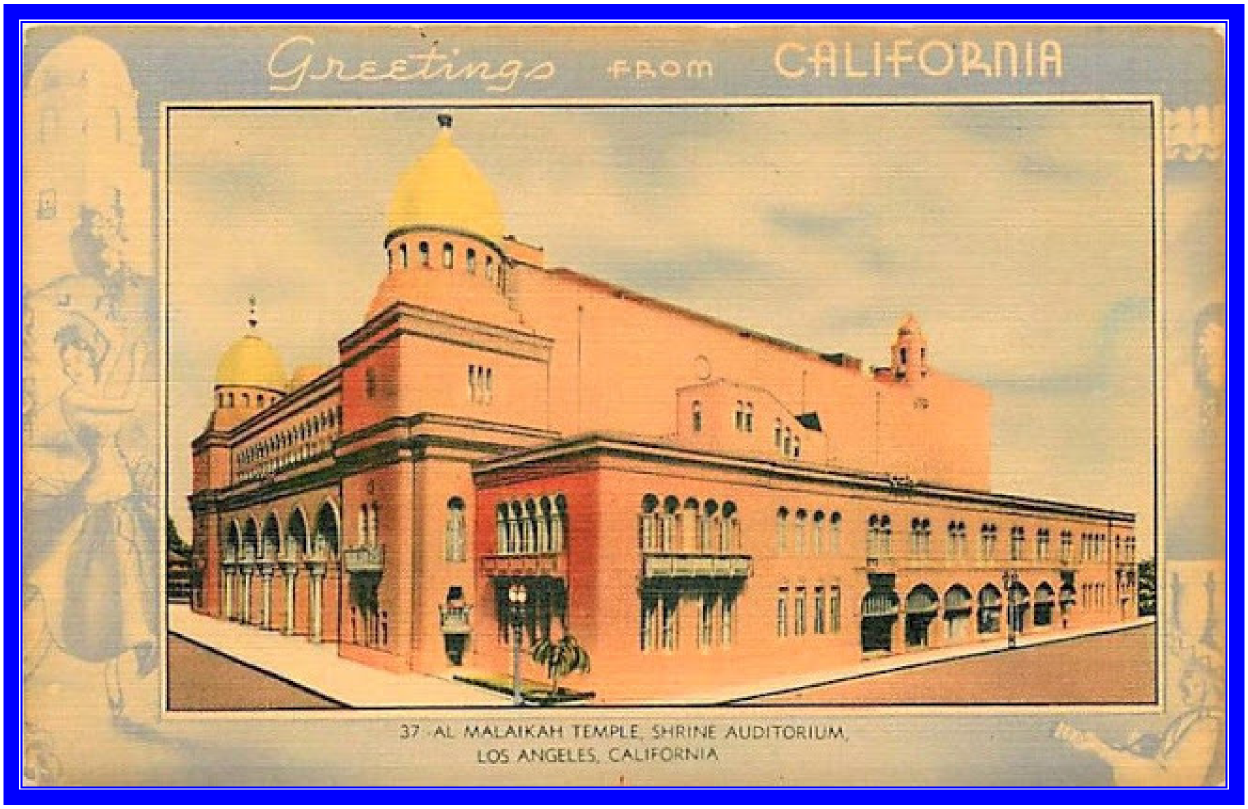


RESTORED MOVIE THEATRES

PART THREE
BUILDING SERVICES ENGINEERING

Eur Ing BRIAN ROBERTS CEng Hon.FCIBSE
Life Member ASHRAE

CIBSE HERITAGE GROUP

R E S T O R E D
MOVIE THEATRES

PART THREE

1926 SHRINE AUDITORIUM, LOS ANGELES CALIFORNIA, USA (6717)

Built with a seating capacity of 6,717, this is America's largest theatre, even with its now current seating capacity of 6,308, it still beats the 5,940 capacity of Radio City Music Hall in New York City. The Shrine Auditorium was built as a replacement of the smaller 1906 built Shrine Auditorium, which burnt down in 1920. Money totalling $2.5 million was raised between 1921 and 1924 by public subscriptions as well as from the Ancient Arabic Order of Nobles and the Mystic Shrine, and it was first known as the Los Angeles Civic Auditorium. Later, the Al Malaikah Temple branch of the Shrine re-purchased the public shares and renamed it the Shrine Auditorium. They still own the building today.

The Shrine Auditorium opened on January 23, 1926. It was designed by John C. Austin & E.M. Edelman, with the interior designed by noted theatre architect G. Albert Lansburgh. The exterior of the building resembles a gigantic double-domed Middle Eastern mosque. Built of poured concrete, the building covers almost 3 acres and it took almost two years to complete. There is a basement under the entire building area, and further facilities are on the left-hand side of the building which houses an Exposition Hall. This vast area alone measures 150 feet wide by 250 feet in length with a main floor, a basement and mezzanine levels. The facilities here include a sprung dance floor and kitchens.

Inside the main auditorium seating is provided on orchestra level and a huge cantilevered balcony, which actually seats more than the main orchestra floor. The decoration is in a Moorish style with hardly any decoration on the side-walls up to the cornice. There are decorative organ grilles and a large box located on each side of the proscenium. The ceiling is formed like a gigantic decorated tent measuring 192 feet across. Made of concrete, it weighs 1,870 tons. From its center hangs a huge crystal chandelier weighing 5 tons. It is 20 feet in diameter, 28 feet long and has over 500 light bulbs in four colours; white, red, blue and amber, which uses 64,445 watts of power when fully lit.

