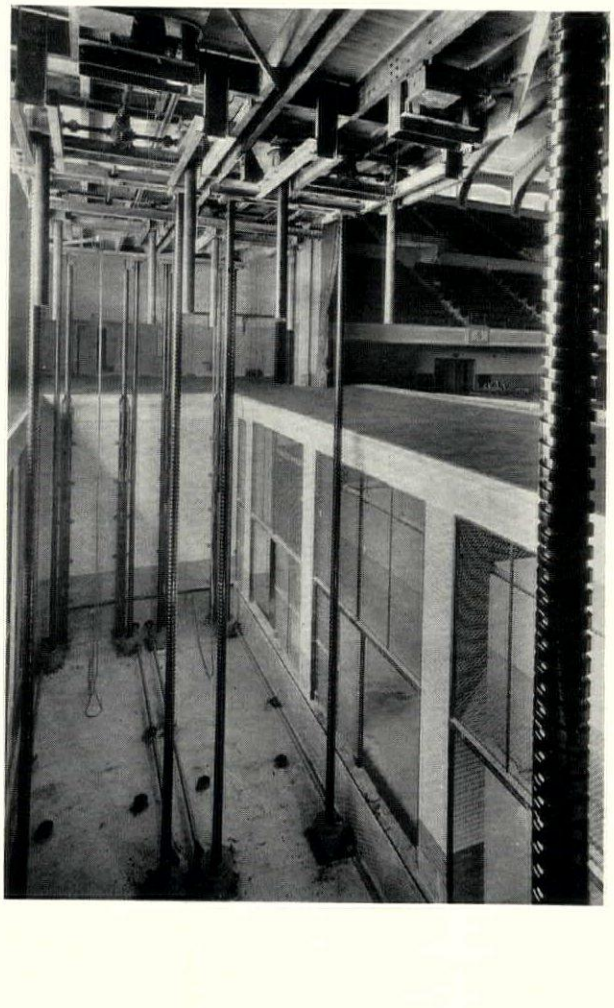
Large presentation houses are usually equipped with orchestra elevators and stage elevators, with a separate elevator for the organ console. The requirements of these elevators are sufficient depth of pit, below the low limit of travel, suitable provision for motor and machine rooms, and proper door openings into the orchestra pit so the organist and orchestra musicians may have safe and ready access to the elevator platforms. Provisions must be made for these elevators in the early stages of planning.

A cyclorama with its lighting trough is in high favor in these larger theaters and provision must be made in the architectural and structural drawings for this trough to house the lights. The same is true of the footlights and here we find disappearing footlights rapidly becoming standard equipment in new houses of this size. The use of the disappearing footlight enables the stage show to be carried right up to the apron and if an orchestra elevator is used, it can be run up to stage level, thus extending the performance out into the audience. Footlights of



Bond Brothers Photos

Two other views of the stage elevators in the Philadelphia Convention Hall. The one above shows them in a stepped formation often used to produce unusual stage sets. Below is a view of the underside of the elevators showing the mechanism. This particular installation is operated by a gear drive. Others, such as that in the International Music Hall, are operated hydraulically

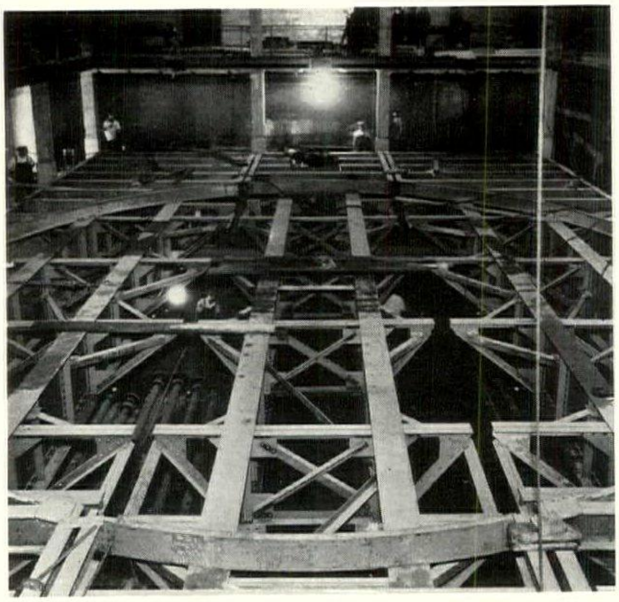


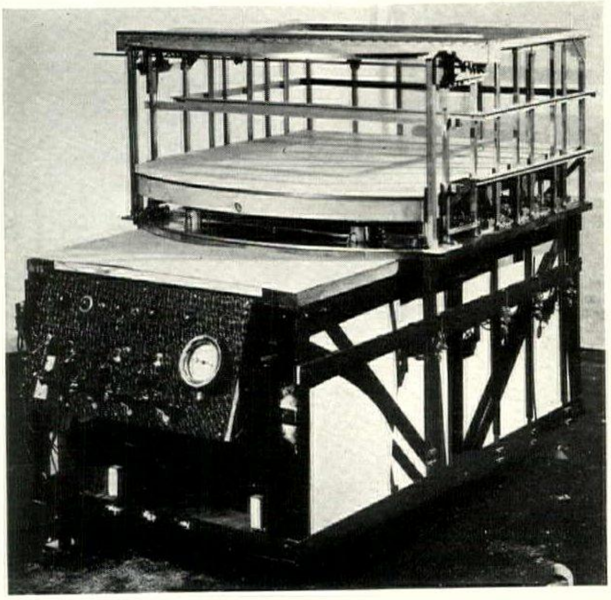
this type are motor operated. At the pressing of a button the footlights will rise to their lighting position, slightly above the stage floor, or by reversing their travel will recede into the footlight trough, the covers following and closing, thus presenting a flat, smooth working floor from orchestra rail to back wall.

On some of the larger stages, electrically driven counterweight sets have been installed and drops are raised or lowered by the pressing of a control button. Curtains and maskings are of a variety of forms ranging from the simple draw curtain to the more elaborate forms of false prosceniums and contour curtains, where, in the latter, the curtain is brailed at several points, the amount of brailing being controlled from a control board. All of this equipment is electrically driven and operates at high speed. By this high speed startling effects can be achieved with the contour curtain. With an alert and experienced man at the controls, an almost numberless variety of curtain forms can be made.

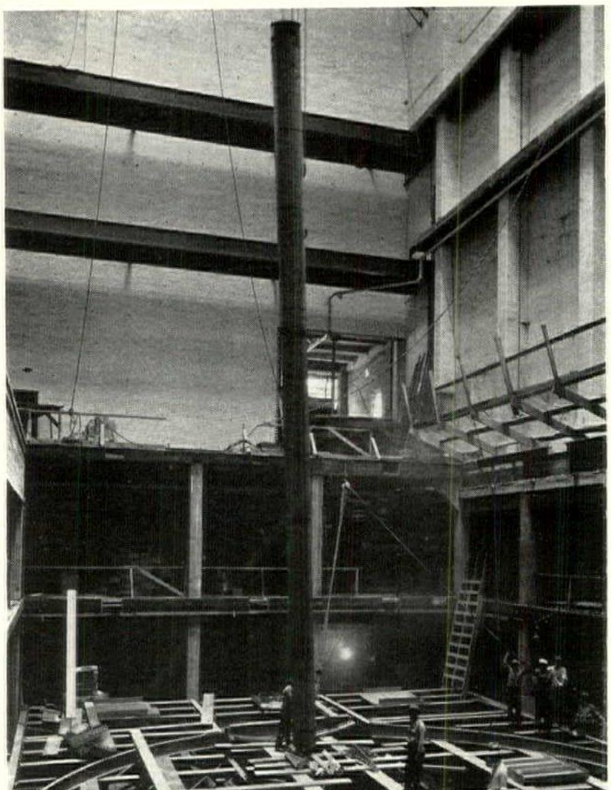
The equipment requirements of a large presentation house are very involved and require much individual study for each project. It is impossible to enumerate the equipment required as it will vary with the purposes of the operator, depending in turn on the type of presentation planned.

Theaters built to house productions of the musical comedy or revue type now embody equipment similar to the presentation house, with the exception





The stage elevators for the International Music Hall at Rockefeller Center, New York, are an important part of the stage equipment. They operate from about 15 ft. above the stage to approximately 30 ft. below it and are controlled by a series of hydraulically operated plungers. Above and below at the left are illustrations showing the elevators in process of construction. Above at the right is a view of the working model which was built to facilitate their actual design



Benmosche

that no permanent provision is made for a picture screen nor methods of handling the speaker horns.

The influence of equipment installation on the design and construction of a theater stage is well illustrated by the two theaters now under construction at Rockefeller Center, New York. Before architectural plans and structural drawings were made, provision was made in preliminary sketches for the proper housing and space for equipment backstage.

For the International Music Hall, a ½ in. scale working model has been built with lights and elevators in scale, on which all productions will be planned in ½ in. scale. The entire production can be reproduced in miniature and workings of the whole production studied and timed before it is built for the main stage. The stage of the International Music Hall is 144 ft. wide by 80 ft. deep. This will be the greatest expanse ever provided for indoor entertainment. The magnitude of this theater can be judged from the size of the proscenium opening, which is 100 ft. wide by 60 ft. high. It has a semicircular arch and is protected by a steel and asbestos fire curtain, which will weigh 48 tons when completed. The main act curtain is a contour curtain, operated by thirteen motors all with separate controls. These thirteen motors can be operated separately or together to give curtain openings of various designs and sizes. The material used for this curtain is of a special character and design and the curtain has an average of 125 per cent fullness.

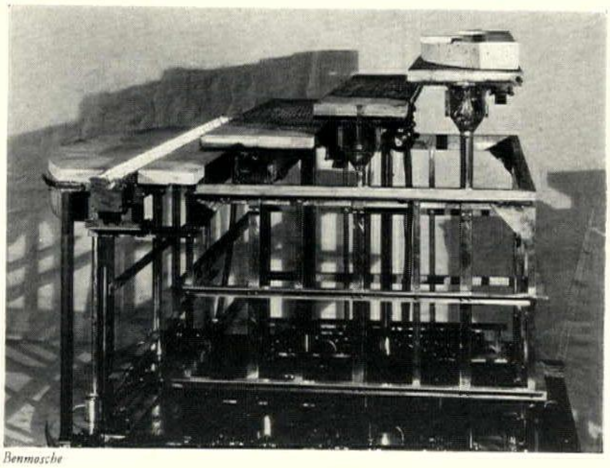
The stage will have a second proscenium which will be adjustable. This proscenium or portal can be opened from a small individual door size up to an opening 100 ft. wide by 60 ft. high. This is also motor-controlled from the stage manager's switchboard. The entire stage is equipped with the most modern counterweight system for handling and hanging of scenery. Included in this counterweight system are a number of electrically driven counterweight sets operated by remote control, which are of extra heavy construction and can be used for flying ballet or handling heavy effects.

This theater is equipped with the largest cyclorama ever built, 117 ft. wide by 75 ft. It is built with a steel frame covered with composition pressed wood. It is so wired electrically that various star formations can be projected from its electrical equipment by remote control operation from the manager's control station. This cyclorama has special lighting. It has a special overhead quadruple bank of lights with a similar set of footlights sunk in the stage. There are electrically operated covers for closing over the footlights flush with the stage when not in use. The cyclorama is raised by an electric hoisting machine to clear the rear projection booth so that the projection booth can be used for motion pictures and for projecting special sound and lighting effects.

The equipment of the stage also consists of four light bridges, 104 ft. long, raised or lowered by motor-operated machinery. They are equipped with Selsyn-operated spots with five colors. They are also arranged to tilt mechanically for projecting light straight down on the stage or at an angle. When the lights are set, whether they are in straight formation or at an angle, they never project beyond the sides of the bridges, which are operated from the manager's control station. The amount of lighting on these bridges can be judged by the feeder cables to them. Eight electric border cables of 1½ in. diameter are required. There are also four side light bridges, two on each side of the stage, which have mechanical arrangements for adjusting spot lamps on the stage between the wings.

On each side of the stage are four portable light towers, each with connections for 25 arc and incandescent lamps. These towers are equipped with overhead cables when in operation to keep the entire stage free from overhead obstructions. In addition, there is a recess 3 ft. wide around the entire proscenium arch in which are installed spot and arc lamps for the floodlighting of the entire stage. The operating switchboard for the International Music Hall is installed in the auditorium so that the operator has a full view of the stage at all times. In addition, there is a rear projection booth set in the back wall of the stage with an additional room built above to house the sound projectors for sound effects. This rear projection room is used for back projection of special effects on a large screen which will show a picture of approximately 40 x 70 ft.

The elevator equipment for the International



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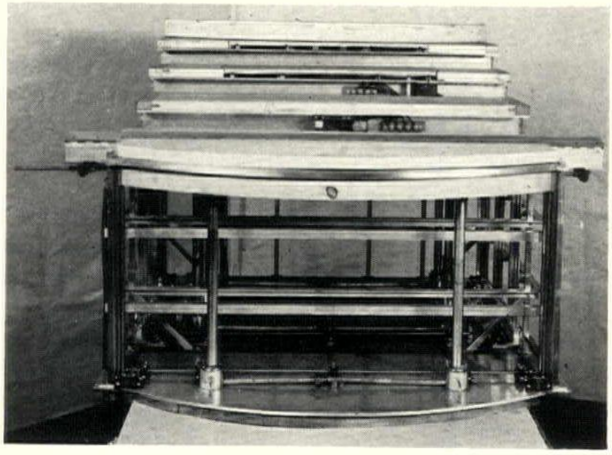
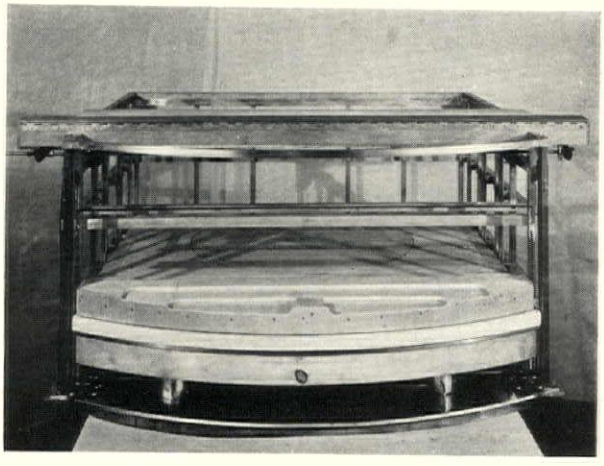
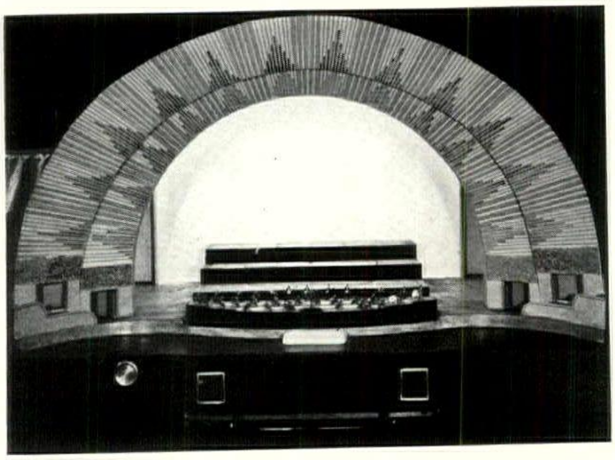
A view of the model from the side, showing the elevators locked in a stepped position

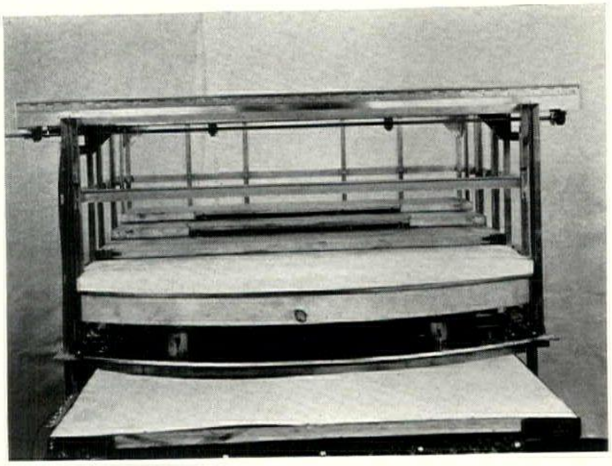


The model from the front, with the elevators in a similar position to that in the illustration above



The elevators in a position below the stage with the orchestra band car in place





Two additional views of the model stage for the International Music Hall at Rockefeller Center. At the left, the model has been draped in the same way as shown on page 266, with the elevators locked in a stepped position. At the right is a view of the model with elevators in the same relative position but below the stage level

Music Hall includes the largest stage and orchestra elevators ever built. The orchestra elevator operates from a high position flush with the stage to an elevation below stage of approximately 30 ft. On top of the orchestra elevator there is an orchestra band car built to conform to the shape of the orchestra elevator. This band car is operated by storage batteries and motors and can be run under the auditorium in a storage space built for it, or can travel at subbasement level under the proscenium arch, to allow its use on any one of the three large stages. It can be taken up on either one of the stage elevators which rise from the elevation 30 ft. below stage to 15 ft. above stage.

