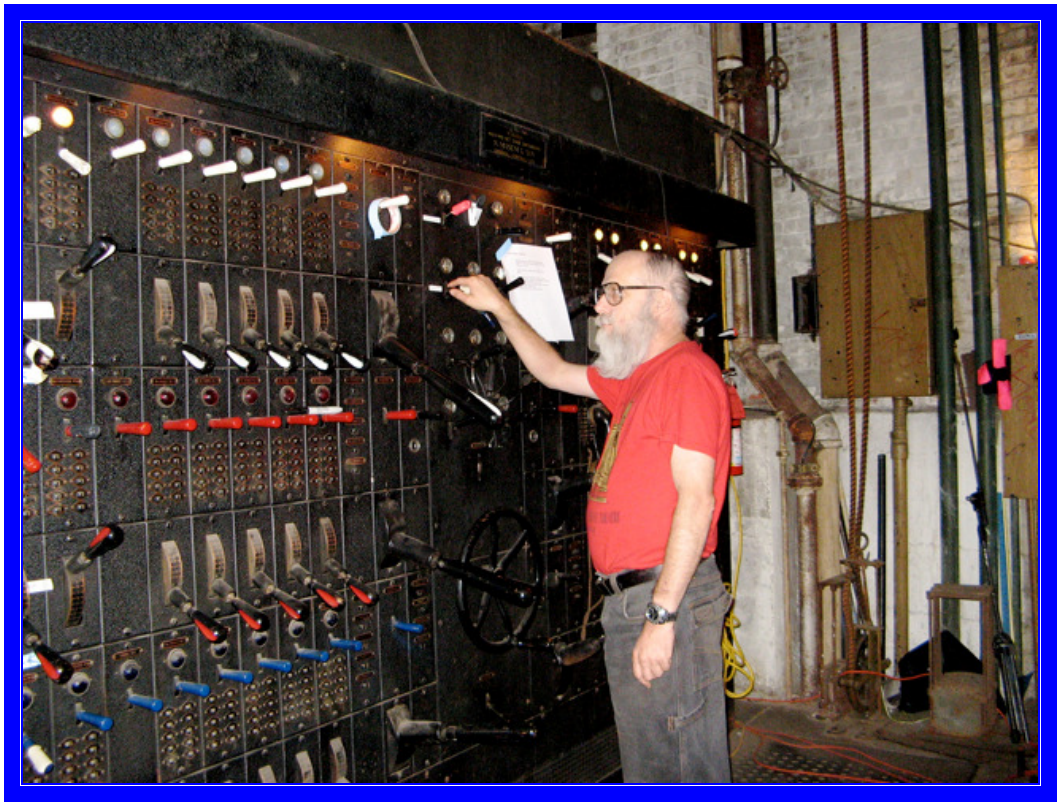

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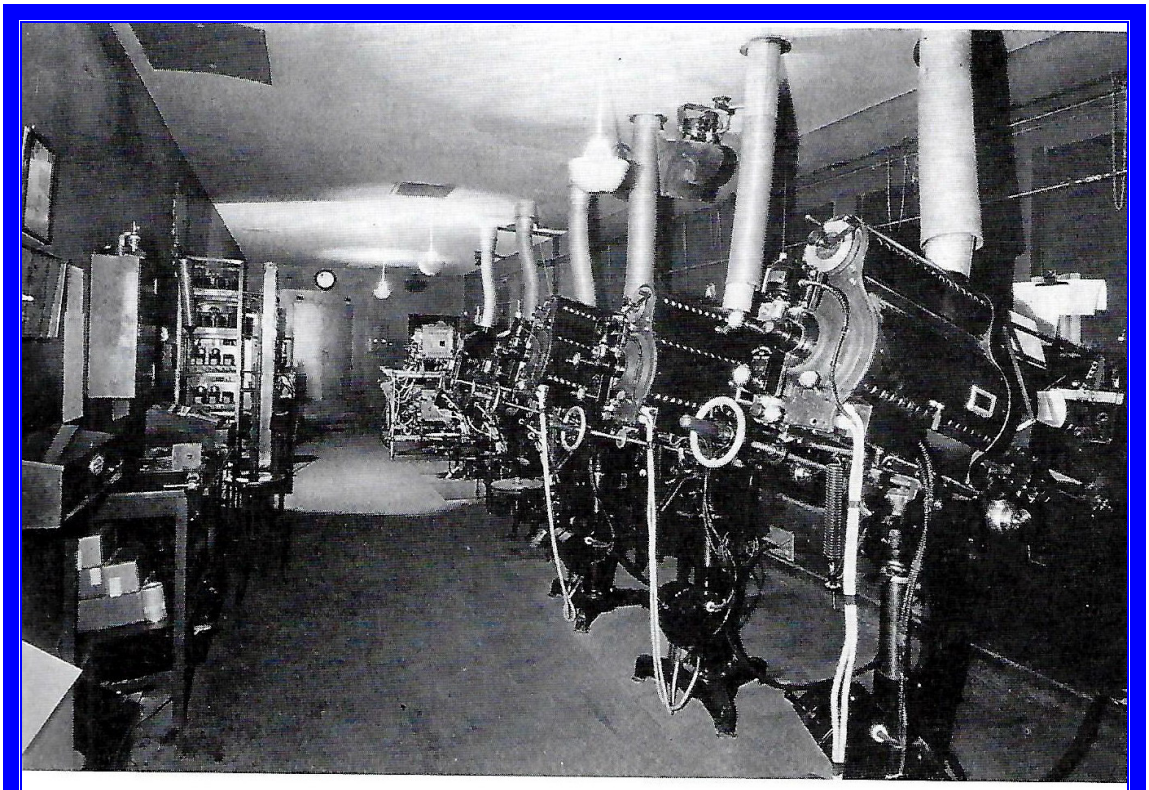


Projection room, Kings Theatre, Brooklyn, New York
C. W. and Geo. L. Rapp, architects

ELECTRICAL INSTALLATION IN THE MODERN THEATRE

From **American Theatres of Today**
Volume Two, Chapter V, 1930

AMERICAN THEATRES OF TODAY

CHAPTER V

ELECTRICAL INSTALLATION IN THE MODERN THEATRE

By EDWARD B. SILVERMAN, *Electrical Engineer*

ELECTRICITY is the valuable servant upon which the theatre is dependent for its satisfactory operation.

The electrical plans and specifications for the modern theatre are rather intricate, and for that reason, the architects who specialize in such work have found it profitable to include on their permanent staff an experienced electrical engineer. To those who are occasionally confronted with a theatre project it would prove to their advantage to employ the services of a professional engineer who has made a specialty of theatre work. The author, however, will endeavor to enumerate and describe the different phases of this work in the forthcoming pages.

In designing the electrical installation of a theatre it is important that thorough knowledge of the client's requirements be given first consideration, particularly when the project is being done for the operators of chain theatres. To this end it is advisable that a form questionnaire including all items of importance, such as stage equipment, projection booth equipment, sign lighting, communication equipment, and so forth, be prepared. If such a questionnaire is submitted and properly signed, it will relieve the designer from any responsibility should his client, according to a common practice, change his wishes after the award of the contract.