Photographs and text extracts from losangelestheatres.blogspot

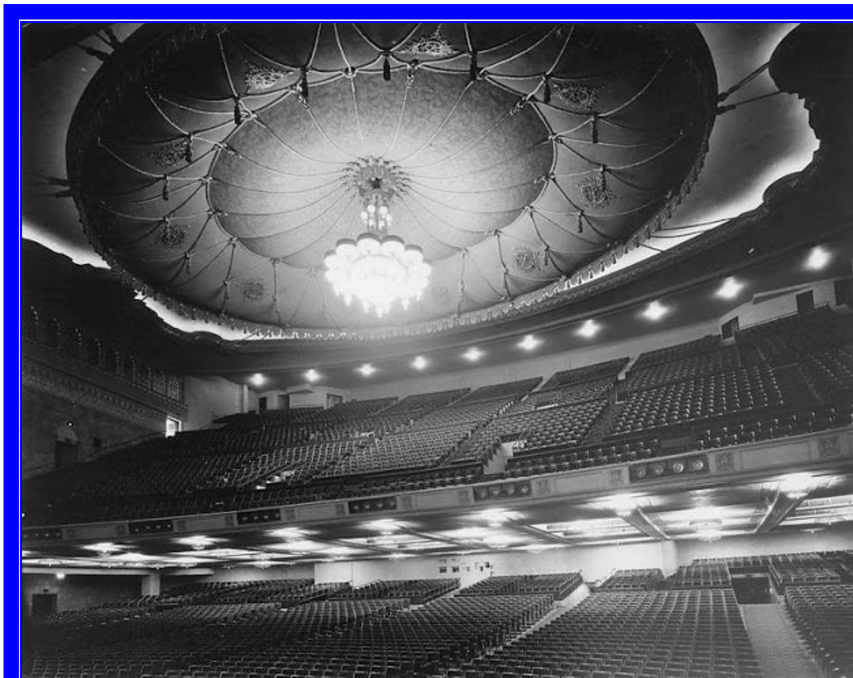
SHRINE AUDITORIUM, LOS ANGELES

SHRINE AUDITORIUM, LOS ANGELES

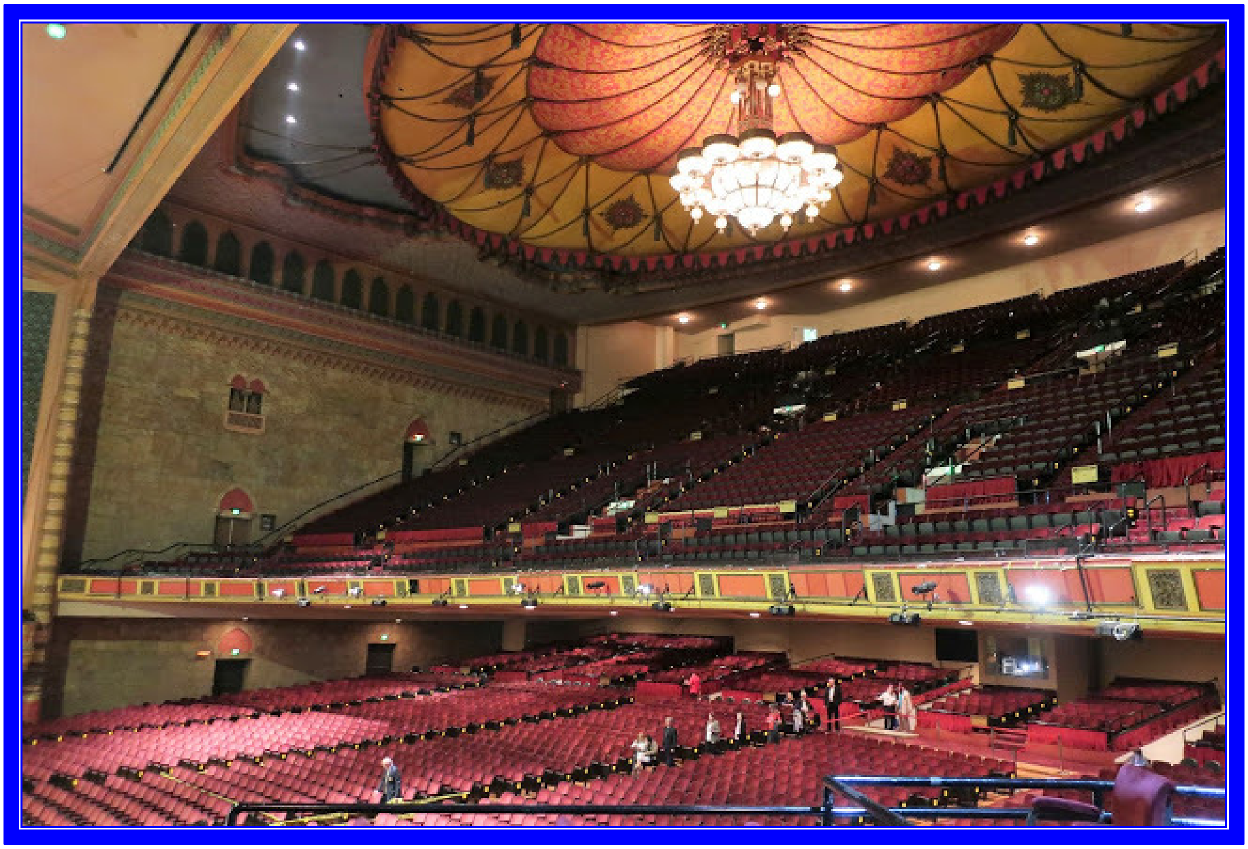
The Academy Award Ceremony for the Oscars was held here in 1947-1948, 1988-1989, 1991, 1995, 1997-1998 and 200-2001. Other prestigious award ceremonies that regularly use the building are The American Music Awards, the Comedy Awards, the Grammy's , the Emmy Awards and the Soul Train Awards.