These elevators are all operated by hydraulic plungers and have an especially designed equalizing system. Their operation is controlled from the stage manager's board, operated by push button control, with special indicators which will indicate to the stage manager or the operator the position of the elevators with reference to their travel. All the elevators can be preset to any desired elevation, and the three stage elevators have built into the top a sectional revolving stage. When locked together electrically, they can travel as one elevator with the stage revolving while the elevators are going up or down as one unit.

The stage is also equipped with disappearing footlights which operate by motor drive and which, when level, become part of the stage floor. When the band car is removed from the orchestra pit and is used backstage, there is a flush stage from the back wall to the orchestra rail. These footlights revolve and produce a beam or curtain of light to the top of the proscenium arch.

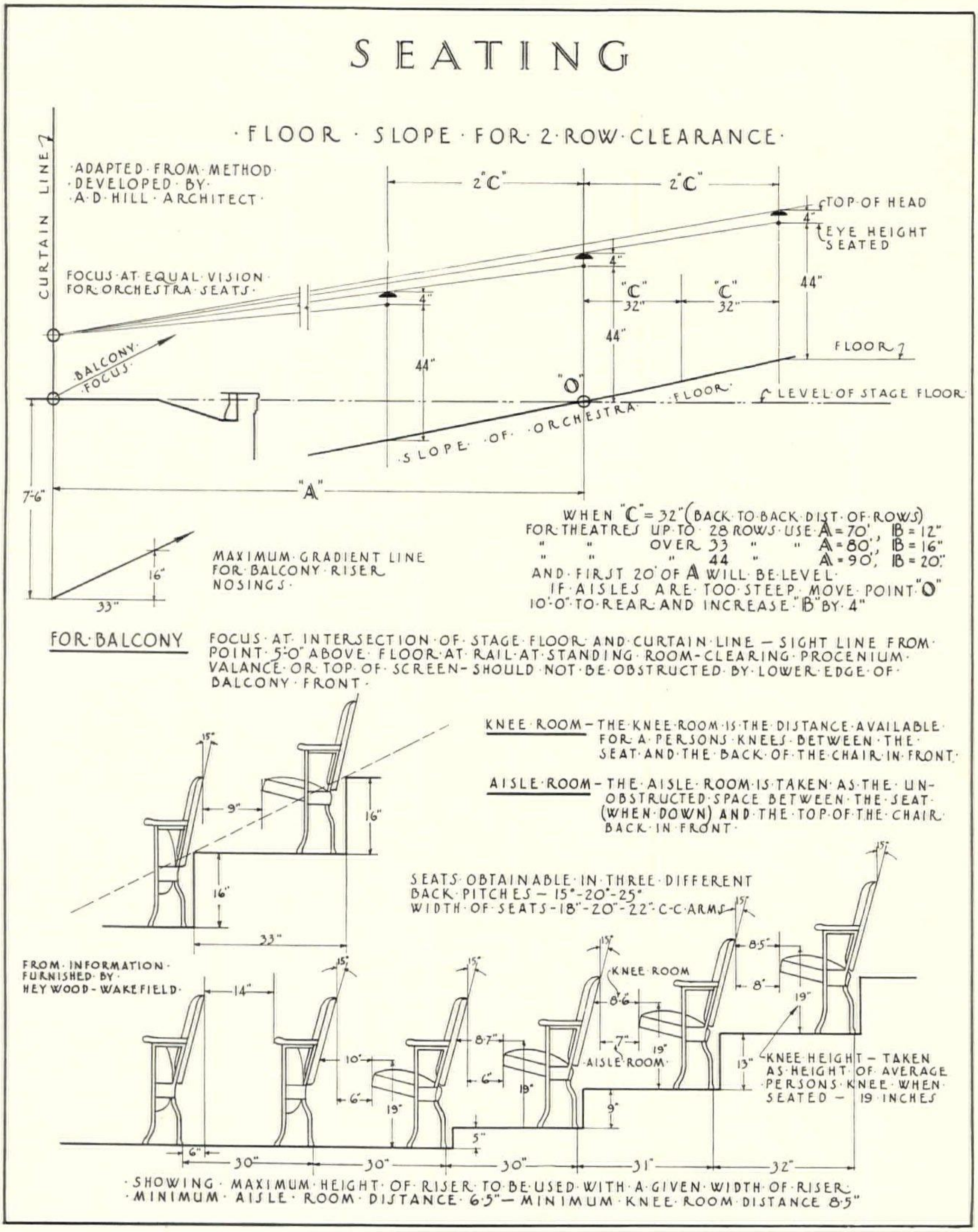
There are two organ consoles in the International Music Hall. These are set in niches on either side of the proscenium arch. They are set on motor-driven cars and travel from the niche out on to the runway, which is at stage level. They are thus visible to the entire audience and when not in use, are run back into the niches, the opening being covered by decorative curtains.

The International Music Hall can be used for any kind of production — dramatic, opera, legitimate, musical comedy or spectacular plays — without any alteration to lights or equipment.

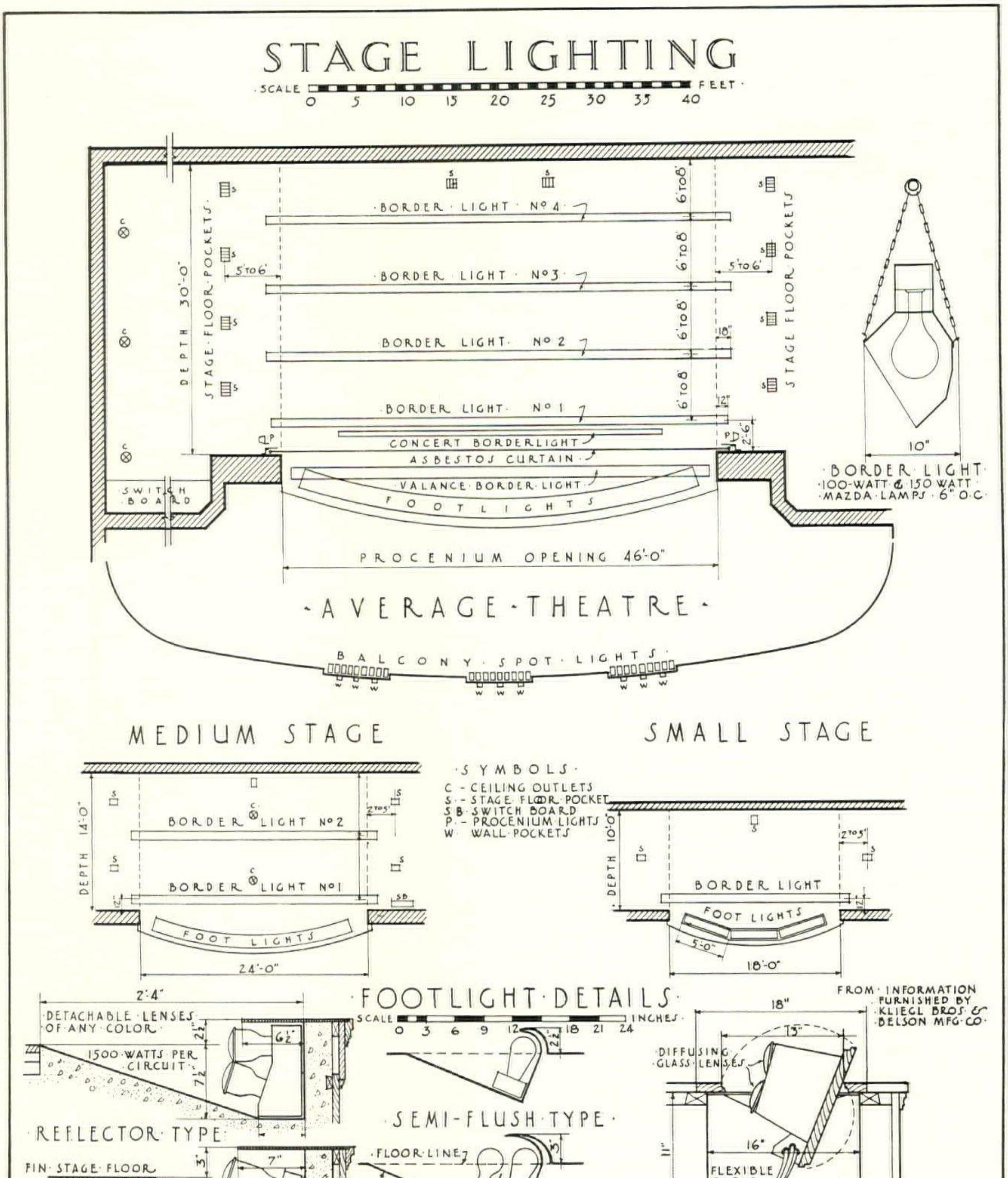
The R K O Sound Theater of Rockefeller Center is equipped similarly to the International Music Hall and has disappearing footlights, special rigging, a cyclorama, three-sectional stage elevators with a revolving stage, an orchestra elevator and an additional organ console elevator located in the center of the orchestra elevator, and capable of being used separately or as a part of the orchestra elevator.

This cinema theater is the most unusual theater of its kind ever constructed. The audience, on entering the theater, will see two enormous curtains that reach from the stage to the ceiling of the auditorium — a height of 70 ft. — instead of the customary asbestos curtain. There are two special kinds of curtains used for this purpose. One curtain rolls to the sides and directly behind is a contour curtain of special design which is operated by nine electric motors. While the front curtain is rolling to the sides, the contour curtain automatically forms the desired procenium opening. This can be done only when a curtain has the great height that this has.

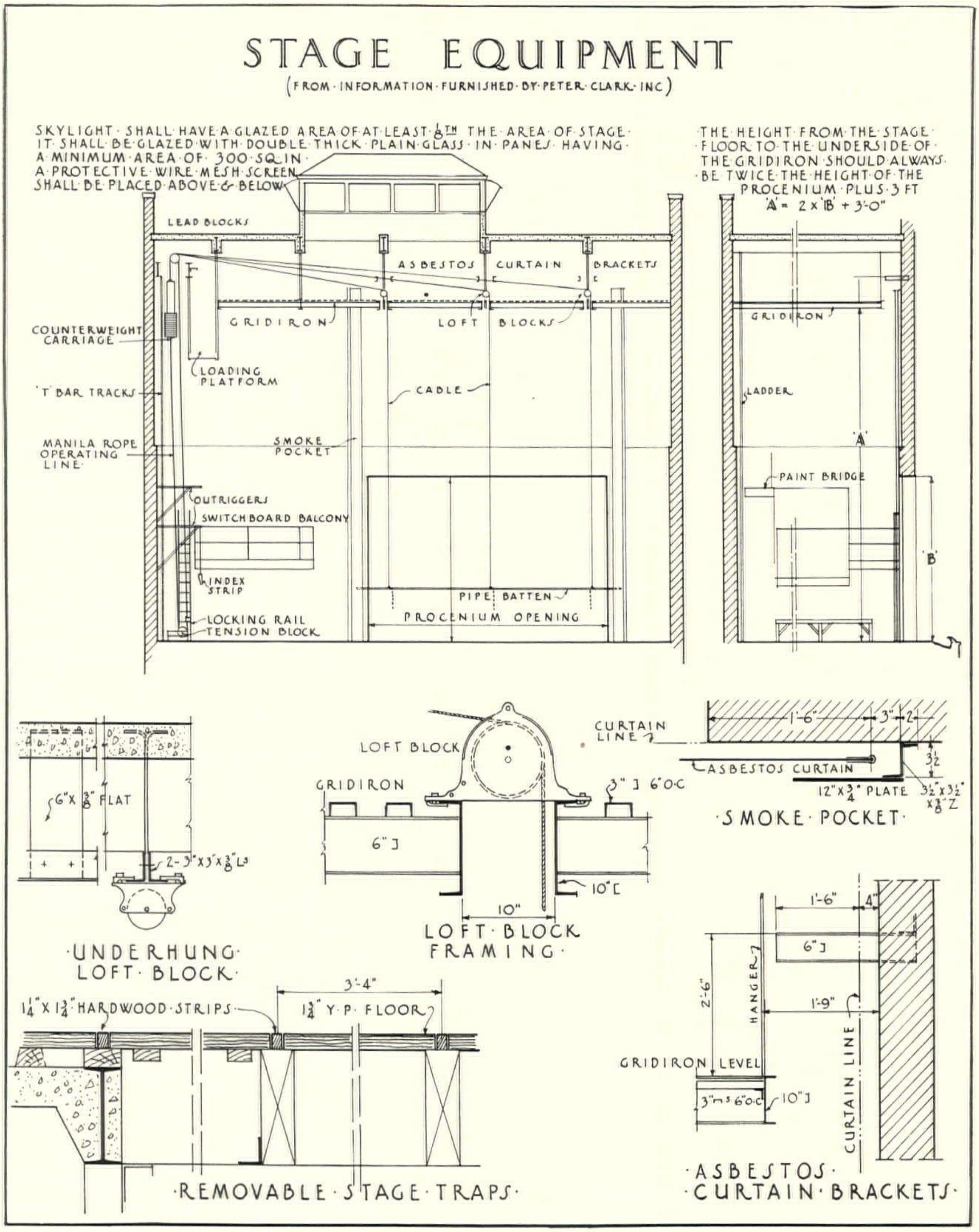
This theater is equipped in miniature exactly the same as the large International Music Hall. It is so arranged that any type of production can be performed, whether it be presentation, variety, drama, musical comedy, opera or cinema. For this theater all the various drapes and sets are being especially designed so that they are interchangeable for all productions.