Whether the architect or engineer secures an answered questionnaire or the installation is left to his own judgment, it is necessary in either event that the installation designed, while economical, shall be adequate to provide for flexibility of the entertainment policy.

If the theatre is for a small operator, it should be taken into consideration that this theatre may eventually be operated by larger companies and the installation, therefore, should be designed accordingly.

In order to properly present for estimating a description of the electrical installation, a set of wiring plans is essential which shall indicate the location of all outlets, panelboards, motors and other equipment complete with the diagrams of connections and the indications of circuits and feeders. The specifications should include a thorough description of the type, quality and arrangement of all electrical apparatus and the labor in connection therewith. There should be only a single interpretation possible.

In addition to being familiar with the installation of electric work in theatre buildings, the designer should acquaint himself with the laws, rules and regulations of the municipal or district departments having jurisdiction, with the requirements of the Board of Fire Underwriters and the company supplying the power.

It is also important that every consideration be given to provide facilities to maintain the equipment; and, in such locations as main ceilings, where concealed lighting sources exist, access ladders and platforms properly arranged and lighted should be included. Absence of such accommodation would give the maintenance man sufficient reason for neglecting this equipment.

SERVICE ACCOMMODATIONS

The accommodations and location of the service room should be determined after a fair analysis has been made of the amount of lighting and power equipment followed by a discussion with the company supplying the power. It is a general practice that a large service room be located in the basement at a point economical to the installation and acceptable to the utility company.

The majority of installations today are served with alternating current and the loads in connection with the theatre are of sufficient magnitude to require the installation of a transformer vault. This vault should be of fireproof construction and arranged with an exterior access door and area at one end to permit the removal of any equipment. The vault should also be provided with a vent area at the opposite end to permit a natural circula-

tion of air in the vault. A secondary exit door opening into the building can be included in this vault provided there are no local rules to the contrary. Figure No. 1 shows the scale plan of a typical transformer vault. At the street grade over the main areaway, a removable grille should be provided having a hinge section for access. The vent area should also have a removable grille at the street grade for cleaning purposes. Both areas should be well drained and the vault proper should be equipped with a catch basin for any oil that may leak from the transformers. The size of the vault varies and should be determined by the requirements of the utility company.

Immediately adjacent to the vault and within convenient access to it, an additional room should be provided for the distribution of the electric service and the accommodation of the meters and miscellaneous equipment. This room can be built of hollow tile blocks and should be equipped with a 3 feet 7 inches by 7 feet calumein door. The average size of such a room is approximately 12 feet by 20 feet, with a headroom of 9 feet.

A distribution switchboard, preferably one of the "dead front" safety type construction is the important feature of this room. The entire electrical system is fed by arteries or feeders emanating from the switchboard to the various lighting and power load centers.

An emergency lighting system of the type required by local ordinances should be included for public safety and so arranged that, in the event of the failure of the normal lighting service, the emergency equipment could be instantaneously brought into operation until restoration of the normal service.

Emergency lighting applies to such locations to which the public has access and is normally used during the performance, and definitely includes exit lights, aisles in the auditorium, corridor, stairs and lobbies. The system may be supplied by a separate service to the building or an emergency battery system, the latter equipment being mandatory by law in many of the states.

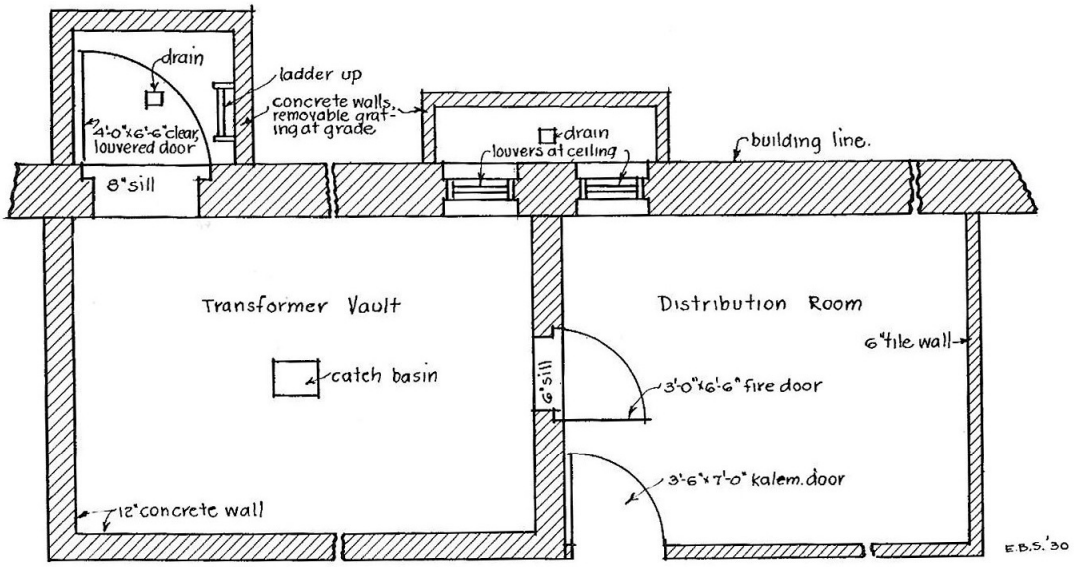


Figure 1

Plan of typical transformer vault and distribution room

The Stage

"Light" is the valuable medium for creating effects upon the stage and therefore the utmost consideration is required in the selection and location of the operating and producing equipments. These equipments vary according to the type of theatre and may be divided in two principal classifications, namely, the combination or variety policy, which provides for sound pictures, presentations, vaudeville and legitimate entertainment, and the straight sound-picture policy. The former type requires a full stage of 30 feet or more depth and the latter a platform of sufficient depth to accommodate the picture sheet, a stage setting and the speaker units.

In this discussion the author is eliminating the large operatic stage and public auditoriums as each case is of special nature; however, the two arrangements covered by the following paragraphs may be applied in proportion.

The combination stage should be completely equipped to provide for any change in entertainment as the time for such changes is generally limited.

Stage Switchboard

For the operation of the combination stage equipment a stage switchboard provided with operating switches and dimming controls for each of the lighting units is required. The proper location of the board is at the side of the stage where the rigging operating equipment is located. A six foot recess should be provided in the proscenium wall so that the face of the switchboard will not extend beyond the curtain line. The width of these recesses depend upon the number of controls, but twenty feet can be considered as an average. A greater width is preferable if the layout permits A space of 4 feet 6 inches should be allowed at the front of the board for the operator. Figure 2 shows the plan of a typical switchboard recess.