In 1993, a $15 million improvement plan was completed which included a new multi-level parking facility, a complete overhaul of the stage with new computorised equipment, new lighting and sound systems, new air conditioning and heating systems, plus many other improvements to the building. Because the Shrine Auditorium has lost out on hosting the Academy Award Ceremony to the new Kodak Theatre in Hollywood since 2001, it received a $4.5 million upgrade in 2002. New seating was installed and the surrounding street and sidwalks were improved, to 'woo' the Oscar's back to the Shrine, which has twice the seating capacity of the Kodak Theatre. To date (2009) this has not happened.

SHRINE AUDITORIUM, LOS ANGELES



SHRINE AUDITORIUM, LOS ANGELES



Working within the constraints allotted for a designated landmark can be challenging enough, but when paired with the venue's expansive offerings in event type—from rock concerts & award ceremonies to conferences, conventions, and trade shows—such constraints require an even greater level of creativity and engineering expertise. Meeting the cooling needs of a space that can go from being packed with people—and thus body heat—dancing their hearts out under bright stage-lights to a sporadic spattering of business executives—sauntering as they network—at a small trade show requires dynamic adjustment and strict system capacity expertise.

Accomplishing this with comprehensive airflow design that cannot meaningfully alter the structural integrity of a building built before even the most basic of refridgerants—Freon—was *invented*, required our team at California Energy Designs to implement a series of highly-imaginative, specific changes in the existing system architecture to turn *restrictions* into *opportunity*. The venue utilized a large under-floor supply system with 100% fresh air and 100% exhaust. Within this framework, our team physically reversed the two 100,000 CFM supply fans, turning the under-floor supply plenum into a return. This prevented any need for an invasive renovation process, preserving the structural integrity of the unique facility.

SHRINE AUDITORIUM, LOS ANGELES

ENGINEERING AND CONSTRUCTION

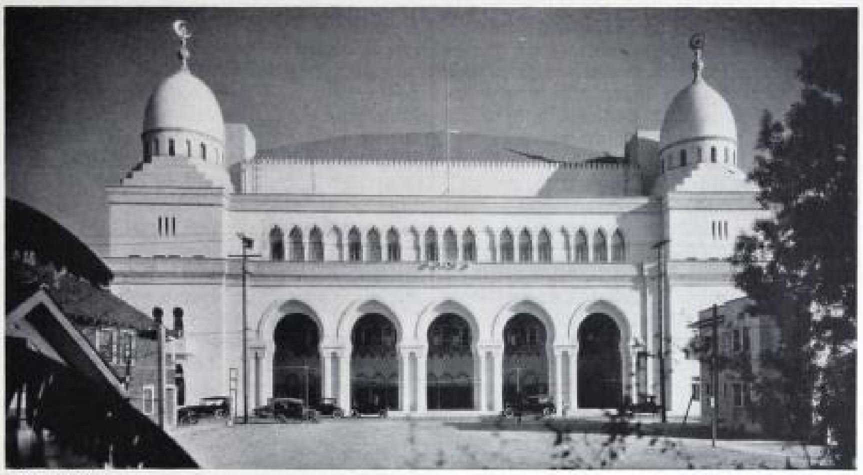


Photo by Mott

AL MALAIKAH TEMPLE, LOS ANGELES, CALIF.—JOHN C. AUSTIN, ARCHITECT

UNUSUAL ENGINEERING FEATURES OF THE AL MALAIKAH TEMPLE, LOS ANGELES

JOHN C. AUSTIN, *Architect*

By R. McC. BEANFIELD, ASSOC. M. AM. SOC. C. E., *Consulting Engineer*

The Proceedings of the American Society of Civil Engineers issue of December, 1927, contained on pages 2645 to 2674 a description of the "Unusual Engineering Features of An Immense Theatre Building" by R. McC. Beanfield, Assoc. M. Am. Soc. C. E. Extracts from this article are published by permission of the author and the American Society of Civil Engineers.—THE EDITORS.

THE Al Malaikah Temple in Los Angeles, locally known as the Shrine Civic Auditorium, occupies nearly three acres and may be divided into three units, as follows: The auditorium, or theatre, with facilities for housing the various Shrine organizations; the banquet hall, with a large basement for public exhibition purposes; and a kitchen wing, with facilities for serving large banquets. The auditorium is 200 ft. wide and 294 ft. deep including the stage, which is 72 ft. deep and 192 ft. wide. The proscenium opening has a clear span of 100 ft. and a height of 37 ft. at the crown. The orchestra pit can accommodate 200 musicians. There are 3,200 seats on the orchestra floor and 3,350 in the balcony. With the exception of 22 seats behind balcony columns, the entire audience has an unobstructed view of the stage. The stage has a seating capacity of 1,700. The auditorium, or theatre, consists of a reinforced concrete frame with exterior concrete curtain-walls. The roof construction consists of reinforced concrete joists, supported on structural steel purlins connected to the roof trusses.