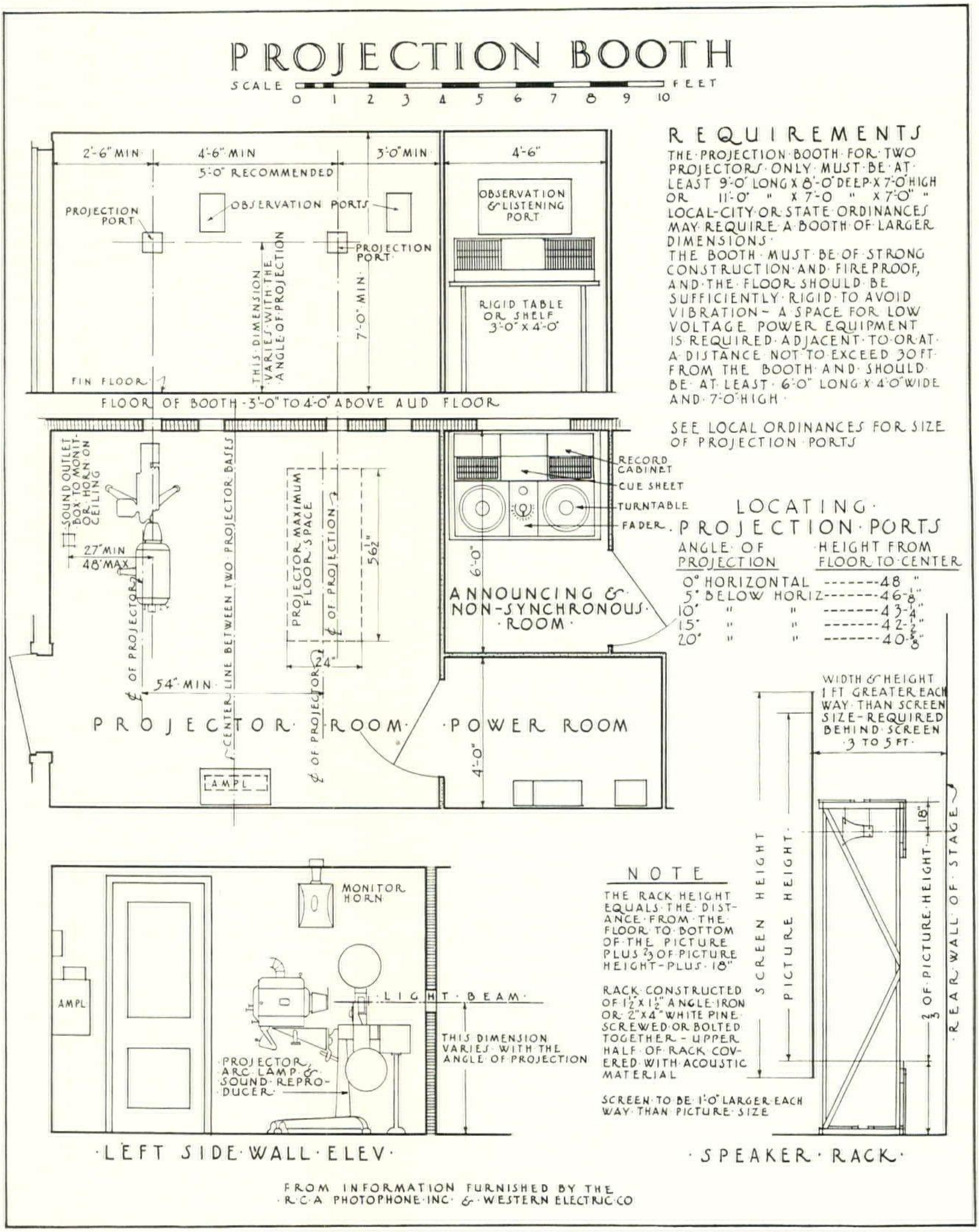
Theater seating arrangements should be predicated on the development of adequate sightlines to the stage from all parts of the house. At the top of the sheet is an outline of a method for determining the slope of the floor and the seat spacing in the orchestra. The diagram below is useful in establishing minimum average clearances in balcony seating problems



Information on this sheet, accurately drawn to scale, gives the usual lighting requirements for three types of theater stages. Stage lighting is a special equipment problem and the architect should receive in every case the advice of a specialist in this work. The details show average sizes and structural limitations for several typical installations



The design and installation of stage equipment should be worked out at an early stage of the theater project in full cooperation with a stage equipment engineer for it imposes serious limitations upon the layout and construction of the stage itself. These details are typical of the average structural requirements which should be included on the working drawings



The layout of projection booths is subject in many details to the local fire ordinances or building codes as far as structural requirements are concerned. The installation of projectors, sound machinery, etc., comes within the province of the specialist in this type of engineering, who should be consulted by the architect in the preliminary stages of the theater project

CHECK LIST OUTLINE FOR THEATERS

COMPILED BY

FREDERIC ARDEN PAWLEY

THEATER types may be classified under the following heads determined by the management and presentations intended:

1. COMMERCIAL

(a) Legitimate; (b) musical revue or opera; (c) motion picture

2. ART THEATER (*often including theater school*)

(a) Repertory; (b) community; (c) university

3. PRIVATE PLAYHOUSE

Building or room for miniature stage or screen performances

The requirements of each type differ. This check list analysis has been prepared to enable an architect to discuss any theater project intelligently with those building it or to suggest needed facilities. There are many elements common to all. These will be developed first. The additional distinguishing requirements of each type will follow and the indicated sections need only to be added to the general group to obtain the complete check list for the class desired.

A. FACTORS TO BE CONSIDERED FOR ALL TYPES:

1. LOCATION: Accessibility, ample parking space, freedom from noise

2. ACCESS, CONTROL AND PUBLIC SPACES: Auto and foot entrances separate. Area of vestibules, lobbies, foyers, lounges, width of exits, stairs, fire escapes, passages, courts, required by local code. Balconies must often have separate exits. Checkroom near entrance, smoking room, ladies' rest room, lavatories. Ticket-taker, brass rails and plush ropes. Sinkage for mats. Vending and entertainment machines, extra income concessions. Advertising

3. AUDITORIUM: Capacity. Distribution of seating: orchestra, balcony (stadium), mezzanine, gallery, loges, boxes. Seating: types of chairs (never use wicker), widths, angles of backs (watch especially the 8 to 10½ in. overhang of backs in last balcony rows). Seating system: Continental or with aisles. Back to back distance. See code for required aisle widths, floor gradients, and hand rails for stairs and balcony fronts. Crossovers, vomitories, where required by law. Floor slopes, relation of walls to presentation space and height of stage floor above auditorium govern the sightlines in vertical and horizontal planes. Study the "stage picture" from many points, allowing for three- or four-row head clearance. Horseshoe balconies are bad

4. FIRE PRECAUTIONS: Check location of fire lines, hose reel recesses, extinguishers, alarms, sprinklers, tools

5. ACOUSTICS: Concave curved areas of wall, ceiling or balcony front may cause sound foci and echoes. Splays at proscenium, resonant paneling, absorption values of audience, seats, floor and wall coverings, broken or pierced surfaces, and volume of auditorium per seat, all have a bearing on design for acoustics. Prevention of outside and inside disturbing noises will require insulation. Insulate all apparatus foundations

6. PRESENTATION SPACE: Stage or screen and horn room where dramatic action takes place. Is a strong proscenium frame desirable?

7. PRODUCTION AND PREPARATION SPACES: Rooms needed for operations unseen by audience and preliminary to performance

8. STORAGE AND MAINTENANCE SPACE: For all factors of presentation. For advertising material, programs, posters, letters for electric signs. Janitor's closet or room, slop sink rooms on each level; space for vacuum cleaner, brooms and brushes. Maintenance shop and material storage

9. ELECTRICAL WORK: Uses: illumination, projection, signs (advertising and indicating), signal systems, fire alarms, bells, buzzers, telephones and lights; power A.C. or D.C. Intensities of lighting desirable. Types of fixtures (mostly indirect). Access for relamping. Control: where preferred? Provision for expansion of electrical system, empty conduits. Battery room for emergency lighting. Transformer vault and distribution room

10. HEATING, VENTILATING AND AIR CONDITIONING: Type of heating, boiler, fire protection and location (law). Special heating and cooling for vestibules. All radiators in passages recessed. Automatic control. Fuel storage and access. Radiation stage back wall and skylight. Separate ventilating systems (law) in projection booth, dressing rooms, toilet rooms. Maintain proper air temperature, humidity, motion, purity, and prevent mechanical noises from reaching audience. Air conditioning system: upward, downward, or ejector. Machinery located in basement or in truss space over auditorium. Room for plenum chamber under auditorium. Will more than one mechanical refrigerating unit result in economies of operation? Is city water (rates and temperature) acceptable for condensers for mechanical refrigeration? Will a cooling tower or spray pond be needed on roof (steel load)? Check three dimensions of all equipment. Washer, heater, cooler, filter (dry or viscous), fans, dehumidifier, motors. Insulation and material of cooling ducts

11. PLUMBING: Location of sewer connection (storm and sanitary). Sanitary fixtures. Kind of pipe and insulation. Insulate all supply lines. Downspouts and conductors. Sumps, pumps, ejectors, pipe trenches and covers

12. MATERIALS: Floors, walls, ceilings (acoustic quality important in auditorium). Wainscots, rail cappings, bases, stair treads, interior paints and finishes that will stand crowd use. Finishes in auditorium should not be light reflecting, especially on side toward screens for motion pictures

13. EXTRA-INCOME POSSIBILITIES: Offices, stores, studios, art gallery, tearoom, ballroom, pool and billiard rooms, beauty parlor, barber shop, bootblack, soda fountain, candy and cigar counters. Use of roof. Pay telephones, scales, machines vending candy, tobacco, self-photographs, or voice tests

B. ADDITIONAL FACTORS FOR COMMERCIAL LEGITIMATE THEATERS:

1. PRESENTATION SPACE — STAGE: Types: high stage-house with gridiron, low stage-house with sky dome, removable or fixed forestage. Tripartite stage, portals flanking main stage, or flexible treatment of opening. Inner proscenium adjustable for varying scale performances. Mechanical: revolving, end-pivoted, wagon, elevator, or combination of these

2. PRODUCTION REQUIREMENTS:

a. (1.) *Stage equipment, mechanical:* Gridiron. How high? (Twice proscenium height plus 3 ft. for blocks absolute minimum.) Walkway on gridiron; overhead or hung loft blocks; how many lines per batten; hung or wall-bearing gridiron; counterweight system; free wall for pin rail; fly gallery; act curtain track and control machine; soft wood stage floor, hardwood apron; trap doors, loose beams; footlight trough, disappearing or fixed footlights; light trough for cyclorama; cyclorama flown fabric or rigid, rolling on upright rollers, permanent sky dome, or plastered back wall. (2) *Stage equipment, electrical:* Switchboard. Large switch to serve portable company board; working space behind board; location: on stage floor, on permanent bridge over stage, or controlled from auditorium, apron, or booth having full view of stage and signal system to stage manager's prompt board; border lights; footlights; strip or tormentor lights at sides of proscenium with permanent ladders; light bridges; stage floor pockets; auditorium beam lights; access, balcony rail spots, or spot booths; (check sightlines by hanging fixtures and persons standing in balcony). Prompt board with communication to all parts of stage, dressing rooms, and building important for cues; location: above stage manager's desk, near proscenium or under apron

b. Provision for actors: Dressing rooms (location and exits depend on code); star, 2- 3- 4-person rooms, mob or chorus rooms; contain make-up tables with mirrors, full-length mirrors, lockers, wardrobes, drawers. Lavatories, toilets and showers; trunk and baggage access; green room; crossover on or under stage (stairs); drinking fountain

3. Miscellaneous Building Code Requirements: Area and construction of skylights and ventilators over stage. (Do not place over unprotected electrical equipment.) Ladders to grid, through roof, and down outside; exit widths, locations and doors, firedoors, metal covered doors; asbestos and steel curtain; brackets to hang same; smoke pockets, cutting line, knives, signs, fusible links; fire apparatus: sprinklers, hand-extinguishers and tools, standpipe risers, sprinkler tank, hose recesses, fire pump. Roof over fire escapes

4. Storage Space: Scenery stacking space or scene dock; property room; electrician's shop and storage for lamps, cables, gelatin cabinet; trunk and baggage storage for actors

5. Auditorium: Study sightlines for stage performance in three-dimensional space. Lighting: aisle, seat, and program. See code for area of standing room. Standing rail only good place for free-standing columns; wind shield; sinkage for carpets and rubber mats; exit doors open outward and clear of passages

6. Management: Stage manager's office near stage; box office, ticket rack, stage door control; ushers' room with lockers; manager's office; press agent's office

7. Advertising: Marquee; vertical sign over marquee; cove-lighted or spotlighted poster or photo frames in lobby and at entrance; future attraction announcer; sign on stage-house; flasher room; empty conduits to signs

C. ADDITIONAL FEATURES OF MUSICAL REVUE THEATER OR OPERA HOUSE: (A)+(B)+(C)

1. Musical Revue: Orchestra pit, rail, access to musicians' room with lockers and lavatory. Music room; musicians' electric outlets; orchestra elevator; large chorus rooms; costume checking rooms (mirrors); dance routine practice rooms; large wardrobe; space for scenery stacking; wide stage and apron; runways; future ticket sales window; act announcer

2. Opera House: Great increase in size and scale of foregoing. Chorus rooms for 300 each; studios; ballet rooms; boxholders' clubroom and separate entrance; scenery dock and scene handling equipment on huge scale; prompters' hood at apron; deep stage sink. All other elements to corresponding scale

D. MOTION PICTURE THEATER REQUIREMENTS:

1. Cinema Without Stage Presentations:

a. *Projection booth:* Projectors, spots, stereopticon. Ports: sizes and locations, automatic gravity shutters; self-closing doors; fireproof construction; independent ventilation; rubber floor; check sightlines and keep projection angle small — 19° maximum for best projection; rewind room, generator room, battery or rectifier room; rheostat room, toilet room. See code for exit requirements. Monitor horn, booth electric panel, screen modifier control, curtain control, signal and telephone; film, record and gelatin cabinets; waste film disposal; projectionist's desk

b. *Screen:* There are types for wide and narrow houses and for color: matte, metallic, and beaded. Trans-Lux. Size, location, distance from front row of seats (sightlines); mask, modifier. Future developments may require larger screens, a variety of proportions, or even special types for stereoscopic projection

c. *Sound:* Horn or speaker sizes, locations, directions for effective distribution; volume control; public address system

d. *Provisions for continuous performance:* Handling of crowds; ticket booth with several windows, lobby space, standing room, brass rail controls, detector seat panel showing occupied seats; turnstile entrance

e. *Auditorium:* Sightlines for cinema, action in three dimensions on two-dimensional screen, permit use of parabolic reversed floor slope (Schlanger) with greater efficiency and economy

f. *Organ:* Console, elevator, turntable. Echo organ; organ chamber, blower, organ heater. Empty conduits for wiring, galvanized iron pipes from organ to blower, console and relay; stud frame for shutters in organ chamber, blower room and air inlet

g. *Advertising:* See B-7

2. "Presentation" House, Cinema With Stage: (A)+(B)+(C−1)+(D) Horn elevator or truck; nursery or children's playroom; glass-enclosed mother's room with view of stage and loud-speaker (on balcony or upper level); hospital or first aid room backstage and for public; miniature screen in lounge using prism in front of projector lens, deflecting rays through light tunnel. Menagerie or zoo backstage for animal acts

E. REPERTORY THEATER: (A)+(B)+(E)

1. Requires increased accessible space for stacking scenery, for storing properties, costumes, and for the maintenance of these
2. Rehearsal room with raised stage equal in area to the working area of the main stage and planned acoustically
3. Library, study room
4. Increased space for management; business or subscription department, space for play readers, drafting rooms for technical staff

F. COMMUNITY THEATER: (A)+(B)+(E)+(F)

1. Preparation Space: Well-lighted design rooms, shops and storage for scene painting (using frame on wall with or without well, or floor); electric or gas range, hot and cold water; for scene carpentry work; electric work; well-lighted rooms for costume sewing, dyeing, fitting; closets for costumes in process, large cutting table, storage for materials; wardrobe with long closets with bars and much drawer space. Ample space for inexperienced scene swinging
2. Kitchen, pantry, refreshment room, terrace, court or patio
3. Laboratory theater (amplified rehearsal room); marionette theater
4. Game rooms
5. Board meeting room
6. Only a small amount of advertising needed