There are many types of switchboards but the two principal standard systems can be classified as Remote Control and the Mechanically Interlocked types. The former, which is now the more extensively used, is a system by which pilot switches on the stage board operate singly or collectively, through set up combinations, magnetic switches mounted on a switchboard in a ventilated room, preferably in the basement, beneath the stage board, affording economy in wiring. The mechanical board is a system whereby the switches on the stage board act as direct disconnects for the lighting units. This board, standardized by various manufacturers, is of "dead front" safety type construction having operating handles at the face of the board and the switches at the rear are operated by rods protruding through the front of the board. In either type of board the dimmers and switches should be compositely constructed so that each switch has its respective dimmer control directly over it.

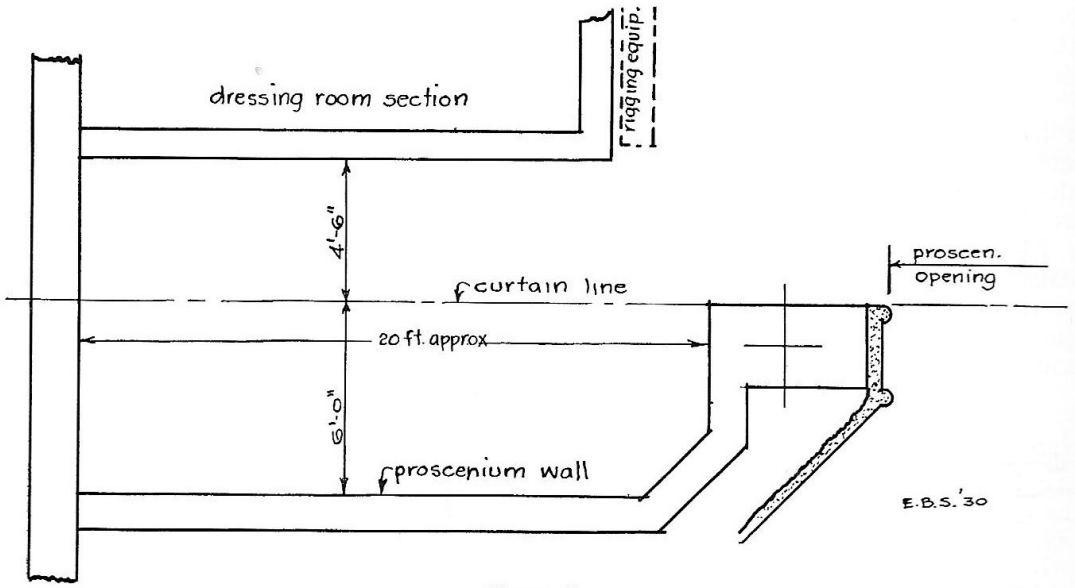


Figure 2
Plan of typical stage switchboard recess

Stage Equipment

A well lighted stage is essential and for its accomplishment sufficient overhead lighting is required. This lighting is provided by borderlights which consist of a continuous metal troughing housing individual reflectors or compartments, wired alternately for different colors, which, in general practice, are white or amber, red and blue. Standard clear

lamps are used and the color effects are obtained with the use of glass roundels or framed gelatine mediums.

These borders are horizontally supported to the riggers pipe batton by means of adjustable chains and are electrically connected by multi-conductor cables to the overhead gridiron, where the wiring is continued to the stage board. The borders are hung by steel cables of the rigging system and can be lowered to the stage floor, for maintenance, or raised to the grid when not in use, for clearance of the stage scenery.

The following borders are necessary for the average 32 foot deep stage:—One (1) Valance Border located at the proscenium arch soffit, two feet shorter than the width of the proscenium opening. Four (4) other borders each six feet shorter than the width of the proscenium opening. The first border should be located approximately three feet from the curtain line and the remaining borders approximately six feet six inches on centers.

A complete stage should be equipped with a light bridge wired with separable pin plugs and mountings for spot units and effect machines. The location of this bridge may be over the second or third border light.

Efficient footlights are essential for good stage lighting. The equipment consists of a continuous metal troughing with hood and gutter, housing individual reflectors wired and equipped as described for the border lights. The trough length should be approximately six feet less than the proscenium opening.

Care must be taken in designing the recesses so that the top of the footlights do not exceed three inches over the stage floor, a factor that should also be considered in figuring the sight lines. To conceal the footlight construction, the fascia of the stage apron should be built to the top of the equipment as shown in Figure No. 3.

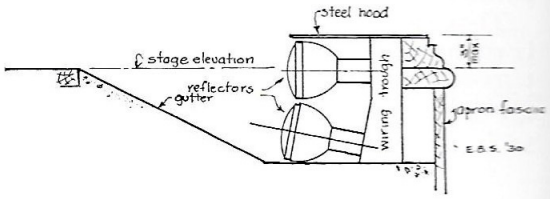


Figure 3
Detail of footlight recess

To provide electrical service to the various portable lighting and effect units at different locations away from the switchboard, plugging pockets are necessary for the stage. When these units occur in concrete slabs, a slot should be formed before pouring. The pockets are located at the sides and rear of the stage. Figure No. 4 shows a typical stage electrical layout.

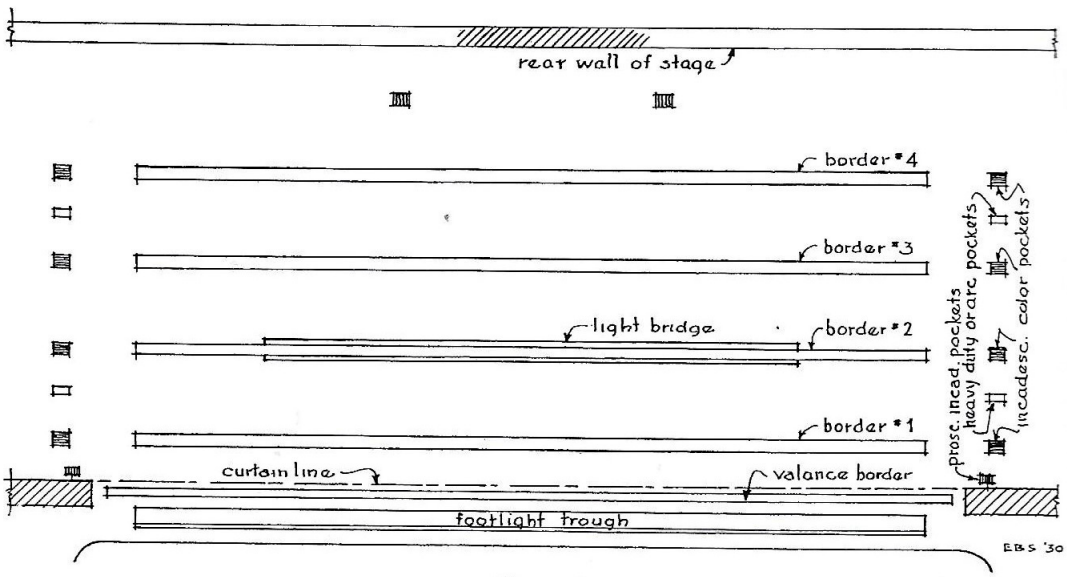


Figure 4
Plan of stage lighting equipment

Stage Platform

For the theatre equipped with a platform for presenting only sound pictures, the lighting equipment consists of footlights, one border and a plugging pocket at each side of the stage. The footlights can be either of the fixed type, as described for the stage or of the disappearing type, which is equipped with a wooden cover and frame set flush with the floor when not in use. The control of the lighting is arranged from a switchboard located in the projection room and within convenient distance of the projectionist.