The auditorium balcony risers and treads are of reinforced concrete, supported by eight steel cantilever trusses having a maximum overhang of 45 ft. which, in turn, are supported by a main balcony steel truss. This truss is, doubtless, the largest steel balcony truss yet constructed for the purpose. It weighs nearly 250 tons, and has a clear span of 168 ft. It is of interest that the balcony truss columns were located to displace a single seat on each side of the auditorium nearest the aisles adjacent to the walls, instead of outside the auditorium walls,

SHRINE AUDITORIUM, LOS ANGELES

which arrangement would have increased the span 20 ft. The obstructed view for a few seats is relatively unimportant as compared with the increased difficulties in design and greater cost if 20 ft. had been added to the span of the main balcony truss.

As it is necessary to have sufficient clearance through the center part of this main truss for the balcony exit passageways, pin joints and eye-bar diagonals were used instead of the usual built-up members and riveted joints with larger gusset-plates. Riveted joints were used where practicable to obtain general stiffness. Where pins were necessary, nickel steel was chosen, particularly, to reduce the size of the pin-holes in the lower chord.

The balcony truss was delivered to the job in sections, the largest (center lower chord section) weighing 47 tons and being 80 ft. long. The truss was erected on a steel substructure consisting of the same members as were used in the falsework for the roof trusses. The lower chord sections were first set on camber screw-jacks. The web members were next placed, and followed by the top chord sections.

The jack trusses, T-1, tend to equalize the overhang of the cantilever trusses, which project a maximum of 45 ft. beyond the main balcony truss. It was desirable to prevent excessive and unequal deflections of the structural steel trusses supporting the balcony, particularly the cantilevers, and the possibilities of cracking and otherwise shearing the relatively thin monolithically finished 2½-in. slabs and narrow 5-in. risers of the reinforced concrete balcony framing. Hence, it became necessary to design and arrange the balcony trusses so that their deflections would be relatively uniform and slight. Deflections of the various trusses were carefully computed and checked graphically. The maximum computed deflection of the cantilever trusses under dead load was ¾ in. Secondary stresses were carefully computed for the balcony trusses and the roof trusses. Deformations in the main balcony truss, T-2, under full dead load conditions, were partially compensated by the forcing of initial stresses in the truss members during erection. Subsequent strain gauge readings did not indicate a very close relation between the computed stresses and the actual stresses. Those members which showed maximum secondary stresses by extensometer readings were likewise indicative of maximum secondary stresses by the analytical methods. In any event, the strain gauge readings indicated that all stresses were within the maximum safe stress allowable.

It is interesting to note that the strain-gauge

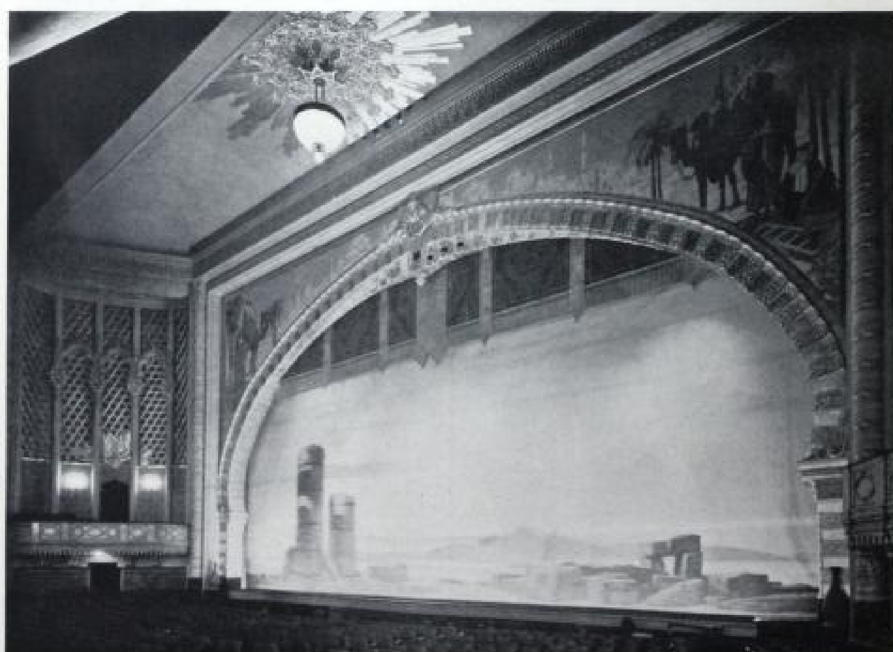
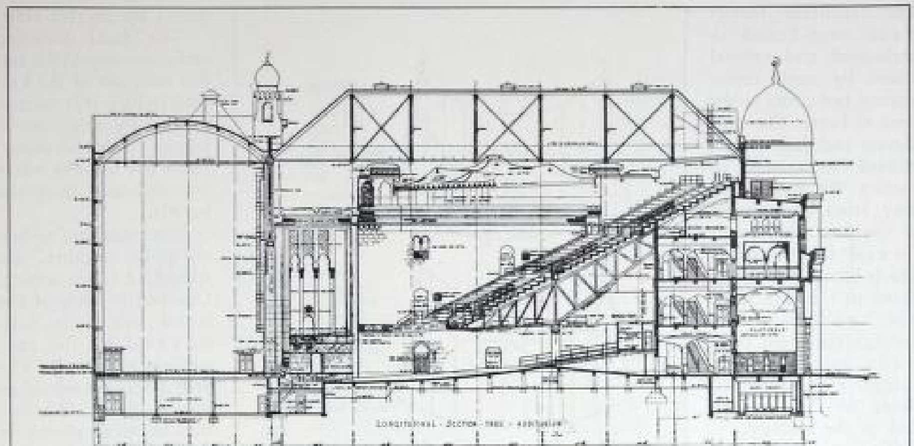