G. UNIVERSITY THEATER: (A)+(B)+(C-1)+(D−1−A, B, C)

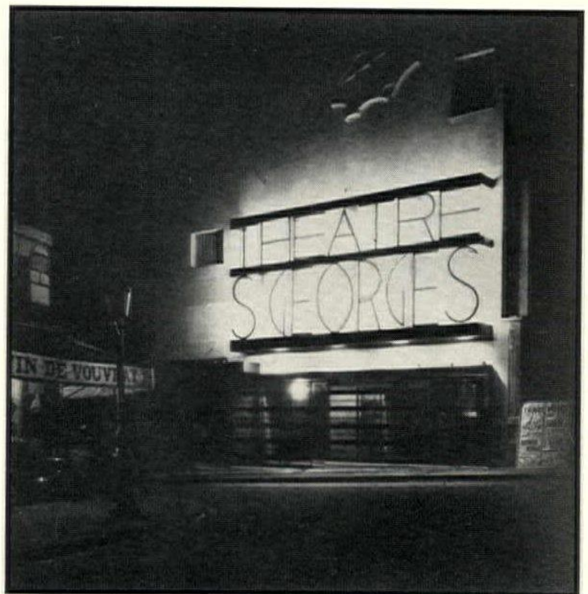
1. How many students, teachers
2. Faculty offices grouped with own lavatory, consultation, or conference room
3. Model building room, classrooms, enlarged shops for instruction
4. Doorman's office controlling stage and school; locker rooms
5. Cafeteria, kitchen and service; intramural, for university, public. (E and F sometimes require school facilities)

LIGHTING THE LEGITIMATE THEATER

BY

STANLEY R. McCANDLESS

ASSISTANT PROFESSOR, STAGE
LIGHTING, YALE UNIVERSITY



Bonney — Charles Siclis, Architect

THEORETICALLY, the function of lighting in the theater is to provide visibility, a sense of locale, a unifying composition, and a dramatic atmosphere called mood. The degree to which light can be made to serve this inclusive function depends upon the special ability of the designer and the tools with which he has to work. The limitations of the instruments and control apparatus available today force him to adopt a special method — a technique — permitting the utmost freedom in use, with a certain minimum equipment. Tradition and practice have proved that flexibility of space — an unencumbered stage into which any form or combination of units of scenery can be built — is absolutely necessary; but flexibility in the selection and placing of lighting equipment in connection with the variety of forms of scenery does not seem so thoroughly established. The reason for this situation lies perhaps in the lack of definite appreciation of the extent to which light can be used in each type of production and in ignorance of the methods of so using it.

It is understood that light can give a wide range of intensity and color, and, under the proper control, can alter the appearance of things, either instantaneously or over a long time cycle, through its quality of movement. In addition, from the standpoint of the architect, the most important quality of light now becoming appreciated is that it is a plastic medium which can be designed or distributed throughout space as definitely as brick or stone. The practical methods of handling this medium to present it most effectively with the instruments available, establish certain practical steps to be followed.

Methods of Lighting. Methods of lighting determine the selection of instruments, the position for their use, and the structural elements that are involved. These instruments can be grouped according to the parts of the stage or auditorium which they illuminate. It is not the purpose of this article to discuss the lighting of the foyers, lounges, and rest rooms, beyond the point that the fixtures should be in character with the purpose and style of the room they illuminate. Broadly speaking, an audience entering the theater should be encouraged to anticipate some of the glamour and excitement that they expect to find on the stage itself. They are entering a world of "make believe," something that usually exists only in their imagination, and the lighting and decoration can do more to create this feeling than almost any other medium.

Auditorium Lights. The glitter of the great chandelier such as was used in the days when only small light sources were available has set a traditional atmosphere in the auditorium which should not be disregarded entirely. However, from a practical point of view, with the sources available, the limitations of this fixture can now be overcome. In general, the principle underlying the lighting of the auditorium has two aspects: utility lighting on the seating area, and decorative lighting to create the atmosphere (varying, if desired) that one expects to find in the theater.

The utility lights should illuminate the aisles and seating area so that it is possible to move about easily, and yet they should not interfere with the decorative idea of the auditorium. Aisle lights can be incorporated in the ends of alternate rows of seats. Down lights, either incorporated in the fixture or fixtures or projecting through the ceiling, can supply general light to the seating area. Where fixtures are used, and especially where they are apt to be in the line of sight, the apparent light source should be spread out over as large an area as possible. This can be carried out in the form of large

SCHEDULE OF THE EQUIPMENT FOR A STAGE WITH A PROSCENIUM 24 x 30 FEET

ITEM	NUMBER OF INSTRUMENTS	TYPE OF INSTRUMENTS	LAMP: NO. PER SEC.	LAMP: WATTAGE	LAMP: BULB	LAMP: LIGHT CENTER LENGTH	LAMP: SERVICE	ACCESSORIES: LENS: DIAMETER & FOCAL LGTH	REFLECTOR: SHAPE	REFLECTOR: DIAMETER IN INCHES	REFLECTOR: FOCAL LGTH IN INCHES	REFLECTOR: MATERIAL	CUTOFF	COLOR: COLOR FRAME SLIDE	COLOR: COLOR FRAME	COLOR: COLOR MEDIUM	DIFFUSER	MOUNTING APPARATUS	CONNECTIONS: INSTRUMENT CONNECTION	CONNECTIONS: END OF PIGTAIL OR LEAD	CONNECTIONS: LGTH OF PORTABLE FEED CABLE AND SIZE IN B.S. GAUGE	CONNECTIONS: TOTAL WATTS PER COLOR	POSITION: LOCATION	POSITION: DISTANCE FROM CUR. LINE	POSITION: HEIGHT ABOVE STAGE	USE OR AREA LIGHTED	GENERAL
1	6	SPOTLIGHTS	1	1500	G-40	4¼"	SPOT	8x12	SPH	6	3	CHRO.	18"x12"x12" F.	VERTICAL	10"x10"	—	—	YOKE & PIPE CL.	18" P.T.	15A PIN CON.	25' #14	—	BEAM	20'	30'	ACTING AREA	
2	6	SPOTLIGHTS	1	1000	G-40	4¼"	"	"	"	"	"	"	8"L x 9" DIA. F	"	"	—	—	" "	"	" " "	" "	—	BRIDGE	±2'	±20'	" "	
3	4	5'-6" SEC. FOOT LIGHT STRIPS	4 " " "	100	A23	4⅜"	—	—	SPHERICAL PARABOLIC	4"	—	CHROM. OR ETCH. ALUM.	—	VERT. SLIDE AND ROUNDEL HOLDER	4"x5" AND GLASS ROUNDELS	RED GREEN BLUE AMBER	—	FOOT LIGHT TRAP	18" P.T. BOTH ENDS	15A PIN CON. MALE AND FEMALE	4-10' #14 OR PERMENT CONNECT'D	1600 " " "	APRON	±2'	—	BACK GROUND AND FACIAL SHADOWS	ESSENTIAL FOR LIGHTING THE AVERAGE INTERIOR SET
4	2	9'-0" SEC X-RAY STRIPS	" " "	200	PS-30 OR A-30	6"	—	—	"	8"	—	"	6" SHADOW BOX	"	9"x9" AND ROUNDELS	MAG. CYANB AMBER	WITH CL. PS LAMPS ONLY	END STUD EX-ARM & PIPE CLAMP	"	"	3-10' #12	1600 " "	BRIDGE	±3'	±20'	GENERAL ILLUM. ON ACTING AREA	
5	45	CYCLORAMA FLOODS SEC.	20 15 10	500	PS-40	7"	—	—	ELLIPSOIDAL	14"	3"	ETCHED ALUMINUM	—	VERT.	15"x15"	BLUE RED GREEN	—	YOKE AND PIPE CLAMP	18" P.T.	15A PIN CON. TO MULT. PLUG	4-10' #8 3-10' #8 2-10' #8	10,000 7500 5000	SPECIAL FRAME	±12'	±30'	OVERHEAD CYCLORAMA LIGHTING	ESSENTIAL IN ADDITION TO THAT ABOVE FOR LIGHTING EXTERIOR SETS
6	10	5'-0" DOUBLE ROW SECTION HORIZON STRIPS	3 " " "	300 200 150 100	A-35 A-30 A-25 A-23	7" 6" 5¼" 4⅜"	—	—	SPHERICAL PARABOLIC	12" 8" 6" 6"	—	CHROM. OR ETCHED ALUM.		VERT. SLIDE AND ROUNDEL HOLDER	13"x13" GL. ROUN. 9"x9" GL. ROUN. 7"x7" GL. ROUN. 7"x7" GL. ROUN.	BLUE RED GREEN AMBER	—	IN TRAP OR ON TRUCK END STUD AND STAND	18" P.T. BOTH ENDS	15A PIN CON. MALE AND FEMALE	3-10' #8 3-10' #12 3-10' #14 3-10' #14	9000 6000 4500 3000	IN TRAP OR ON FLOOR REAR OF STAGE	±30'		CYC. BASE OR HORIZON LIGHTING	
7	6	PROJECTORS	1	500	G-40	4¼"	FLOOD	—	PAR.	14"	3"	SILVER GLASS	CONCENT. LOUVRES	HOR.	18"x20"	—	—	YOKE & STAND	18" P.T.	15A P.C.	50' #14	—	TOWER	—	—	SPECIAL	ONE HALF OF EACH ITEM ESSENTIAL
8	8	SPOTLIGHTS	1	1500	G-40	4¼"	SPOT	8x12	SPHER.	6"	3"	CHROM.	—	VERT.	10"x10"	—	—	" "	" "	" "	100' #14	—	"	—	—	"	
9	12	SPOTLIGHTS	1	250/400	G-30	3"	"	5x9	"	4"	2½"	"	—	"	7"x8"	—	—	" "	" "	" "	25' #14	—	TORMEN.	±3	—	"	
10	6	FLOODS	1	500	PS-40	7"	—	—	ELLIPS.	14"	3"	ET. AL.	—	"	15"x15"	—	—	" "	" "	" "	50' #14	—	ENTRANC.	—	—	"	
11	6	6 B'KG STRIPS	8	60	A-21	3¾"	—	—	BOX	—	—	WHITE PAINT	—	—	—	—	—	HOOK	" "	" "	50' #14	—	"	—	—	"	
12	4	9' X-RAY	12	200	PS-30	6"	—	—	SPHER. PARA.	8"	—	CHROM.	—	VERT	9"x9"	3 COL.	—	END STUD ARM & PIPE CLAMP	18" P.C. B. ENDS	" "	25' #14	800	BORDER	—	—	"	
13	2-4	ARCS 35-75 AMPS	—	—	—	—	—	8x12	—	—	—	—	IRIS	"	10"x10"	—	—	STAND RHEOST.	LONG FEED	75A PLUG	50' #8 #3	—	BOOTH	—	—	EFFECTS	OPTIONAL

SCHEDULE OF THE EQUIPMENT FOR A STAGE WITH A PROSCENIUM 16 X 24 FEET

ITEM	NUMBER OF INSTRUMENTS	TYPE OF INSTRUMENTS	LAMP: NO. PER SEC.	LAMP: WATTAGE	LAMP: BULB	LAMP: LIGHT CENTER LENGTH	LAMP: SERVICE	ACCESSORIES: LENS: DIAMETER & FOCAL LGTH	REFLECTOR: SHAPE	REFLECTOR: DIAMETER IN INCHES	REFLECTOR: FOCAL LGTH IN INCHES	REFLECTOR: MATERIAL	CUTOFF	COLOR: COLOR FRAME SLIDE	COLOR: COLOR FRAME	COLOR: COLOR MEDIUM	DIFFUSER	MOUNTING APPARATUS	CONNECTIONS: INSTRUMENT CONNECTION	CONNECTIONS: END OF PIGTAIL OR LEAD	CONNECTIONS: LGTH OF PORTABLE FEED CABLE AND SIZE IN B.S. GAUGE	CONNECTIONS: TOTAL WATTS PER COLOR	POSITION: LOCATION	POSITION: DISTANCE FROM CUR. LINE	POSITION: HEIGHT ABOVE STAGE	USE OR AREA LIGHTED	GENERAL
1	6	SPOTLIGHTS		500	G-40	4¼"	SPOT	6x10	SPHERE	5"	3"	CHRO.	12"x8"x8" F.	VERTICAL	8"x9"	—	—	YOKE & PIPE C.	18" P.	15A P.C.	25' #14	—	BEAM	10'	20'	ACTING AREAS	
2	6	SPOTLIGHTS		250/400	G-30	3"		5x9	"	4"	2½"	"	6"L x 6" DIAM.	"	7"x8"	—	—	" "	" "	" "	15' #14	—	1ST BDR	±2'	±14'	" "	ESSENTIAL FOR LIGHTING THE AVERAGE INTERIOR SET
3	3	5'-6" SEC. FOOTLIGHT STRIPS	4 " "	60	A-21	3¾"	—	—	SPHER. PARABOLIC	4"	—	CHROM. OR ETCHED ALUM.	—	VERT. SLIDE AND ROUNDEL HOLDER	4"x5" AND GLASS ROUNDEL	RED GREEN BLUE	—	FOOT LIGHT TRAP	18" P.T. BOTH ENDS	15A P.C. MALE & FEMALE	3-10' #14	720 720 720	APRON	±2'	—	BACKGROUND AND FACIAL SHADOWS	
4	2	7'-0" SEC. X-RAY STRIPS	" " "	100	A-23	4⅜"	—	—	"	6"	—	"	4" SHADOW BOX	"	9"x8" "	MAG CYANB AMBER	—	END STUD EX. ARM & PIPE CLAMP	"	"	"	800 " "	1ST BORDER	±2'	±14'	GENERAL ILLUM. ON ACTING AREA	
5	36	CYCLORAMA FLOODS SEC.	16 12 8	200	A-30	6"	—	—	ELLIPSOIDAL	10"	2½"	ETCHED ALUM.	—	VERT.	11"x11"	BLUE RED GREEN	—	YOKE & PIPE CLAMP	18" P.T.	15A P.C. TO MULT. PLUG	2-10' #12 2-10' #14 2-10' #14	3200 2400 1600	SPEC. FRAME	±8'	±20	OVERHEAD CYC LIGHT'G	ESSENTIAL TO THAT ABOVE FOR LIGHTING THE AVERAGE EXTERIOR SET
6	6	4'-0" DOUBLE ROW HORIZON STRIPS	3 " " "	200 150 100 50	A-30 A-25 A-23 A-21	6" 5¼" 4⅜" 3⅜"	—	—	SPHER. PARABOLIC	8" 6" 6" 6"	—	CHROM. OR ETCHED ALUM.	—	VERT. SLIDE AND ROUNDEL HOLDER	9"x9" GL. ROUN. 7"x7" GL. ROUN. " "	BLUE RED GREEN AMBER	—	IN TRAP OR ON TRUCK END STUD & STAND	18" P.T. BOTH ENDS	15A P.C MALE & FEMALE	2-10' #12 2-10' #14 " " " "	3600 2700 1800 900	IN TRAP OR ON FLOOR REAR OF STAGE	±20	—	CYC. BASE OR HORIZON LIGHTING	
7	4	PROJECTORS	1	250	G-30	3"	FLOOD	—	PAR.	12"	2½"	SILVER GLASS	CON LOUVRES	HOR	14"x14"	—	—	YOKE & STAND	18" P.T.	15A P.C	50' #14	—	STAND	—	—	SPECIAL	ONE HALF THE NUMBER OF EACH OF THESE ITEMS ESSENTIAL
8	6	SPOTLIGHT	1	250/400	G-30	3"	SPOT	5x9	SPHER.	4"	2½"	CHROM.	—	VERT.	7"x8"	—	—	" "	"	" "	" "	—	TORM.	±2	—	"	
9	6	FLOODS	1	200	A-30	6"	—	—	ELLIPS.	10"	2½"	ET. AL.	—	"	11"x11"	—	—	" "	"	" "	25' #14	—	ENT	—	—	"	
10	6	4 B'KG STRIP	6	60	A-21	3¾"	—	—	BOX	—	—	WHITE PAINT	—	—	—	—	—	HOOK	"	" "	" "	—	"	—	—	"	
11	4	6' X-RAY	12	100	A-23	4⅜"	—	—	S. PAR.	6"	—	CHROM.	—	"	7"x7"	3 COL.	—	END ST. P.C.	18" P.B.E.	15A P.C. M.&F.	3-10' #14	400	BORD.	—	—	"	
12	6	SPOTLIGHTS	1	1000	G-40	4¼"	SPOT	6x10	SPHER.	5"	3"	"	—	"	8"x9"	—	—	YOKE & P.C.	18" P.T.	15A P.C.	25' #14	—	STAND	—	—	"	OPTIONAL

This schedule includes only the minimum general requirements and may not meet the special demands of individual theaters. The equipment is not always available in stock from one firm, although each part is standard in different organizations

translucent surfaces or in indirect coves or bowls in the main ceiling, and under the soffits of the balconies. The utility lighting on the seating area should be adequate to make reading of programs easy (from three to five foot-candles) and might well be of a color that is "off" white, but never of a strong hue. The utility lights in any case should be controlled from the switchboard on the stage.