The Auditorium

In creating effects and atmosphere in the auditorium and public spaces of the theatre, here again light is an invaluable medium.

In addition to visualizing the aesthetic effects in connection with the design, the architect should furnish the inspiration for the decorative lighting scheme. The engineer can then develop the necessary details for the arrangement and the accommodations of the equipment and fulfill the architect's desires. It is essential that this information be incorporated on the drawings before the building is too far advanced.

The modern inclination is to create innovations in lighting and we find a tendency towards Spanish, Chinese, rich Romanesque and modernistic schemes being applied.

The Atmospheric House

There is also a recent innovation known as the "atmospheric style," with its sky effects and side walls indicating gardens, interiors, patios, and so forth. In this style of design lighting effects are generally concealed from public observation. In all cases where concealed lighting is provided, sufficient accommodations should be made for maintenance and concealment of the units.

In the atmospheric style of house, platforms should be provided behind the architecture of the side walls. To produce satisfactory lighting for the great span of the sky in this type of house, efficient reflectors should be used at the source of light of the type that would furnish proper diffusion and elimination of shadows.

Accommodations should also be provided on these platforms for the installation of cloud machines. It is also advisable to introduce a number of individual lighting units in the furred space above the main ceiling (sky), arranged with small openings in the ceiling for producing a star effect. These units should be arranged in accordance with the natural constellations to meet with the interest of the patrons.

These holes are generally about ¼ inch in diameter and fitted with a dew drop crystal to take the reflection of the fixtures. If it is desired to produce the twinkling effect to these fixtures, the thermostatic sockets can be used to supplement a constantly burning lamp.

Cove Lighting

The main dome cove, which is so often found in the theatre of Adams design, is the effect that will undoubtedly remain for some time to come as it creates a beautiful tone of warmth and color. These domes, whether they occur as the main motif of the ceiling or are in secondary locations, should bear a true parabolic curve starting from the cornice line. The architect should bear in mind that

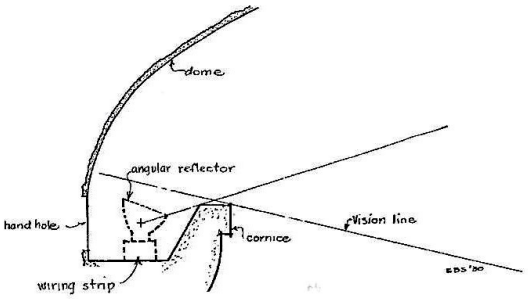


Figure 5
Detail of lighting cove

the higher the crown of the dome, the more even is the distribution that will be obtained. In this way the brilliancy of the source can be avoided. The accompanying figure No. 5 indicates the proper design for cove lighting. Full size architectural details should be made for the plaster contractor for all coves. The domes should have a mat finish to avoid the reflection of the lighting source.

Lighting Fixtures

Where the design requires the use of lighting fixtures, sufficient accommodation should be made in the electric wiring. The fixtures should contain sufficient lighting receptacles

to properly illuminate the area, giving consideration to the absorption of the surrounding decorative color scheme, the glass or material enclosing the lighting source and the maintenance. Where glass enclosures form a part of the fixtures, lamps should be so arranged as to conceal the glare of the lamp filaments. There is nothing so unattractive as a spotted lighting fixture which is caused either by the lamp being too close to the glass or when the glass is a medium insufficiently transfusant.

When the main fixture is to be used in the auditorium or foyer ceilings, exceeding 20 feet in height, the windless and platforms should be located in the attic space and provided for in the ornamental iron specifications. These machines should be of the worm gear type and of sufficient capacity to withstand the weight of the fixture and its trimmings. The cable should be of sufficient length to permit the lowering of the fixture for maintenance.

In establishing the length of the large chandelier, suspended from the auditorium ceiling, care must be taken so that the bottom of the fixture will not occur within the area of the picture projection. A limit for its length can be established by drawing a line of demarcation from the projection openings to the top of the finished stage opening.

It is just as important that the architect include with his plans a schedule and details of the lighting fixtures as it is for him to make the details and schedules of the draperies and hangings. In this way proper proportions and harmony in design will result in this important item.

In determining the intensity of lighting we should start from the very brilliant vestibule and taper down in brilliancy as we come from the lobbies to the foyers, until we finally arrive at the auditorium where there should be a warmth in color. This also shows consideration for the patrons when leaving the subdued light of the auditorium during the picture and eliminates the discomfort of eyestrain caused by glare.

Aisle Lighting

In the selection of the chairs for the balcony and orchestra, the end castings that occur at the aisles should be designed to provide for lighting fixtures that reflect the light downward upon the aisles or steps. In the orchestra these lights should be located at every third row and in a staggered arrangement. In the balcony where the steps occur the lights should be located at every row also in a staggered arrangement. It is standard with many seating companies to include lighting accommodations in their castings; otherwise, there are standard fixtures that are made for mounting on these castings.

As explained in the previous paragraphs, this lighting is to be a part of the emergency lighting system.

Balcony Flood Lighting

Balcony flood lights are a very satisfactory supplement to stage lighting. They consist of an arrangement of lighting units at the balcony fascia, the enclosure of which forms a permanent part of the architecture. This equipment consists of adjustable spot flood lights that are mounted on flat iron or pipe supports and focussed through plaster openings at the front of the enclosure and upon the stage. It provides an excellent opportunity for avoiding face shadows and offers excellent provisions for effective illumination of the curtains. It frequently substitutes the flood lighting from the projection booth. In addition it can be used for illuminating the musicians' pit, particularly when the theatre is featuring an elevating platform.

An average installation of this equipment would be 18 units arranged in 3 colors of projections. The plaster openings vary between 10 and 12 inches, according to the range of projection from the front of the pit to the top of the proscenium drape. The accompanying figure 6 shows the arrangements of this lighting.