Photo by Mott

THE PROSCENIUM OPENING HAS A CLEAR SPAN OF 100 FT. AND A HEIGHT OF 37 FT. AT THE CROWN. AMPLIFYING SPEAKERS ARE CONCEALED IN THE JEWELED CROWN OF THE ARCH

SHRINE AUDITORIUM, LOS ANGELES



LONGITUDINAL SECTION THROUGH AUDITORIUM
NOTE STAGE ROOF ARCHES WITH GRIDIRON AS TIE BARS

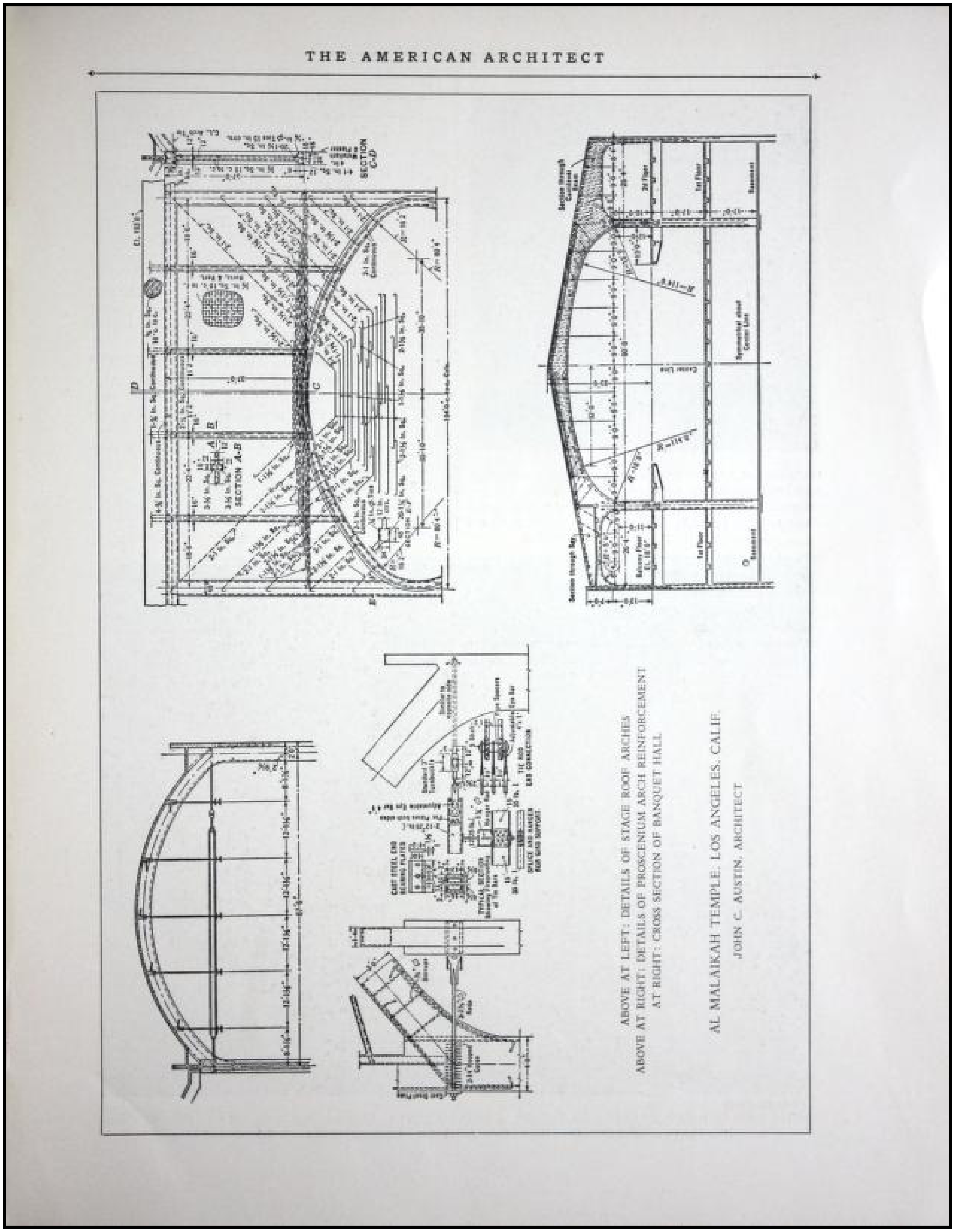
Photo by Mott

THE ROOF OVER THE BANQUET HALL IS SUPPORTED ON REINFORCED CONCRETE ARCHES OF 90 FT. CLEAR SPAN. BENDING STRESSES IN COLUMNS ARE REDUCED BY THE CANTILEVERED BALCONY. DECORATIONS ARE PAINTED ON CONCRETE

AL MALAIKAH TEMPLE, LOS ANGELES, CALIF.

JOHN C. AUSTIN, ARCHITECT

SHRINE AUDITORIUM, LOS ANGELES



SHRINE AUDITORIUM, LOS ANGELES

stage, horizontal diagonal brace beams were installed at vertical intervals in all four corners of the stage enclosure. The stage walls were designed as two-way slabs to resist a wind pressure of 30 lb. per sq. ft. The stage columns were computed for direct stress and bending due to wind, and for partly fixed conditions of the roof arches.

The stage floor was designed for a live load of 250 lb. per sq. ft. The framing consists of standard steel I-beams supporting a wood-joist system. All steel connections were bolted so that any particular section of the floor could be removed without affecting the adjacent parts.