Decorative Lighting. There is almost no limit to the extent to which light can be used for decorative purposes, although, generally speaking, overelaboration in this field is apt to be distracting. In its simplest form, it is the illumination used to light the various parts of the walls and ceiling of the auditorium, generally in conjunction with the utility lighting. Concealed lighting in three or four colors (red, green, blue, and perhaps amber) can be controlled to give a broad range of color, even to the extent of enfusing the auditorium in a particular hue to promote a dramatic effect. If this is to be done, the amount of current required is apt to be great, and perhaps extravagant in view of the uncertainty of the effect of colored light on the individual; but there is no easier way to alter the appearance of an auditorium to suit the various functions for which it is to be used than by this means.

In order to provide different distributions, various groups of lights should be under separate control; for example, different sections of cove lights, wall urns, and balcony soffit lights, can be used, either with or without three or four colors. Colored glass used to produce the color in the decorative lighting absorbs so much candle power that practically anywhere from eight to ten times the wattage is necessary to produce the same results as with white light. The decorative lighting should be controlled from the stage switchboard.

Acting Area Lights.* The most important stage lights to consider are those which illuminate the acting area. These are generally a group of spot-

* See Instrument Schedule.

lights controlled separately and directed from a number of positions to cover the acting area of the stage. The drawings indicate here six conventional areas and two spotlights to cover each. The size of the instruments depends upon the distance of throw, the range of intensity and color desired. Their positions are indicated in ceiling openings, on the bridge, and at the tormentors. The following table indicates the size of spotlights effective at various distances using tints of colors:

Wattage	*Lens*	*Distance*
250 W.	4½ x 7½ in.	From 6 to 12 ft.
400 W.	5 x 9 in.	From 8 to 15 ft.
500 W.	5 x 9 in.	From 10 to 18 ft.
1,000 W.	6 x 10 in.	From 12 to 25 ft.
1,500 W.	8 x 12 in.	From 15 to 35 ft.
2,000 W.	8 x 12 in.	From 20 to 45 ft.

Toning and Blending Lights. This group includes the footlights, which should be controlled in various sections and in three or four colors, and the border lights of which there may be only one or several, controlled in one or more sections, in three or four colors. Since these instruments are used to illuminate the setting, they do not need to be of such great intensity as formerly seemed necessary; the acting area lights illuminate the most important elements on the stage — the actor and the surrounding properties. Thirty to fifty watts per color per foot of proscenium width is adequate intensity for the footlights.

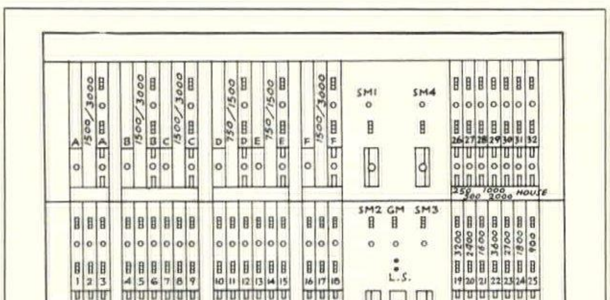
The intensities for the first border can be figured roughly from the following table. For additional borders, perhaps half the amount is adequate, except for the rear border where the intensity should be twice or three times as high, if used to light the backdrop or cyclorama. If the figure for each height is multiplied by the proscenium width, the total wattage for each color circuit in the first border for normal purposes can be computed.

Teaser height —	10 ft.	15 ft.	20 ft.	25 ft.	35 ft.
Watts per foot —	20	40	60	80	100

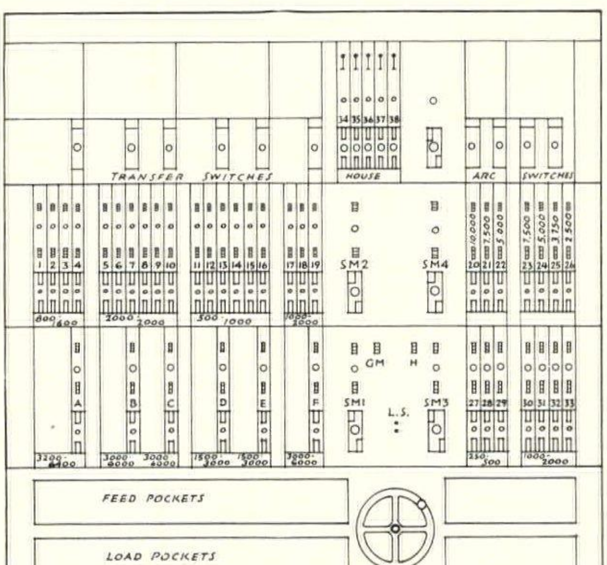
Background Lighting. Although the setting might be considered background, this group of lights refers primarily to the cyclorama or backdrop which should be lighted by a special set of instruments, partly above and partly below, in three or four colors.

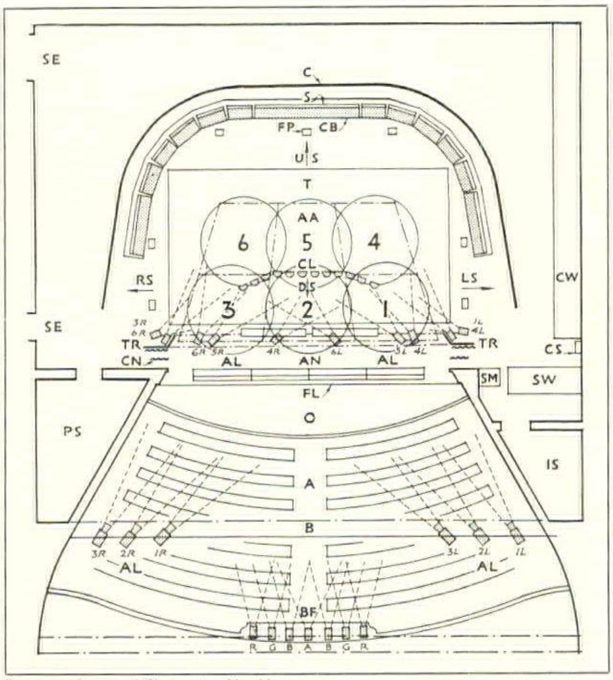
The overhead lights can be comprised in a long strip of high-powered concentrating reflectors or in a group of individual floodlights, hung well away from the background to give even illumination over its surface. In either case, the strong colors (red, green and blue) tend to absorb a great deal of the candle power, so that the total wattage must be relatively high. In addition to this, the various colors absorb different amounts of light, so that if a calculation is based upon this factor, an allowance of two watts per square foot of surface to be lighted for the blue, 1½ watts for red, 1 watt for green, and perhaps ½ watt for amber or white, will give an approach to balanced lighting. Obviously, this depends considerably upon the color of the cyclorama itself, and should be taken only as a starting point.

The horizon lights can be calculated on the basis of the length of the base of the cyclorama, but they do not need to extend around the full distance. For each foot of length, for a reasonably large cyclorama, 75 W. for the blue, 50 for the red, 40 for green, and 25 for amber or white will give an adequate intensity and balance. In both these cases, if



Switchboard faces showing capacities and minimum number of plates. Above for a stage with a proscenium 16 x 24 ft., at the right for a stage with a proscenium 24 x 34 ft.





Drawings, Courtesy of Theatre Arts Monthly

The diagrams on this page illustrate the types and locations of fixtures to light a typical theater stage. Above is the plan. Below are the section and elevation

A	— Auditorium.	LS	— Left stage.
AA	— Acting areas.	MB	— Masking border.
AL	— Acting area lights.	O	— Orchestra pit.
AN	— Apron.	P	— Proscenium.
B	— Beams.	PS	— Property storage.
BF	— Balcony front.	RS	— Right stage.
C	— Cyclorama.	SE	— Stage entrance.
CB	— Cyclorama border.	SM	— Stage manager.
CL	— Cyclorama lights.	SW	— Switchboard.
CN	— Curtain.	T	— Trap.
CS	— Company switch.	TB	— Tormentor batten.
CW	— Counterweights.	TC	— Teaser curtain.
DS	— Downstage.	TE	— Teaser.
FL	— Footlights.	TL	— Tormentor ladder.
FP	— Floor pocket.	TR	— Tormentor.
FS	— Fly space.	TT	— Teaser thickness.
HL	— House lights.	US	— Upstage.
HS	— Horizon strips.	XR	— X-Rays.

IS — Instrument storage.

red and green glass are used in place of gelatin, their order should be reversed, because with certain glass, red transmits more than green.

Special Effects. This group comprises the special instruments which are used to obtain motivating effects such as sunlight, moonlight, lighting fixtures, fire lighting and so on. There should be a number of outlets about the stage from which they can be fed. It is impossible to state just how complete an equipment of this group there should be on hand in each theater. It is often more practical to rent them for a particular production than to own them outright.

Flexibility of Equipment. Obviously, if all the instruments, even including the border lights and footlights, are portable, they can be used in different places as occasion demands and the total amount of equipment can thus be cut to the minimum. With the variety in forms of scenery in use today, each setting requires a special distribution of light so that any fixed equipment is likely to be useful only part of the time. As a principle, only the instruments necessary for lighting a particular production should be mounted and used. To this end, the following precautions should be considered:

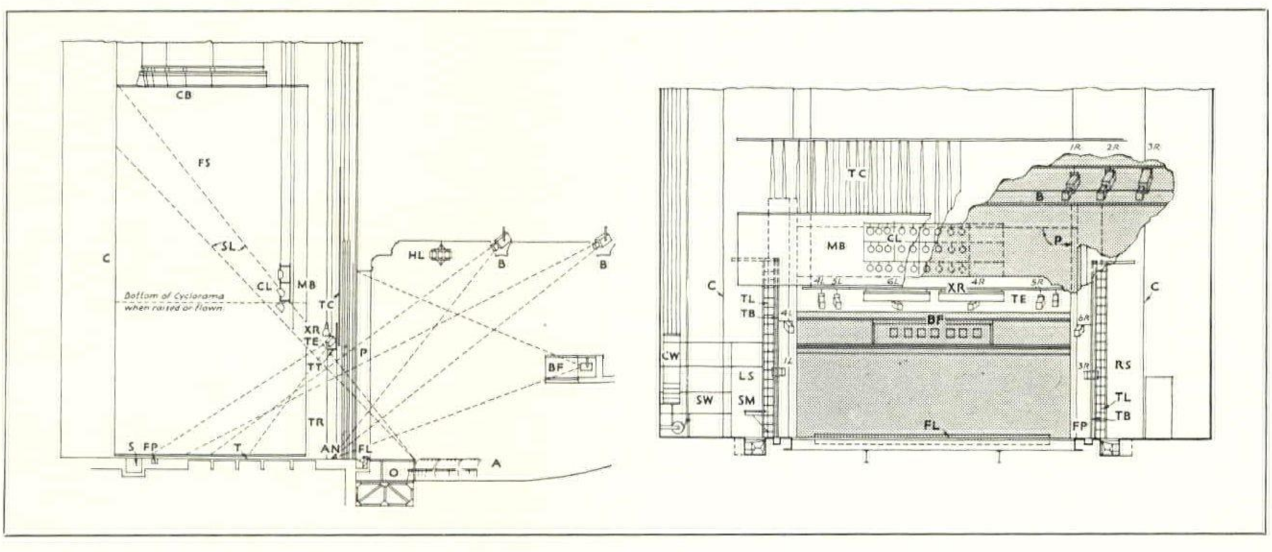
a. As far as possible, instrument hangings and connections should be standardized.

b. Structural details, such as beam openings, balcony front, and bridges, should be provided for mounting instruments.

c. There should be adequate wiring and outlets for connecting the instruments in a large number of places.

d. The switchboard should permit interplugging or cross-connecting between the load circuits and feed circuits to allow grouping of lights as to capacity and for the sake of operating several cue circuits without undue complications.

Division of Budget. The method outlined above considers a certain minimum equipment required for



lighting any production. In addition to this, there should be a flexible control board, a signal system, and other electrical appliances to be considered in the allowance left for electrical work in the building budget. This budget cannot be slighted by the architect nor its importance underestimated. For the sake of comparison, a number of adequately equipped experimental theaters have been examined and it is found that, for the smaller buildings, from 10 to 15 per cent of the total cost of the building should cover the entire electrical and lighting layout. For very large buildings, this might be somewhat less. Of this amount, approximately 40 per cent should go to the switchboard, 30 per cent to the instruments and accessories, 20 per cent to the structural features and wiring, and the remaining to the rest of the electrical layout.

The foregoing factors are the determining elements in any lighting layout. The following indicates more precisely the details, which are submitted as a general guide, not as rules. Each type of theater as well as each type of production requires a particular analysis of the problem to arrive at an economical layout. Wiring to positions to serve the various types of instruments, their number and type, the control board, the signal system, and accessories, such as cycloramas and domes, are essential parts of any layout. The drawings used in connection with this article indicate the type of installation recommended in the foregoing paragraphs and should be used in connection with the outline.

Wiring. The code amply specifies the provisions for exit lighting and the main precautions to follow in laying out the distribution of circuits and equipment on the stage.