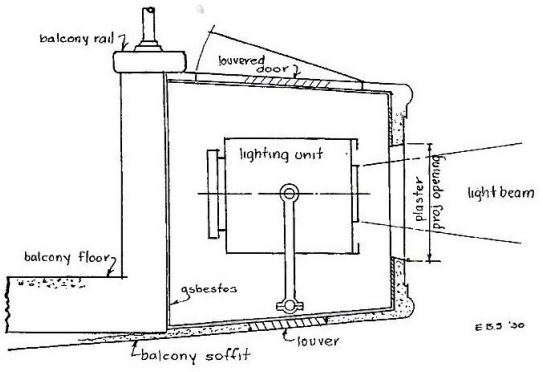
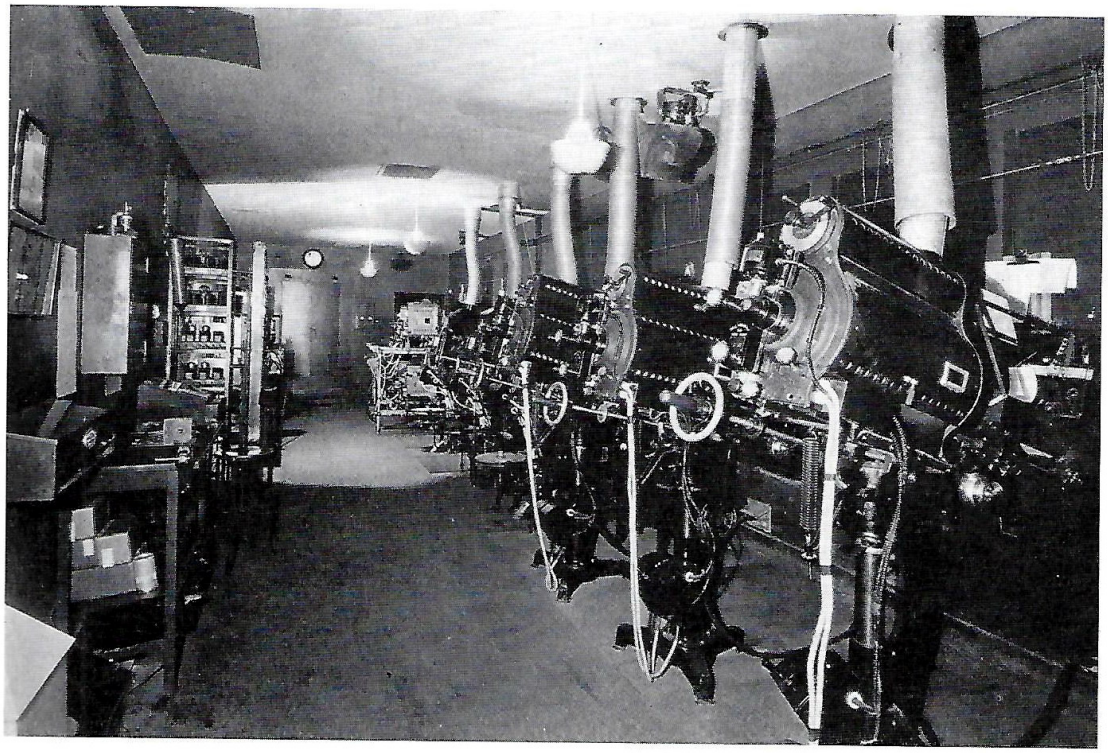


Figure 6
Balcony floodlight enclosure



Projection room, Kings Theatre, Brooklyn, New York
C. W. and Geo. L. Rapp, architects

The enclosure should be lined with asbestos board or asbestos plaster and ventilated either through the auditorium proper or in connection with the auditorium ventilating system. The access doors for the maintenance of these units should be located at the top so that they can be handled from the balcony. These units do not require the use of an operator as they are electrically controlled from the stage switchboard.

Projection Booth

The motion picture projection room should be centralized about the axis of the theatre, either at the rear of the auditorium over the balcony, or at the front of the balcony. The first has its advantages over the latter location inasmuch as it provides better construction and affords access to it with no loss in seating. In establishing its location, special care should be taken so as not to permit an angle of projection exceeding 26 degrees. This angle, which corresponds to the inclination of the projector, is measured between the horizontal and the line joining the projection lens and the centre of the screen.

The construction of the projection booth may be summarized as follows:—

(a) Steel framing with supports between rear wall and roof trusses.

(b) Partitions and enclosures, hollow-tile blocks with Keene cement finish.

(c) Floor, cement on concrete arches with coved cement base, colored.

(d) Doors, fire-proof with combination metal buck frame and trim.

(e) Windows, hollow metal double-hung, with wire glass.

(f) Furred lath and plastered ceiling with ventilation grilles into ducts.

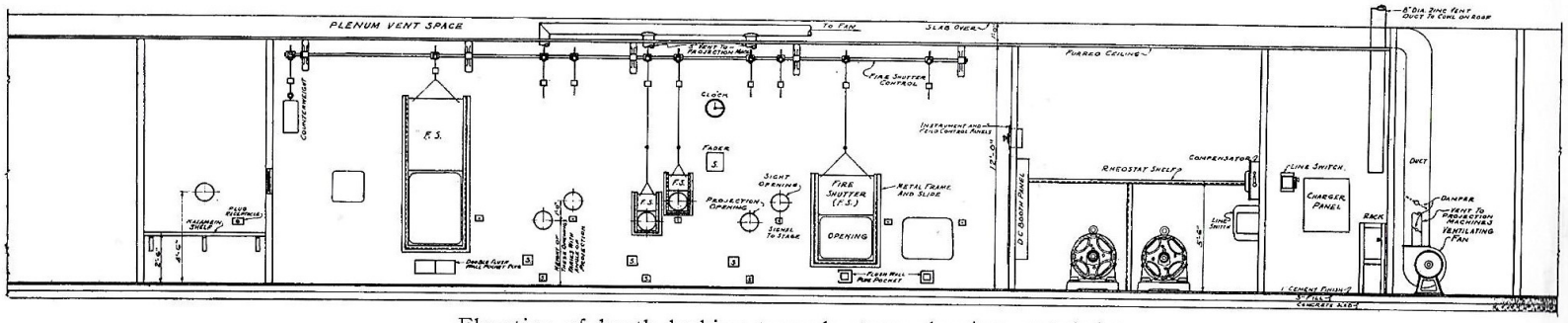
(g) All openings in port wall, metal sleeved, of given size.

(h) All sleeves to be splayed down at top and bottom, equivalent to angle of projection.