The structural steel roof trusses over the auditorium, each weighing 60 tons, have a clear span of 192 ft. and rest on reinforced concrete columns.

The auditorium proper was constructed with double walls on each side to resist earthquake forces and provide duct space for the ventilating systems. The inner walls of the auditorium are metal lath and plaster, supported by reinforced concrete columns and beams. This skeleton frame forms a system of braced bents with the outer walls and columns, which support the roof trusses.

Due to the large area of the auditorium and the long-span roof trusses, it was necessary to divide

MAIN BALCONY TRUSS SHOWING INTRICACY OF CONNECTION DETAILS AND PIN CONNECTION OF JACK TRUSS TO STEEL CASTING ON MAIN TRUSS. ELECTRIC WELDING WAS USED TO OBTAIN METAL-TO-METAL CONTACT WHERE INCLINED SURFACES MADE IT DIFFICULT TO MILL ACCURATELY

MAIN BALCONY TRUSS AND CANTILEVERS. CANTILEVERS WERE HOISTED TO CAMBERED POSITION. HOLES WERE DRILLED AND MATCHED BEFORE RIVETING. NOTE PIN JOINTS IN UPPER CHORD

SHRINE AUDITORIUM, LOS ANGELES

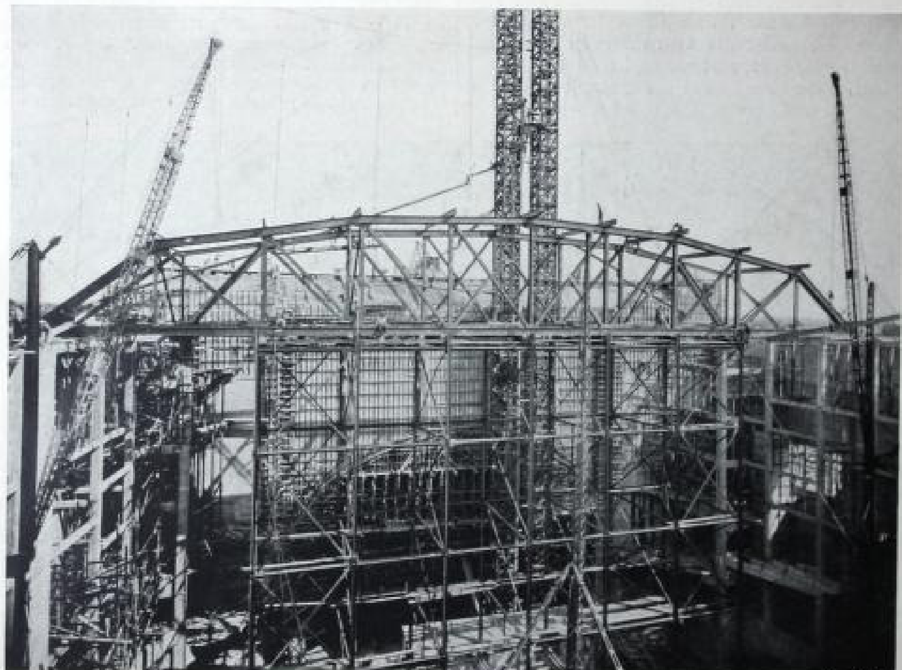
the roof area into sections by expansion joints to prevent excessive deformations due to heat changes.

The south ends of the roof trusses were anchored; the north ends were set on nests of rollers. This provided an excellent structural connection for earthquake resistance. The roller bearings allow the roof and supporting trusses to move (horizontal translation) independently of the north supports with temperature variation, which is also a favorable structural condition of flexibility for relieving seismic stresses. If the roof trusses had been anchored at both ends, they would act like battering rams, tending to pull or push over the supports, particularly if the periods of vibration were different for the opposing supports.

To prevent excessive edge pressure on the reinforced concrete columns at the anchor end of the trusses, due to the slope at the end panel joint, a ⅛-in. lead plate was inserted between the bearing and shoe-plates. Lateral and vertical deformations, based on Williot diagrams, checked very closely with the actual horizontal movement over the rollers (maximum, ⅜-in.) and the vertical deflections (maximum, 2 $^{8}/_{10}$-in.).

The continuous reinforced concrete girders, supporting the banquet hall roof, were designed as a part of a fixed frame. The soffits of the roof girders were curved to represent Saracenic arches, which added to the depth of the girders over the interior columns where large negative moments existed. The use of balcony cantilever girders tended to reduce the moments in the columns. The rear, or wall, columns were required to resist an uplift. The anchor arms of the continuous girders were projected through and above the roof, being hidden from the interior.

John C. Austin, F.A.I.A., was the architect. The writer, as chief engineer for the architect, was responsible for the structural design and the design of the heating and ventilating systems.



AUDITORIUM ROOF TRUSSES WEIGH 60 TONS EACH AND SPAN 192 FT. ONE END IS ON ROLLERS. ANCHOR END HAS A LEAD PLATE BEARING TO PREVENT ECCENTRIC LOADING ON REINFORCED CONCRETE COLUMNS

SHRINE AUDITORIUM, LOS ANGELES

SHRINE AUDITORIUM, LOS ANGELES

Electrical Equipment of the World's Largest Stage

New Al Malaikah Temple Civic Auditorium in Los Angeles Embodies Unique Electrical Features

By C. A. Sanborn
Holmes and Sanborn, Consulting Engineers

FIFTEEN feet wider than the New York Hippodrome, the stage of the new Al Malaikah Temple Civic Auditorium is unquestionably the largest indoor stage in the world. The switchboard is the largest stage switchboard ever constructed, and the main chandelier in the auditorium is claimed by fixture men to be the largest lighting fixture ever built. In the construction of this mammoth auditorium the electrical problems presented to Holmes and Sanborn were no less mammoth. How they were handled is modestly set forth in the accompanying article.