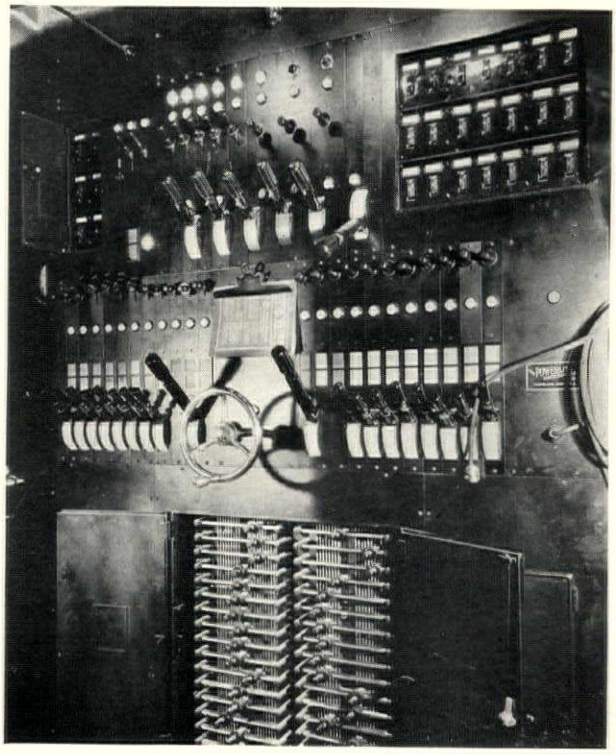
a. The main feed should be brought to the stage switchboard and must be equal in capacity to the total load of the house lights and any possible load that is likely to be required by the stage lights.

b. Distribution from the switchboard to the house lights, stage outlets, fixed instruments, should be permanent wiring, although for very small installations it is permissible to use portable cables connected directly between the switchboard and the instruments.

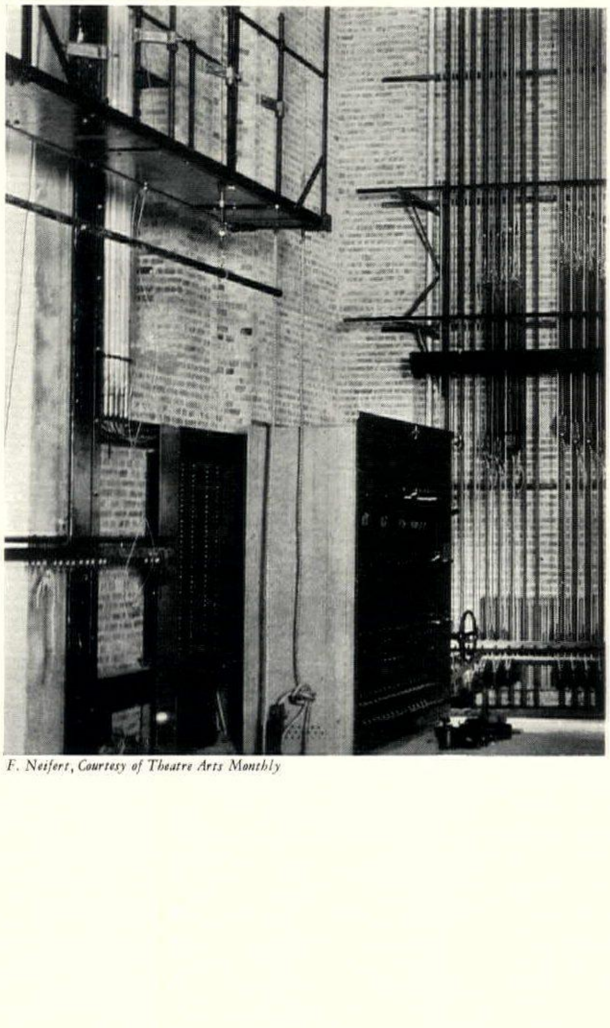
c. Stage floor outlets are generally of the arc pocket type, 50 ampere capacity. In general all incandescent pockets can be standardized in 15 ampere female pin connector outlets, in groups of three or four, or located along the length of a permanently mounted wire-way on bridges, borders, and tormentors. Outlets mounted on pipe battens should be fed from the gridiron instead of from the side wall, through large marine multi-conductor cable.

d. Portable instruments can be fed from the pockets by the use of cable leads equipped with male and female pin connectors.

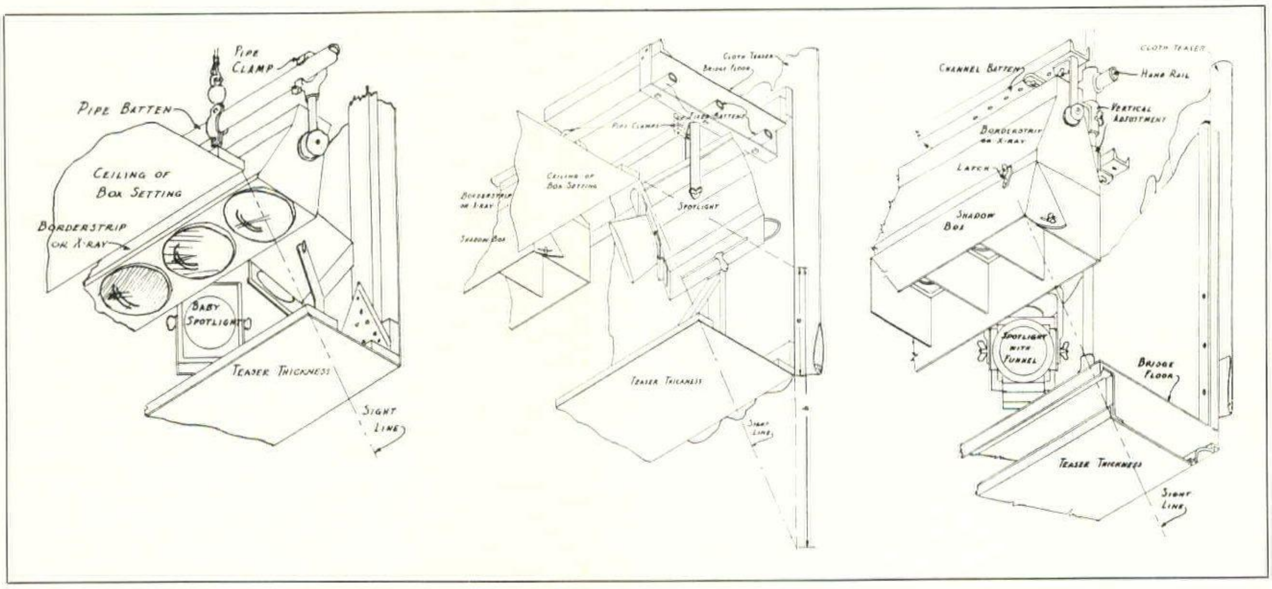
e. A company switch of sufficient capacity to supply the portable board of a traveling company should be mounted near to the proscenium on either side of the stage, preferably near the house board.



Above is a switchboard for the Chamber Music Auditorium of Severance Hall at Cleveland, Ohio, Walker & Weeks, Architects, showing a small cross connecting panel. At the extreme right is shown the extended control cable. The illustration below shows part of the stage equipment of the Kalamazoo Civic Theater, Aymar Embury II, Architect



F. Neifert, Courtesy of Theatre Arts Monthly



These drawings show a typical arrangement for border and spotlights and indicate the way they are masked by the teaser or box seating and shadow box. The illustrations below show various types of footlights on the stage apron

Positions for Outlets. Outlets should be provided in number and capacity at convenient positions based on the methods of lighting to serve a practical number of instruments. The drawings indicate approximately the location of the instruments in the layout recommended. It is well to check the outlets provided against the following recommendations to be sure that all details have been considered.

a. Projection booth: Projection machine outlets, D.C. service. Spotlight outlets. Wiring for sound pictures.

b. House lights: Utility, decorative and promenade lighting. Exits and aisle lights.

c. Front lights: Lights used from the auditorium to illuminate the front of the stage. Three possible alternates; the first, however, most important.

1. *Beam lights,* thrown on the stage from the auditorium require four to sixteen outlets depending upon the length of throw and the desired flexibility of control. Provision for remote color and directionality control. Best position at ends of auditorium ceiling beams for diagonal throw. Angle from the horizontal to be from 35 to 75. Construction of ceiling beams to house instrument and to permit the use of long funnels to prevent the spill of light into the auditorium. Provision of hanging and mounting apparatus.

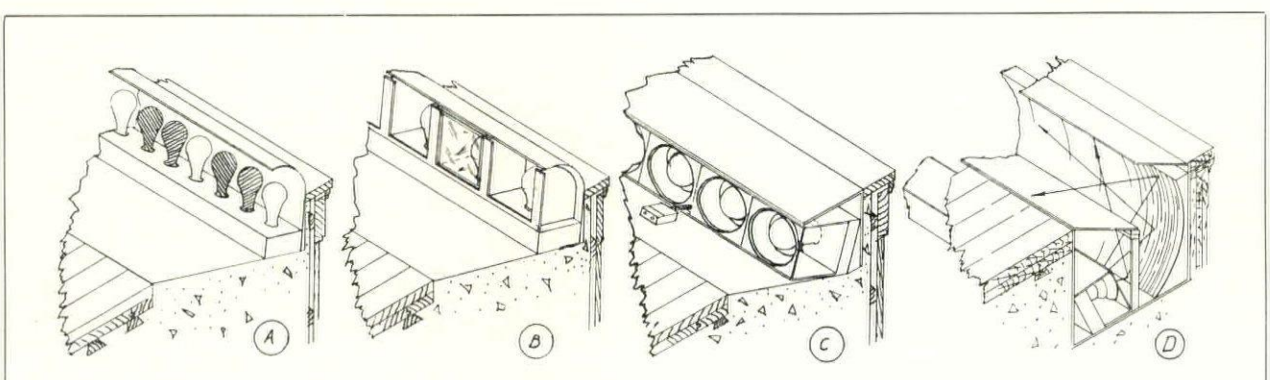
2. *Balcony rail lights,* as an alternate in case beam lights cannot be used. Two to twelve 15 ampere outlets. Provision for remote color control and housing of the instrument.

3. *Side lights* are generally recommended only in case beam lights and balcony rail are not available. Four to six on each side of the auditorium, mounted well up toward the ceiling. Provision for housing and mounting of the instruments.

d. Orchestra lights: Convenience outlets in the floor of the orchestra pit to serve orchestra stands, preferably under each stand.

e. Footlights: Wired in three or four colors and controlled in two or three sections, the center section and two ends. Provision for three or four outlets for footlight spots. Light should be directed completely within the proscenium opening and the cover plate should not be more than three or four inches above the stage floor.

f. Bridge: Hung directly upstage from the act curtain or



teaser. Approximately as long as the proscenium is wide. Provision for mounting instruments on the rail and from battens underneath. Adjustable in height, equipped with from twelve to twenty-four 15 ampere outlets and occasionally two to four arc outlets for effects.

g. First border: Used in case there is no bridge or as additional outlets just upstage from the bridge. Four to twelve 15 ampere outlets on a pipe batten hung from strain insulators to feed spotlights or portable strips, or a permanent striplight wired for three or four colors and controlled in two or more sections, and fed by a cable supported from the grid. Adjustable in height.

h. Additional borders: Conventional distance, 7 ft. apart for the rest of the depth of the stage. Either pipe battens with four to eight outlets or permanently mounted striplights. The former is by all odds the most flexible.

i. Tormentors: Four to sixteen pigtail outlets on each side of the stage attached to the proscenium wall or grouped along a portable wire-way to take the place of the old proscenium strips. These outlets can be incorporated in tormentor towers equipped with operating platforms or ladders, and a vertical batten for mounting the instruments.

j. Grid outlets: Two to four outlets on the gridiron to serve special instruments where it is necessary to hang or "spot" them above the stage.

k. Cyclorama lights: Three to nine large capacity circuits supplying overhead cyclorama units in a position where these units are most apt to be used and fed from a cable supported from the grid. Note the alternate positions indicated in the drawing.

l. Floor pockets: Outlets mounted in a box, equipped with a self-closing lid, under the stage floor. Spaced around the sides and rear of the acting area, generally of the 50 ampere plug pocket type, although better of the 15 ampere pin connector type so that all leads can be equipped with pin connectors only and all connections standardized. Three or four outlets in each box. Sometimes controlled in pairs from opposite sides, but this practice limits flexibility. The number of outlet boxes varies with the conditions of use, usually from three to twelve are sufficient. Arc and incandescent pockets should be identified or in separate boxes. These outlets are to serve stand lamps, towers, stage fixtures, or special effects. Special traps and outlets for horizon strips or cyclorama base lights should be provided at the rear of the stage. The portable type can be fed from ordinary stage floor pockets.

Work Lights. These are used only to illuminate the stage during rehearsal and for changing scenery. They should be controlled from the stage switchboard of the stage manager's desk so that they can be turned on the instant the curtain hits the floor. Work lights can be attached to any of the existing circuits or run independently for the stage area. Sometimes they are incorporated as an independent

Courtesy of Theatre Arts Monthly

The stage of the Civic Auditorium at Kalamazoo, Mich., showing the location of the stage lights circuit in the border lights. In addition to the work lights, there should be operating lights for the switchboard, the pin rail, the prompt board, and orchestra, all controlled from a separate panel independent of the stage lights.

Instrument Schedule. The following schedule indicates the number and types of stock instruments and accessories that are indicated in the accompanying drawings. The first, Group A, is the suggestion for a complete layout for a theater of experimental type having a proscenium opening of professional dimensions — 24 x 34 ft. Group B, of the smaller type, having a proscenium opening of 16 x 24 ft.

Control Board. The switchboard is the most important item of the whole layout. Desirable as it is to have a switchboard located in front of the curtain where effects can be seen, this is practical only through the use of remote control, which is at present exceedingly costly. Ordinary plate dimmers mounted at the side of the stage in such numbers as to provide adequate control over the various circuits necessary to light each scene can be arranged in a panel along the side of the proscenium as suggested in the accompanying diagram.

Signal System. (*Prompt board.*) On account of the size of the ordinary theater building and the necessity of dispatch in performance, communication between all individuals connected with the production should be available to the stage manager. All parts of the stage, dressing rooms, and all parts of the building used in connection with the performance, are important positions to be considered. Signals should be operated on low voltage and lights should be used where the sound of buzzers is liable to be distracting.

a. Intercommunicating telephone is necessary to all parts of the building and stage, particularly with a connection in the auditorium to allow for easy communication between the director and the stage manager or the switchboard. There should be connections between the switchboard and various operating positions, such as the bridge, picture booth, ceiling beams, etc. In some theaters the microphone, electrical pick-up, and loud speaker are used to transmit the orders of the director during rehearsal, or the progress of the play to the actors in their dressing rooms during performance.

b. Curtain, sound and light cue signals. Install the return-answer light signals with extended control at both ends, from the stage manager's desk to the curtain pulls, the switchboard and the various places where sound cues may have to be given.

c. Dressing room signals. There should be return-answer buzzers in dressing rooms with an electrical drop on the prompt board.

d. Act call bell or chimes. In order to announce the beginning of a new act or scene, bell signal or chimes controlled from the prompt board should be installed in the lobbies.

Scenic Equipment. Cycloramas, domes, gauzes, translucent drops, picture screens, and scenery can be considered as secondary instruments which, fixed or portable, serve as part of the complete equipment of any stage. The cyclorama is by all odds the most important next to the various types of scenery used on the stage, and inasmuch as it is a large and useful piece of equipment, it should be carefully considered. Where the head room over the stage is low, a dome may prove to be a practical means of providing a masking background. In either case, the surface of this equipment should be relatively smooth and painted a light gray-blue color. It is impossible in the space of this article to go further into this discussion or to consider the other items mentioned here, except to say that as permanent equipment allowance should be made for them in the budget and they should be considered in connection with the equipment layout.

The theater is a special instrument designed and constructed within practical limits for dramatic production. The diversity of conditions, such as plot, purpose, method of production and budget, determines the plan of equipment, limits standardization, and makes each theater a special problem. The purpose of a particular theater may include provisions for such a variety of types of production that the minimum layout for any one type may prove to be inadequate for others; but in general, that equipment which is planned to provide sufficient flexibility for legitimate productions will, with a few additions, be ample for the staging of concerns, recitals, ballets, and musical shows.