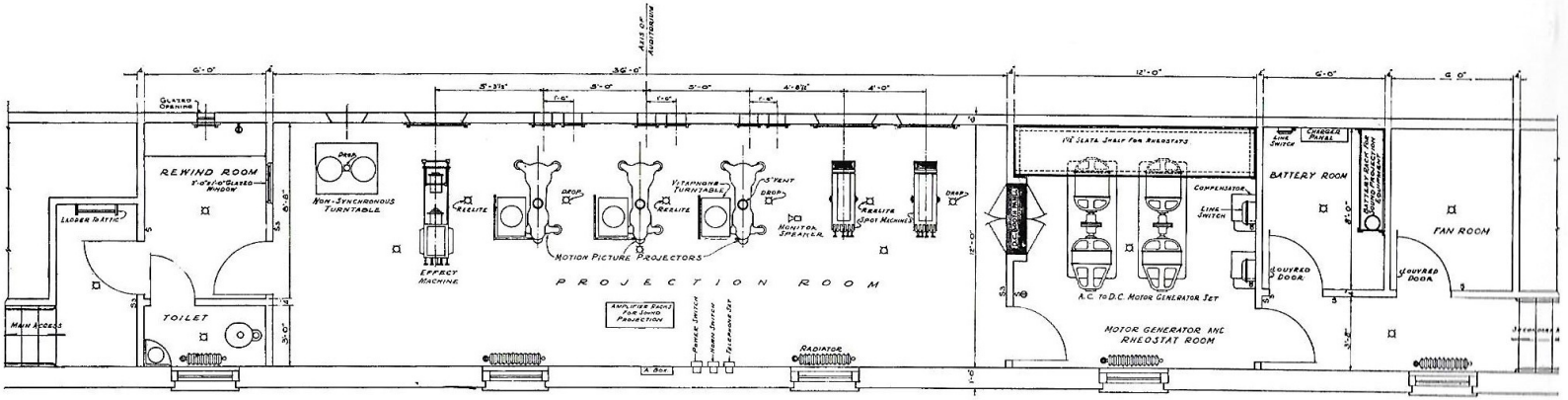
(i) Spot and effect machine sleeves also splayed out at sides.

(j) Rewind-room requires an 18 inch x 60 inch kalamein shelf or work bench.

(k) Rheostat-room requires an angle iron frame supporting slate slabs on which should be mounted the rheostats.



Elevation of booth looking towards stage showing port holes
S—Sound Equipment



Plan of projection booth equipment

Courtesy "Architecture"

Figure 7
Typical plan of a projection booth in a modern theatre
This drawing was prepared in the office of Thos. W. Lamb, Inc., architects, under the direction of Edward B. Silverman

A brief summary of the methods of safety and sanitation of the projection booth is as follows:—

(a) All port openings should be protected with asbestos shutters in metal slides, counterweighted and with underwriters' fusible link control.

(b) Two means of access preferred, at opposite ends of the booth.

(c) Fireman's equipment, chemical extinguisher and sand pails.

(d) Water-closet and lavatory within convenient distance of projection-room.

(e) Mechanical and adjustable ventilation, with separate system for the rooms and projection equipment.

(f) Proper heat radiation at exterior windows.

(g) Diffused lighting.

The accompanying plan, Figure No. 7, indicates the required equipment for the average 3,500 seat theatre having a picture, vaudeville or combination presentation policy, complete with the modern sound-projection equipment of the Movietone and Vitaphone systems.

In cases where direct current is not available, motor generator sets are indicated for converting the alternating current supply to direct current, which is in turn distributed at the panel-board to the various projectors and their respective rheostats in the rheostat-room. These generators may be located remote from the booth, when space is not available.

The location of the non-synchronous turntable, used in connection with sound projection, is also optional. This equipment may be located away from the booth, such as in the rear of the balcony or in some side auditorium recess.

The electrical wiring is somewhat complex, owing to the special nature of the equipment and the requirements of the municipal and underwriters' inspections.

Expert advice is necessary in planning this wiring so that the termination of the conduits are properly indicated and all work concealed.

Exterior Lighting

Exterior lighting plays an important part as a medium for increasing the patronage of the theatre and should therefore be attractive, brilliant and pleasing in design.

There are three major divisions of such lighting:—

Marquee Lighting
Upright or Wall Signs
Flood Lighting

The Marquee

The marquee is the canopy embracing the entrance and extends from the face of the building. Its purpose is not only to protect the patrons from the weather, but to indicate to the public at large the current presentations and features. Accommodations are necessary on the three available sides for changeable signs. These signs should be featured with ornamental corner posts, animated lighting borders around each sign and the name of the theatre.

All the metal work should be of No. 20 ounce copper, artistically painted. The metal work should be properly reenforced to withstand severe weather conditions.

A room approximately 6 feet x 8 feet should be provided adjacent, if possible, to the marquee to house the animation equipment and distribution fuses. The control panel for these signs should be located in the lobby section.

A sign under the marquee over the entrance is advisable. A 5 inch recess should be provided in the construction so as to permit the sign to be flush with the facade.

The marquee soffit should sparkle with brilliance as it also lends itself to the attraction of the people. An artistic and pleasing design is advisable at this location and it should be equipped with an abundance of lighting receptacles.

The construction may be all metal (No. 20 gauge galvanized steel) or plaster cement, with metal ribbing for the receptacles. Ribs forming octagons, squares or any other pleasing geometric form, can be used and may be supplemented with flush opalescent glass fixtures. Coved domes with contrasting colors in lighting add to the warmth of the soffit and are very effective.

Attractive Signs

In many instances, local ordinances prohibit the use of extended signs or marquees. In such cases, an attractive flush sign on the face of the building over the entrance should be used. This type of sign should be very ornate and active in animation. It should be

equipped with a changeable letter section and a fixed monogram section.

Where commercial stores are a part of the theatre building, recesses should be provided over the store fronts for uniform signs. The recesses should be six inches deep, two feet high and the approximate width of the store and should be lined with copper. Hinged covers can be included, built of heavy gauge bronze, which may be cut to receive glass letters as required by the tenant.

The upright or vertical sign should be attractive, distinct and animated with plenty of action. A room should be provided in the building for housing the animation equipment and distribution fuses. Access ladders, foot and hand grips should be provided on the sign for maintenance.

Flood Lighting

With the present improvement of the incandescent lamp and the development of commercial floodlighting equipment, night illumination can be obtained at comparatively small cost. Such lighting contributes greatly to the contours and architectural beauty of the building and undoubtedly results in making the theatre a more imposing structure. As each building presents its own problems in flood lighting, the arrangement and requirements should be determined by the engineer or the manufacturers' specialists.

Sound Projection Systems

There are a number of sound projection systems available for use in theatres, each one involving its own technical problems. Only a casual reference to this new development is being made so that the architect should not overlook the urgent need of expert advice. There are certain designs, methods of construction and electric wiring requirements that vary with the system employed.