RANKING with the great auditoriums of the world and containing one of the largest indoor stages, the Shrine Civic Auditorium recently has been completed by Al Malaikah Temple in Los Angeles. Joined to the auditorium building is a three-story pavilion building arranged to handle carnivals, fairs and exhibits, banquets and large dances, making, together with the auditorium, a group of two buildings sufficient to serve the civic needs of Los Angeles as a convention city.

The Moorish style of architecture with its distinctive features, as designed by John C. Austin, F.A.I.A., dominates the group. The buildings cover an L-shaped area measuring 294 ft. on Jefferson Street, 279 ft. on Royal Street and 564 ft. in length on the east property line and so arranged that the banquet floor of the pavilion building leads directly into the north side of the auditorium stage, making it possible to arrange pageants and processions in the banquet hall before proceeding onto the stage. Housed also in the group are the Shrine organization rooms.

Auditorium Lighting

The auditorium, with seating accommodations for 6,442 people, has an immense stage measuring 192 x 72 ft. and having a proscenium opening of 100 ft., which is 15 ft. wider than that of the New York Hippodrome. The decorative color designs in the auditorium range from rich deep blue, reds and deep scarlet and royal purples to bright blues and soft shadings of buff and yellow, making an extremely artistic effect. The ceiling is in effect a tinted canopy with the blue sky and stars above. A double cove illuminating the sky and the canopy, with its draped folds held by huge ropes, is lighted by the main chandelier.

Reported to be the largest electric chandelier ever built, this fixture weighs approximately 5 tons and has a diameter of 20 ft. and an overall length of 28 ft. The lighting is in four colors, the total load in the fixture being 65 kw. Relamping is accomplished through a trap door in the canopy ceiling above the fixture through which a ladder may be lowered.

In addition to the ceiling coves and main fixture, decorative coves in three colors are installed around the front and side walls, about 18 ft. below the main ceiling. A secondary ceiling above the orchestra pit is cove lighted in three colors, no white light being used. At the center of this ceiling is a smaller crystal fixture also in three colors.

The soffit of the balcony is panelled to provide for ventilating grilles. In each of the seventeen panels is a fixture in four colors. The ceiling space outside the panels is provided with fixtures in white light only, to give uniform illumination during conventions.

Emergency lighting in the auditorium is provided by aisle lights which are located at every fourth row on the main floor and at every third row in the balcony.

Stage Lighting

All of the stage lighting is in four colors. A single row footlight with 150-watt lamps wired in a sequence of red, white, amber, white, blue, white, red, etc., provides down-stage illumination. This is augmented by six banks of four 500-watt floods set in front of the balcony and 96 500-watt spot floods overhead for orchestra pit and front stage lighting. In addition to the above the stage has:

7 99-ft. borders using 500-watt lamps.
68 30-amp. incandescent pockets.
8 30-amp. proscenium strip pockets.
15 75-amp. d.c. pockets.

SHRINE AUDITORIUM, LOS ANGELES

The first border is of the "concert type," and is equipped with four-unit suspension hoods, each unit being provided with separate leads, terminating in a screw plug for attachment to raceway outlets. There are also in the concert border 12 pin plug connectors on 12 circuits for the additional attachment of spotlights.

Due to the extreme width of the stage the ordinary type of prescenium strip lights was not desirable. Therefore a four-section pocket was provided on each side of the proscenium opening, into which portable strip lights can be plugged. The two pockets of the same color on both sides are connected to the same dimmers. Four 1,000 to 2,000-watt dimmers per color are supplied and arranged with paralleling switches to dim any wattage from 1,000 to 8,000 watts per color.

Due also to the great width of the proscenium opening, the electrical equipment was engineered so as to allow a segregation of the center 50 ft. of the stage in order to provide for the ordinary show and visiting theatrical companies, which in general cannot utilize a 100-ft. opening.

It will be seen from this view of the auditorium that no columns are used to support the balcony. The largest bridge truss known to have been used inside a building supports the balcony. The immense ceiling fixture, 20 ft. in diameter, floods the auditorium and particularly the balcony.

The circuits and dimmers for the footlights and borders, therefore, are arranged so that either the "full proscenium" or the "short proscenium" can be used, using the same switch and dimmer handles on the switchboard for the control of lights for either opening. Each border is divided into three sections, the center one being 49 ft. long and the two end sections each 25 ft. long. Each section is hung independently of the others, allowing the raising of the two end sections when the "short proscenium" is used so as not to interfere with the sets.

As the building is located outside the downtown section, no direct current is available. A 100-kw., 3-wire, 110/220-volt direct-current generator set consisting of two 50-kw. 110-volt generators in series driven by a 150-hp., 2,200-volt, 3-phase, 60-cycle induction motor was provided, located in the auditorium service switchboard room. This generator set provides direct current for all the d.c. arc pockets and also provides an extra feed to the projection room supplementing the generator set for projection service.

In addition to the above equipment, a 400-amp., 3-wire auxiliary lead is brought up to both sides at the rear of the stage from which additional capacity can be obtained for any effects which need not be controlled from the stage switchboard.