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AIR CONDITIONING THE AUDITORIUM

BY

A. WARREN CANNEY

OF THE STAFF OF

CLYDE R. PLACE, CONSULTING ENGINEER

BECAUSE there is less standardization in theater work than in almost any other type of structure, air conditioning systems are anything but standardized in existing theaters. In place of presenting isolated statistical information from the standpoint that the architect designs such systems, it seems much more advisable to give enough data for preliminary rough cost approximation, and enough specific information to help him in his early planning and in his relations with air conditioning engineers.

Operation of Systems. A present day air conditioning system consists essentially of equipment for the simultaneous automatic compensation for *the rate of gain* or the *rate of loss* of heat and moisture to the air, below or above a given heat and moisture content datum. This must prevail in any combination and regardless of varying *rates* in different locations within the same structure. The system is therefore reversible, and with the exception of providing a source of steam or cold water as required, this should be accomplished automatically.

Sometimes a system must operate so as to humidify and cool at the same time. This implies automatic operation. It therefore follows that the automatic control of an air conditioning system is the heart of the system. But however good the controls may be, they cannot improve the results limited by basic layout.

When the system cools, both the excess heat and moisture are absorbed at the exact rate they are emitted. The heat is usually rejected to the spray water, and is absorbed by the refrigerant which is boiled at a low temperature. The refrigeration machine rejects this heat in a condenser to city water or to another recirculated water pumping system which sprays this water in a cooling tower. There the heat absorbed in the theater is dissipated to the atmosphere.

The water vapor in that portion of the air returned to the conditioning chamber is condensed. Where the quantity of the resulting water is considerable, it is carried away to the sewer from an overflow.

There are several methods used in the conditioning chamber for cooling and dehumidifying. These might be classified as follows:

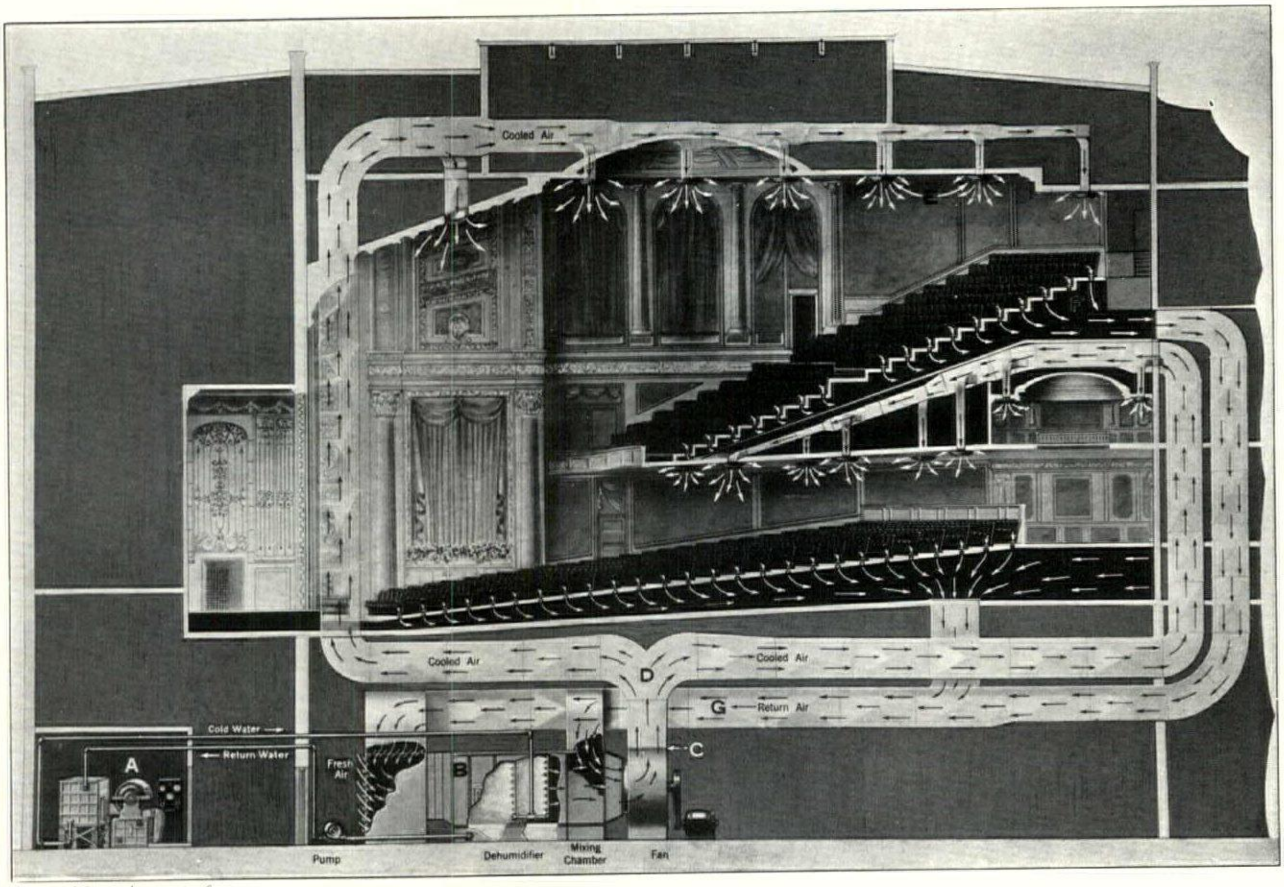
1. Water spray
   a. With provision for by-passing
   b. With no provision for by-passing
2. Combined direct expansion of refrigerant in path of air with water spray
3. Same as No. 2, but with no water spray
4. Cooling a brine, circulating it through surface air duct pipes or fan cooling and dehumidifying
5. The use of refrigeration for cooling only, employing either pipe coils or a spray; and a chemical for dehumidifying

Depending on its layout and size, a theater may have one or more of these conditioning chambers, each with an independent air-handling system. Any of the above methods may employ one or more refrigeration units. These may be cold water wells or bunkers where the spray water is directly cooled with ice. If other conditions are similar, a comparison of initial and operating costs will determine the choice of a system.

For reasons of air distribution in the space conditioned it is considered unwise to deliver air at the low temperature necessary to attain proper dehumidification with most spray water systems. One patented system provides for the admixture of air beyond the spray chamber, this air being obtained from the space cooled. This system limits the minimum delivery temperature desired without jeopardizing the thermal balance of the system by limiting the refrigeration load. Heat is obtained, however, only at the expense of additional fan horsepower and by somewhat larger fans and ducts. This does not necessarily mean larger than other systems, but means over and above the theoretical minimum, in order to obtain what in effect is reheating.

Such a by-pass permits the automatic shunting of other air, which is returned through the spray in accordance with a changing demand of the cooling load. This permits a constant volume of air through the fan and, in fact, many other desirable advantages, and is not only a standard, proved method but permits of the close accuracy of control necessary in good theater air conditioning practice.

Air conditioning for the comfort of theater pa-



Courtesy of Carrier Engineering Corp.

A diagram section through a common type of theater showing typical arrangement of air conditioning apparatus and distribution ducts. In the diagram, "A" is the refrigeration equipment, "B" the dehumidifying chamber, "C" the supply fans, "D" the supply ducts, "E" the outlets, "F" the plenum chamber under the balcony, and "G" the return ducts

trons involves much more than the maintenance of specified temperature and relative humidity. Many theaters with good plants, designed for adequate fresh air quantities do not receive this amount unless doors are open so that prevailing winds do not block it. The question of pressure is of prime importance. Regardless of the location of the outlets and return air grilles, the air will move to the lower pressure region. The pressure carried above atmosphere is usually only equal to the weight of a half-hundred sheets of paper, and the right thing to do is to design a house with double sets of doors between spaces conditioned and the outside, and then provide for the relief of air in amount to that introduced under automatic regulation. This is in advance of general practice but has been successfully accomplished.

At the same time stage ventilation should be designed to maintain a pressure exactly equal to that in the house to prevent the bulging of curtains and scrims. Designing the theater tight against stack effects and outdoor winds is extremely important and is often completely neglected. Otherwise many complications set in and the quantity of outdoor air introduced becomes very variable. In winter drafts result and the system is difficult to adjust, due to the pressure variations tugging at the various parts of the auditorium proper. Moreover, the outdoor air is an appreciable percentage of the refrigeration load. In an effort to cut price, many theaters do not receive nearly so much fresh air as they should. The amount of fresh air per person in the mezzanine systems need not be so great as that on the main auditorium or orchestra system, since the air change usually figures less on the latter and the dilution consequently greater.

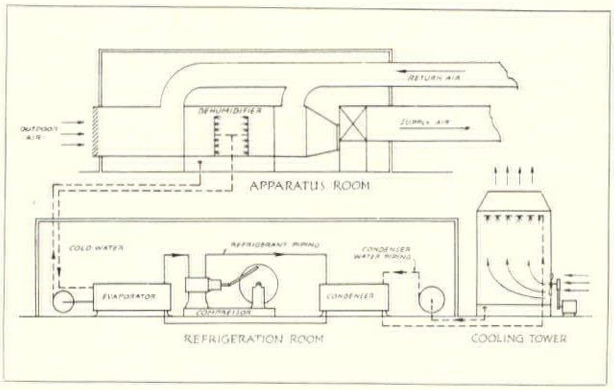
Air Distribution. The technical design of a system may be correct, but its success depends on the all important question of distribution. Distribution depends on a great many variables, such as the number of outlets, their size, location, velocity and relative density of air leaving them, their relation to the return air grilles, etc. The method of introducing air from overhead and returning it near the floor line has gained greatest favor.

There is no greater chance for an architect to ruin an air conditioning system than by departing excessively from what the designing engineer ought to have. In general, overhead, horizontal discharge of air should be provided from many outlets; nothing should be placed in the path of this discharged air. There is no possibility for variation in this respect. The best results are accomplished when positive circulation is provided toward the faces of the audience. The engineer should not be forced to supply air vertically downward or in concentrated, large quantities. The design should be conceived with the idea that air must be introduced into the space, and that outlets must be introduced into the design, which are sufficient to distribute the necessary cubic feet per minute.

Mezzanines are difficult to condition satisfactorily. It is better to have one or two large mezzanines than several, in order to get better headroom. Low headroom conditions seriously hamper proper air conditioning. A plan that projects one mezzanine far beyond the one above is to be definitely avoided. The air will roll over the edge unless properly located return air fans are incorporated in the air conditioning design, a feature strongly to be advocated on every mezzanine system.

Full consideration must be given to the standees. They deserve, in fact, greater comfort than those who sit, but cautious design is required here to prevent excessive cooling when the house is not filled. The higher the main ceiling, the greater latitude in the method in introducing the air. While long narrow-band grilles look well, they increase costs and for uniform distribution call for specially designed duct work in which the usual ventilation contractors have no experience.

The ejector system is deserving of special mention as it is lower in cost when adaptable, particularly to houses of from 500 to 2,000 seats which are free from structural and architectural complications. It is in every way a full-fledged air conditioning system productive of good results, but requires more than ordinary design and installation skill for its success. In this system one main nozzle supply header is

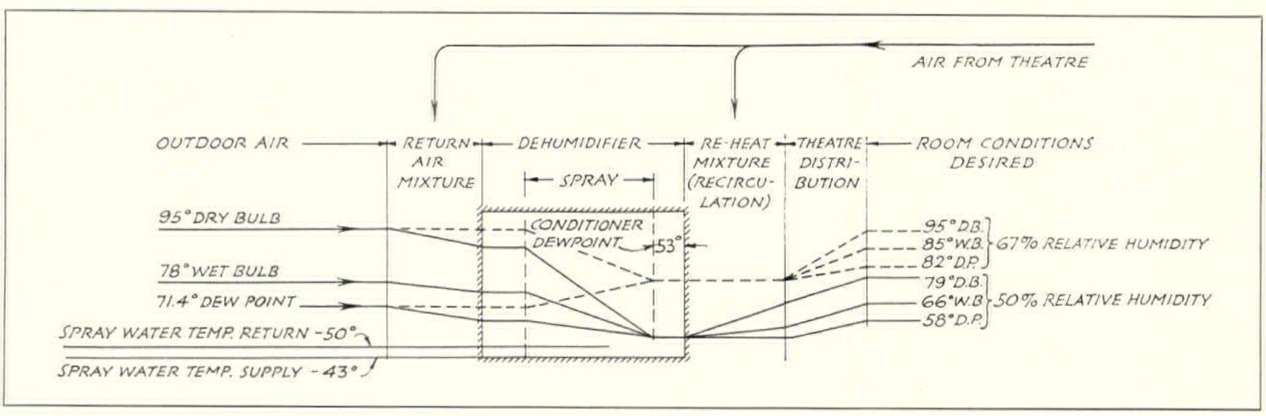


A compact diagram of the essential apparatus contained in a typical air conditioning system

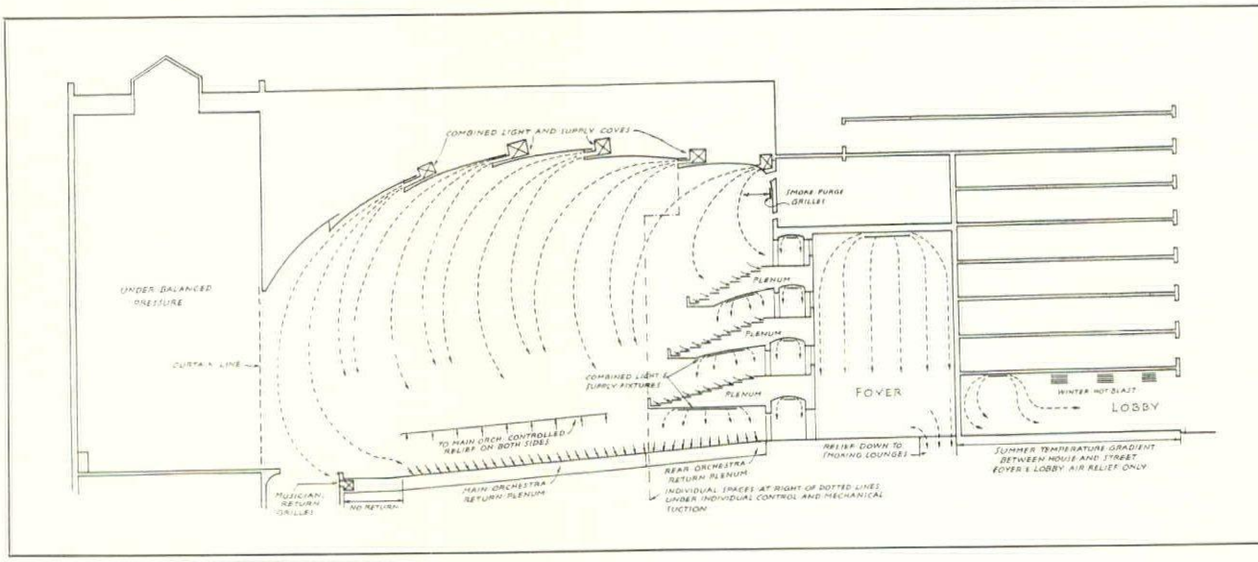
located at the rear of the house near the ceiling, discharging air toward the stage. Should there be a balcony, a secondary header is employed. The ejector system affords ideal distribution and is a rational method of obtaining good air conditioning at lower cost. It is somewhat more sensitive in operation, however, as the design is exacting and nozzle pressures must not vary after adjustment.

In smaller houses employing this system no orchestra plenum is used, the air being returned in the rear rail which is designed to receive the necessary duct work and grilles.