Pellissier Building and Theatre, Los Angeles, California
Morgan, Walls & Clements, architects
G. Albert Lansburgh, architect, associated as architect for theatre

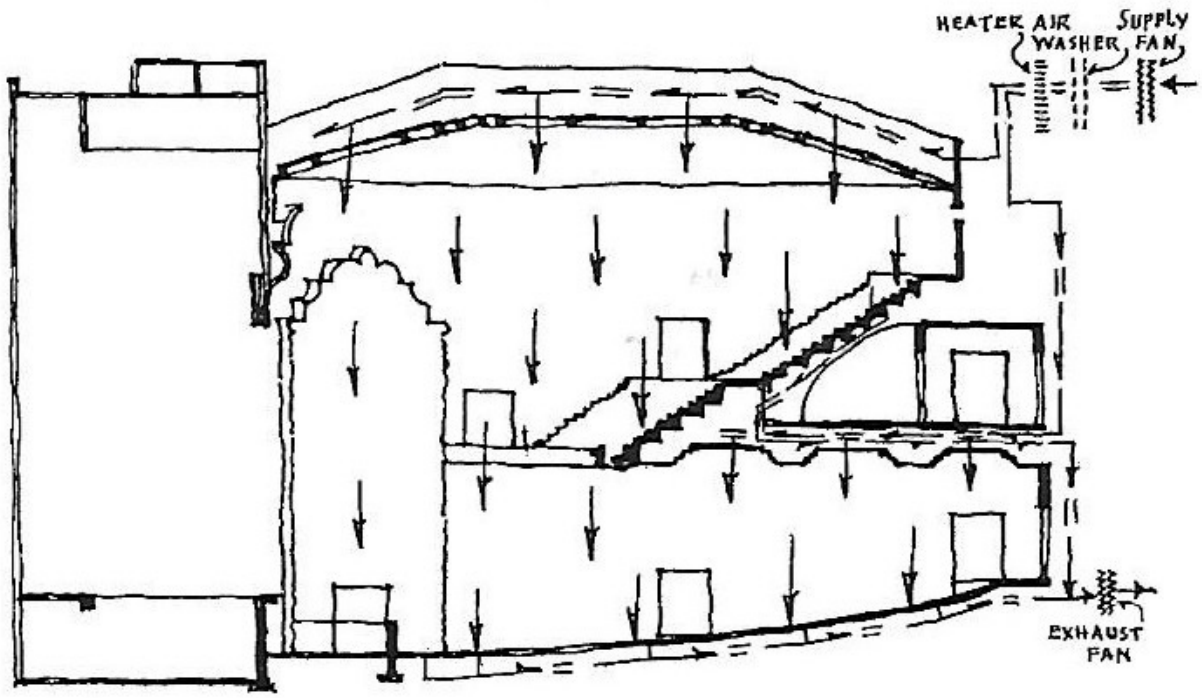


Figure 4

The air-washing cooling system

HEATING AND VENTILATING A THEATRE

From **American Theatres of Today**

Volume Two, Chapter VII, 1930

AMERICAN THEATRES OF TODAY

CHAPTER VII

HEATING AND VENTILATING A THEATRE

By EDWIN A. KINGSLEY, *Consulting Mechanical Engineer*

SOME one once said that there are five requisites to the design and construction of a successful theatre: safety, good acoustics, good vision, comfortable seats, and pleasant surroundings. I would add one more: good air. In fact, it might be better to substitute the word "comfort" instead of "comfortable seats" and list the other requisites as they are. For comfort includes the seats, the space between the seats, the size of the lobby and foyer and the matter of heating and ventilating as well. For a theatre patron cannot be comfortable, no matter how comfortable the chairs may be to sit in, if the theatre is not properly heated and ventilated.

Naturally these days when architects and engineers work in such close cooperation, the theatre architect almost invariably entrusts the heating and ventilating of a theatre to an engineer who specializes in this field. He therefore puts up to another the problem of the installation of apparatus, by which fresh air is brought into the building and distributed and foul air is taken out. But I think it is advisable for the architect to familiarize himself with the fundamental principles

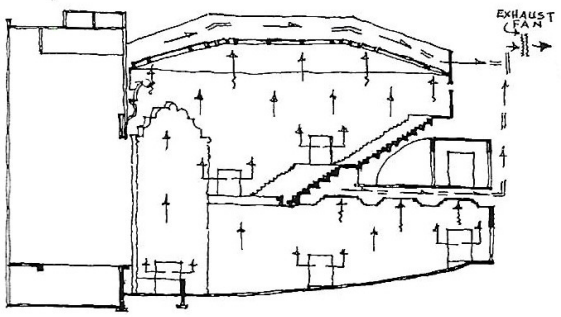


Figure 1
The exhaust system

which guide the heating and ventilating engineer in his work so that the necessary appliances may be installed with the least effort and to the greatest economy for the owner. So I will write only in generalities rather than going into the subject in too great detail. Besides, each problem has its own solution and what might be desirable in one theatre would not apply at all to another.

Generally speaking, then, we might say that there are four systems by which a theatre may be heated and ventilated. They are (1) the exhaust system; (2) the supply system,—down-feed; (3) the up-feed system;

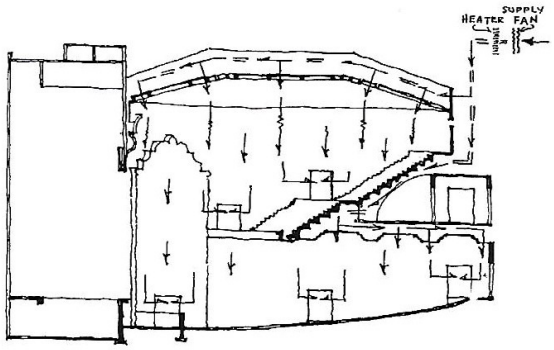
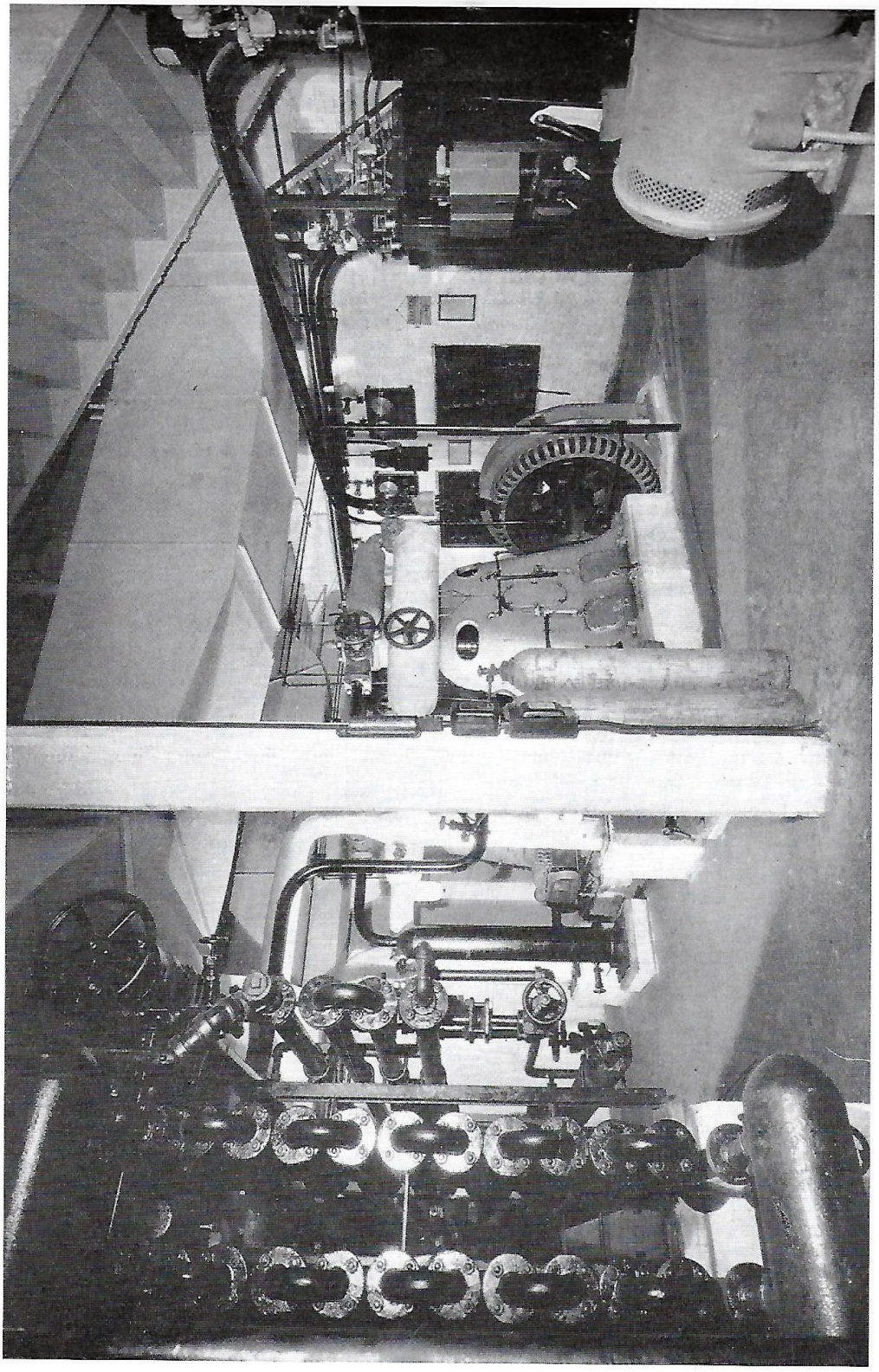


Figure 2
The supply system—down-feed

and (4) the air-washed cooling system. The first or exhaust system is the simplest, the cheapest and the least effective. It is used in small, cheap houses. Fresh air is supplied only by means of open doors, windows, and so forth. There is no supply fan or fresh air intake other than these. The air is exhausted by means of ducts which lead to an exhaust fan. Grilles in the soffit of the balcony and in the ceiling of the auditorium lead to these ducts and so the foul air is taken out of the theatre and the doors and so forth, open again to let in more fresh air. The supply system is almost the reverse of the exhaust system. Fresh air is brought in through an intake and a supply fan; it then passes through a heater which gives it the desired temperature, and is distributed downward throughout the theatre by means of ducts in the ceiling and in the balcony soffit. The foul air is then forced out through the doors and other openings. It may be said here that about 50 to 75 per cent of the air can be used in recirculation, the amount being governed by thermostatic controlled dampers. In some cases, too, the air



Refrigeration plant, Kings Theatre, Brooklyn, New York
C. W. & Geo. L. Rapp, architects

is partly purified by filters before it passes through the heaters.

The up-feed system is more complicated. A supply fan located near the fresh air intake duct brings the air through the filters, passes it through the heaters and it is distributed by ducts to floor mushrooms or aisle hoods in the orchestra and mushrooms, aisle hoods or step grilles in the balcony. The foul air is let out through grilles in the auditorium ceiling and balcony soffit and carried by means of exhaust ducts to the exhaust fan and then outside. In this system also 50 to 75 per cent of the air can be used in recirculation.

The air-washed cooling system is generally a down-feed system. Between the supply fan

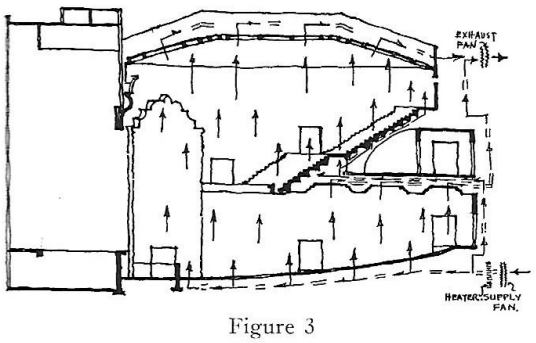


Figure 3
The up-feed system

and the heaters is an air washer. Ducts lead to grilles in the auditorium ceiling and in the balcony soffit and thus the air is distributed downward throughout the house. The foul air leaves by means of floor mushrooms or aisle hoods in the orchestra and step grilles or mushrooms in the balcony, and is taken to the exhaust fan by means of ducts. About 50 to 75 per cent of the air is recirculated by means of a by-pass damper placed in the exhaust fan, thermostatically controlled. Where it is desired to install an air conditioning system, a refrigeration plant is added to this air-cooling system. This plant is usually located in the basement of the building and it supplies cold water to the air washer so that fresh air is cooled to the desired temperature as it is led to the ducts by which it is distributed throughout the house. Where air cooling or air conditioning plants are installed it is necessary to also install wet and dry blub control.

In every case, supply and exhaust fans may be located wherever is most convenient. It is sometimes thought that fans must always be in the top of a building. This is not always desirable or convenient. It is interesting, perhaps, to note that all basement rooms are heated and ventilated separately. The dressing rooms, too, are controlled by another system. In some cases this is a supply and exhaust system and in others an exhaust system only. A separate exhaust-only system is also installed for the toilets. It is also necessary that projection booths have a separate exhaust system of ventilation.

The size, amount and location of supply and exhaust grilles, mushrooms, aisle hoods and step grilles is determined by the amount of air in cubic feet supplied to each person in the house per minute (C. F. M.). In cheap houses this generally runs from 20 to 30 C. F. M., 20 being the minimum. In medium priced houses the rate is apt to be increased to 25 to 30 C. F. M., while in the better class houses 30 C. F. M. is generally found to prove more satisfactory.

In all cases where fans are installed it is essential that the fans have proper sound deadening foundations and that all ducts and grilles are properly sized so as to prevent noise from entering the theatre, as well as to prevent annoying drafts. In first class houses the spaces used for ventilating apparatus are soundproofed.

Where refrigeration is used it is also essential that spaces assigned to the refrigerating apparatus be entirely enclosed with sound-

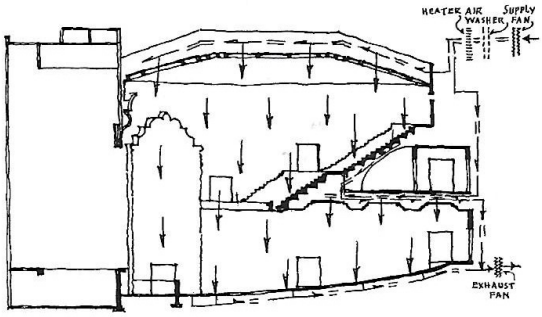


Figure 4
The air-washing cooling system

proofing material. Where cooling and air conditioning systems are used it is sometimes necessary to install a cooling tower, but this greatly increases the cost and the only justification for the use of cooling towers is in those cases where the city or municipality will not otherwise allow the use of water. The cooling tower is generally located on the roof of the theatre.