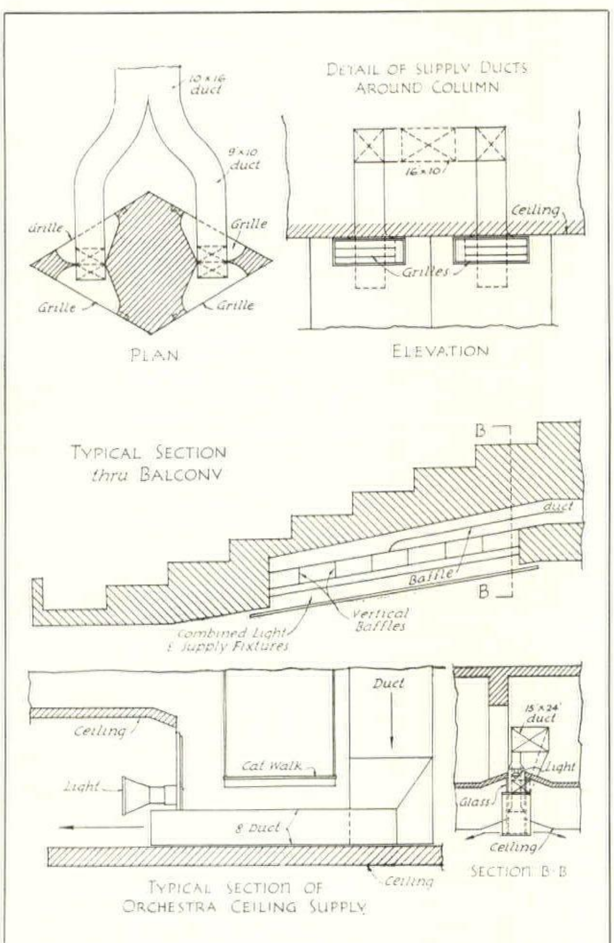
The entrance vestibules should be some distance from the rear orchestra doors in order to permit the quick bringing up to temperature of any cold inrush blasts in winter. The idea of feeding mezzanines, lounges, the main orchestra, the rear orchestra, lobbies, musicians' rooms, executive offices, etc., from the same supply duct, is the height of false economy, ignorant air conditioning practice, or both. The more conditioning units, the better, and the more subdivision of independently controlled ducts feeding these spaces, the better. The number



A chart showing the effect of complete air conditioning. The solid lines show how the air is processed with refrigeration and the consequent relative humidity within the theater, compared with theater air conditions produced by a washer without refrigerated water as indicated by the dotted lines. Without refrigeration the relative humidity is somewhat higher



The diagram above shows one possible method for obtaining a concealed distribution of conditioned air within the essential parts of a theater of large capacity. Notice particularly that the stage is under balanced pressure at all times and the air inrush from the lobby is prevented by a winter hot blast. Below are details of the duct outlets



of conditioning units depends entirely on the size of the house and its layout. These are based primarily on initial cost as regards the number and proximity to spaces served, subdivision for sufficiently close relative humidity control, and an operating economy based on the way the seats are filled for a given type of house.

It is the habit of some designers to base the fan capacity on the cubic feet of air per minute per seat. These figures are interesting for a check, but beyond that they have no meaning. The relative humidity desired, the absorption capacity that has been fixed per C.F.M. introduced and more particularly the type of distribution that can be best provided are the controlling factors. Dependent on these, satisfaction can be obtained between 20 and 33 C.F.M. per seat.

Location of Units. It is good practice to keep the mechanical air handling apparatus and the refrigeration units grouped closely for the supervision of one man. One of the reasons for so much overcooling is that the operator fixes his attention on the refrigeration machine, the air handling equipment operating independently on the roof or in some other remote location. With the controls set for 73°, for instance, the temperature outside rides up to 90°, or more. Even if he knows about it, the operator finds it either too inconvenient to change it or else — and this frequently obtains — the management has given him orders to maintain a temperature five degrees below that of their competitive theaters.

Altogether the air-handling apparatus in most theaters receives miserable attention. The reason is (for not all operators are ambitionless) that there are not sufficient meters, gauges, and thermometers provided for him to find out what the plant was doing in the first place. In many houses the operator keeps calling up the ticket booth with, "How is it out?" He then calls up elsewhere and inquires, "How many inside now?" From this data he takes a chance on what is happening.

If the air-handling apparatus cannot be located in the basement with the refrigeration, a central air-handling equipment room, for ready access, should be provided. Under any condition, enough money should be appropriated to obtain a plant which can be intelligently and economically operated.

A well-designed plant will be able to maintain somewhat lower relative humidities with less temperature differential from that outside. The icicle advertising indulged in by theater managers is a menace to good air conditioning practice. A plant having inadequate refrigeration capacity to provide adequate dehumidification can still obtain a relatively low temperature, but this is not air conditioning for comfort as it should, and can, be made to be. Under such conditions the higher relative humidity will produce clamminess. It is up to the architect to force the owner to get an adequate air conditioning plant laid out in such a way to permit indifferent management and operation to secure proper results with comparative ease.

Refrigeration Equipment. There are several types of refrigeration equipment available. The proper location for these is in the basement or in a separate structure on well sound-insulated foundations. Some machines create air-borne noises rather than a foundation vibration, but all are absorbed at the source so as not to be transmitted beyond the boundaries of the room containing them. The various types of refrigeration machines applicable are:

Carbon Dioxide — CO_2 reciprocating
Dichloroethylene — CH_2Cl_2 Carrene rotary
Dichlorodifluoromethane — CCl_2F_2 (Freon) reciprocating
Steam jet — water vapor — no mechanical parts except water pump

Carbon dioxide is one of the early refrigerants, and is approved almost anywhere by the fire underwriters. Its high pressures make it somewhat dangerous to operators, although accidents are notably few. The high pressures carried cause leaks, otherwise harmless, which build up the operating cost by replacement of refrigerant. In order to overcome all the objections to other known refrigerants in such matters as fire hazard, toxicity, obnoxious odor, high pressures subjecting parts to bursting and other panic-producing causes, refrigerants are available which meet these requirements most satisfactorily. Carrene is used in the centrifugal compressor, this type being more compact than CO_2. Freon, a more recently developed refrigerant very similar to Carrene from the hazard standpoint, is used in reciprocating machines, but under moderate pressures. The centrifugal machine operates under a vacuum, which increases its safety, and uses step-up gears for motor drive.

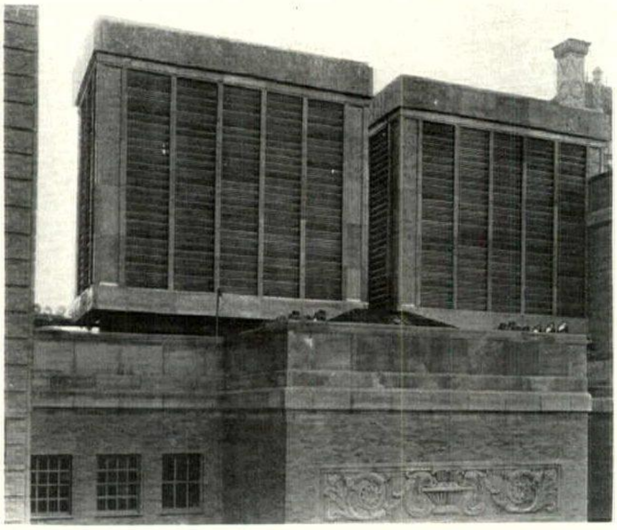
The adaptation of the steam jet to the water temperature ranges required in air conditions has been recently seized upon by several reputable manufacturers. With low steam cost and the use of a cooling tower marked economies are indicated. It operates similar to a steam boiler injector or vacuum condenser ejector, is quiet and has no moving parts to get out of order. It appeals to existing theaters in that the parts can be piped together using odd-shaped, very much smaller spaces which other machines could not get into.

Cooling towers for condenser water are finding increased usage, particularly where a danger of water shortage threatens, or where a cost set-up based on the cost of street water indicates their advisability. A cooling tower is, however, a rather bulky piece of apparatus requiring more than ordinary engineering judgment in the matter of type, capacity, quietness and freedom from fan noise and spray mist after discharge. Furthermore, ingenuity is required of the architect where disguise is desired as well as proper performance.

Sound Insulation. It has become more necessary to know what not to do than what to do in quietizing systems to prevent disturbing sounds from the outlets or returns due to apparatus or air-rush sounds. There is also the necessity of so soundproofing the system that sounds will not be carried through the ducts, which, incidentally, are fine speaking tubes.

Sound transmission must be considered when initially locating the apparatus. Location of any air-handling apparatus on a special slab in a truss space over the main hung ceiling is something to avoid. The designer must avoid short radius elbows in the ducts anywhere, and within fifty feet of the outlets the ducts must have easy elbows and streamline proportions. Friction in the ductwork is relatively small compared to the total resistance of the system from apparatus. Placing apparatus close to the outlets may save some sheet metal, but the idea that a comparatively long run of duct jeopardizes a system is no longer tenable. In general the best policy is to isolate and soundproof at the noise source, and to absorb sounds entrained within the duct as close to the outlet and return air connections as possible.

The use of sound absorbers and filters calls for fans capable of delivering against higher resistances than is experienced in general ventilation practice, and special precautions are needed in the selection of fans, a subject not too fully understood. Generally, the more efficiently a given fan operates the quieter it will be for the type and speed selected. Advanced and careful air conditioning practice calls for much more attention to the selection of fans than usually is supposed, a complex and specialized phase of the work in itself.



A typical cooling tower for condenser water. Cooling towers are being used more and more in air conditioning systems but require ingenuity of the architect in the matter of design

Because of the difficulty of cleaning the acoustical plasters used for interiors (owing to their high porosity and consequent weakness), it is considered good practice to provide filters of one type or another, in the return ducts, particularly to prevent the delivery of dirt tracked in from the street. Floors can be improved by incorporating the grilles in the legs of the seats. Plenum chambers should be practically free from structural restrictions; otherwise all the air will be returned near the duct connection to the plenum and getting air to remote points of the orchestra will forever be impossible without radical revisions at prohibitive cost. The plenum construction employing channels parallel to the orchestra aisles is *passé*. Good distribution is next to impossible with this method.

Costs. In the following discussion of costs only complete temperature and humidity control systems will be considered. While the cost per seat would naturally seem to decrease with increase of size for a given theater type, the increased number and relatively larger spaces usually conditioned, together with added refinements, plus a larger proportional budget for air conditioning in the larger houses, seem to offset any theoretical decrease in cost per seat. The following figures for theaters with one main lobby and one lounge are approximate averages, and include refrigeration but no cooling tower. The figures in Table I give an index to the base price per seat on this basis. A, B and C refer to theater classifications based on the grade theater for a given seating capacity. A+ refers to air conditioning systems designed for better than average results, that is, 50 per cent in place of 55 per cent relative humidity, with complete facilities for record-keeping and the development of cost data.

TABLE I

	Cost per seat 1,000–2,500 Seats	*Cost per seat 2,500–3,000 Seats*
A+	$30–$33	$33–$38
A	28– 30	30– 35
B	24– 26	28– 31
C	18– 20	23– 25

TABLE II

FOR MEZZANINES, ADD AS FOLLOWS PER SEAT

	Neighborhood	*De Luxe*
A+	$3.00–$5.00	$4.00–$6.00
A	2.00– 3.50	3.00– 5.00
B	1.50– 2.50	2.00– 3.50
C	1.00– 1.75	1.50– 2.50

For inclusion of miscellaneous spaces, such as musicians' lounges, unproportionately large foyers, special provision for standees, add from $1 to $2 per seat to left columns and $1.50 to $3 to right column. For installation in existing theaters add 10 to 30 per cent dependent on amount of old apparatus used, structural difficulties, etc., contractor's price only. Ventilation systems with evaporative cooling or other features which pass for air conditioning may be obtained from $8 to $15 per seat.

Maintenance. In practice, the refrigeration tonnage will run between fifteen to twenty seats per ton for neighborhood houses and twelve to seventeen seats per ton for de luxe houses. In recent years installations have been within the lower brackets.

The electrical energy consumption of eleven continuous-show theaters in New York City without cooling towers for all motorized air conditioning equipment averaged 79 k.w.h. per year per seat, ranging from 50 to 110 k.w.h. per seat, and an average of 184 k.w.h. for each 1,000 cu. ft. gross volume per year.

Reliable figures on water consumption were not available due to other services on the water meter. This would vary widely with various types of theaters, their occupancy from year to year, dependent on the weather and the type of refrigerant, the care of operation. Consumption ranges from 800 to 1,500 cu. ft. per year per seat.

Ice should receive special mention due to the attractive initial cost. Theaters have been changed over, seating less than 1,000, for $10 per seat, contractor's price. Ice bunkers occupy ½ cu. ft. per seat. Loss is slight during shutdown at night and the melting rate is automatically controlled. Over 1,000 seats, a comparative cost set-up should be carefully investigated. Large ice companies give special rates to encourage this usage for their product and maintain staffs solely for cooperating with architects and engineers. Ice, in the opinion of the writer, has not yet definitely established its superiority over mechanical refrigeration for operating costs. About 1.15 tons per seat per season are used.

THE JUDGMENT OF EXPERTS

SINCE over 90 per cent of the "self-liquidating" projects under consideration by the Reconstruction Finance Corporation are engineering in character, it is both natural and logical that a Board of Engineers be appointed to determine which projects shall receive financial aid. Since many of the projects have also architectural considerations, especially the $100,000,000 of slum-clearance and housing projects, it is important that the judgment of experts in this field be exercised in the selection of such projects. For that reason, in addition to the editorial in the September issue of THE ARCHITECTURAL FORUM, this subject was brought to the attention of the Administration in the following telegram of August 15, 1932 to President Hoover:

> "THE APPOINTMENT BY RECONSTRUCTION FINANCE CORPORATION OF ENGINEERING ADVISORY BOARD GUARANTEES TO THE TAX PAYERS PROMPT AND ECONOMICAL ADMINISTRATION OF FUNDS TO BE EMPLOYED FOR ENGINEERING PROJECTS STOP APPOINTMENT OF AN ARCHITECTURAL ADVISORY COMMITTEE HAVING PARALLEL FUNCTIONS ON SLUM CLEARANCE AND OTHER SELF-LIQUIDATING PROJECTS IS CLEARLY INDICATED IF THE HOUSING PROJECTS WHICH THE R. F. C. WILL BE CALLED UPON TO APPROVE AND FINANCE ARE TO BE CARRIED OUT EQUALLY EXPEDITIOUSLY AND EXPERTLY STOP THE ECONOMIC AND SOCIAL IMPLICATIONS OF THE NATIONAL HOUSING PROGRAM WHICH YOU HAVE SPONSORED HAVE WON IMMEDIATE AND UNIVERSAL PUBLIC ENDORSEMENT STOP THE NAMING OF THE SLUM CLEARANCE AND HOUSING ADVISORY BOARD IS LOOKED FOR AS THE NEXT LOGICAL STEP IN REVIVING THE GREAT BUILDING INDUSTRY WHICH IS RESPONDING WHOLE HEARTEDLY TO THE IMPETUS OF YOUR CONSTRUCTIVE ACTIVITIES"
>
> The Architectural Forum
> Kenneth K. Stowell, Editor.

The subject matter of this communication was given wide publicity in the leading newspapers throughout the United States. It now seems certain that the R. F. C. will avail itself of the services of architects in selecting the housing projects to which its money will be loaned. With this assurance of the judgment of experts, architects throughout the country can proceed with renewed vigor in their work of developing plans for slum clearance and housing projects, and in their efforts to have the necessary housing laws passed by States and municipalities.

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THE TOWER FROM LEIF ERIKSEN DRIVE

HALL OF SCIENCE, A CENTURY OF PROGRESS
EXPOSITION, PAUL PHILIPPE CRET, ARCHITECT