On the stage adjacent to the pilot switchboard is located the stage manager's station on which is mounted a return call annuciator to all the dressing rooms, curtain control equipment and signals for intercommunication telephones, one on the house system and one on the private line to the projection booth; also a return call buzzer to the projection booth and a stage ventilator control station. A desk shelf is provided for script and notes.

The stage ventilator control operates from the emergency light service and operates to close stage dampers when the circuit is broken. Operating keys are located in the box offices and the stage manager's station.

Stage Switchboard

A Hub Electric Company pre-set, selective, remote-control stage switchboard controls all the stage and house lights. This switchboard is 26 ft. long and has 152 Locke main pilot switches and 279 Ward-Leonard dimmer plates and 147 Sundh contactors. It is the largest stage switchboard ever constructed.

Projection Room

The projection room is located at the rear of the main floor of the auditorium and is of the latest design equipped with two projection machines, four spotlights and one stereopticon. The direct-current circuits are controlled from a switchboard arranged to throw each machine across either the d.c. service from the stage motor-generator set or across the projection room generator-set service.

Return call buzzer stations between the stage manager, orchestra leader and organ console are provided between the projection machine and spotlights. A private phone system between the stage manager and projection room is installed with three phones on the front wall of the projection room, one beside each lookout port.

A complete pilot unit for operation of the stage and house masters on the stage switchboard also is provided on the front wall of the projection room. This permits the operation of any lighting effects on the stage and house, the set-ups having been made on the stage board.

The Pavilion Building

The three-story pavilion building has an exhibition hall and a banquet hall and is 300 x 150 ft. with a wing 120 x 75 ft. adjoining the lobby of the auditorium building.

The basement of the wing is used for boiler and fan rooms and transformer vaults for the exhibition and banquet hall. Portions adjoining the auditorium are used for foyers and passageways from both

SHRINE AUDITORIUM, LOS ANGELES

ner, the organ blower being controlled from the console.

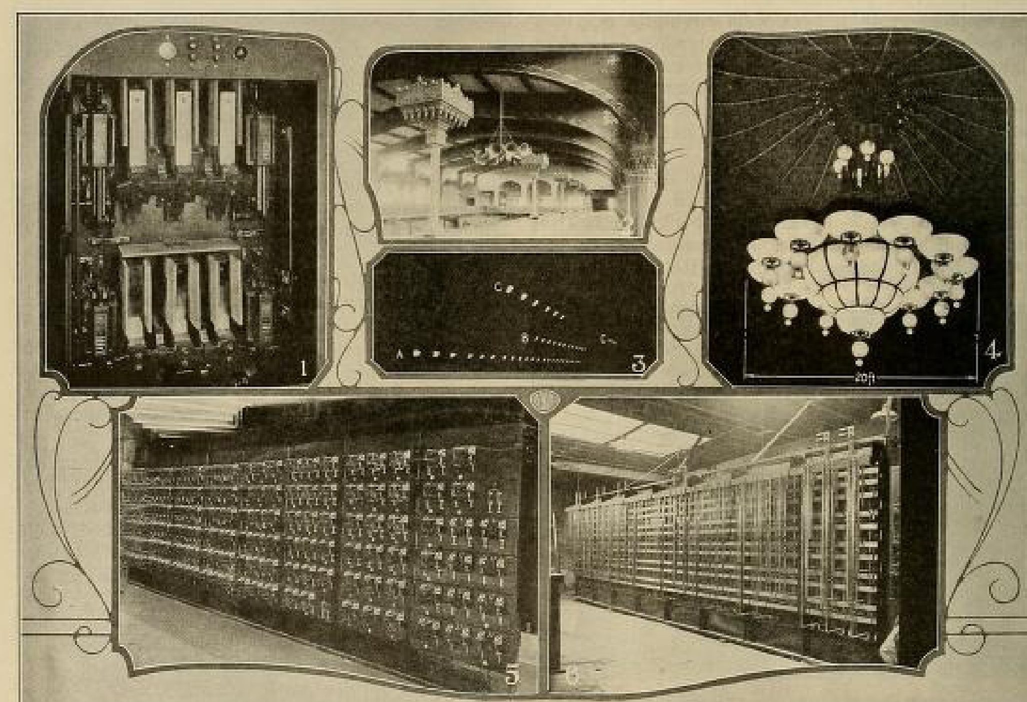
Three 110/220-volt, 1,600-amp. lighting phases are used in the auditorium building. One goes direct to the stage switchboard contactor board, the other two are split to feed the contactor board and the several panel boards throughout the building. Two of the leads feeding the contactor board are connected on the load sides of two Sunhd remotely controlled transfer switches of 600 and 400-amp. capacity, respectively, which normally are fed from the lines of the standby power company. The third lead is carried direct to the contactor board. The two circuits which are on the transferred services are used to feed the operating buses of the remote-controlled switchboard and the footlights and borders No. 1 and 2, switchboard lights and certain other circuits on which power must be maintained. The transfer switches are operated from the stage manager's station, pilot lights being provided to indicate when the normal services are "hot" and when the standby services are being used.

The auditorium building emergency lighting service is taken from the load side of a Sundh semi-automatic transfer switch, which transfers automatically to the standby company on a reduction in voltage below 200 volts. Pilot lights are provided on the service switchboard and at the stage manager's station with the same features as mentioned above for the stage transfer switches. Reset switches are located directly below the pilots.

The lighting service of the banquet hall building consists of one 1,000 and two 800-amp. 110/220-volt phases. An emergency lighting transfer switch similar to the one for the auditorium building is provided for the banquet hall building with resetting stations on the service switchboard and the banquet hall master lighting switchboard.

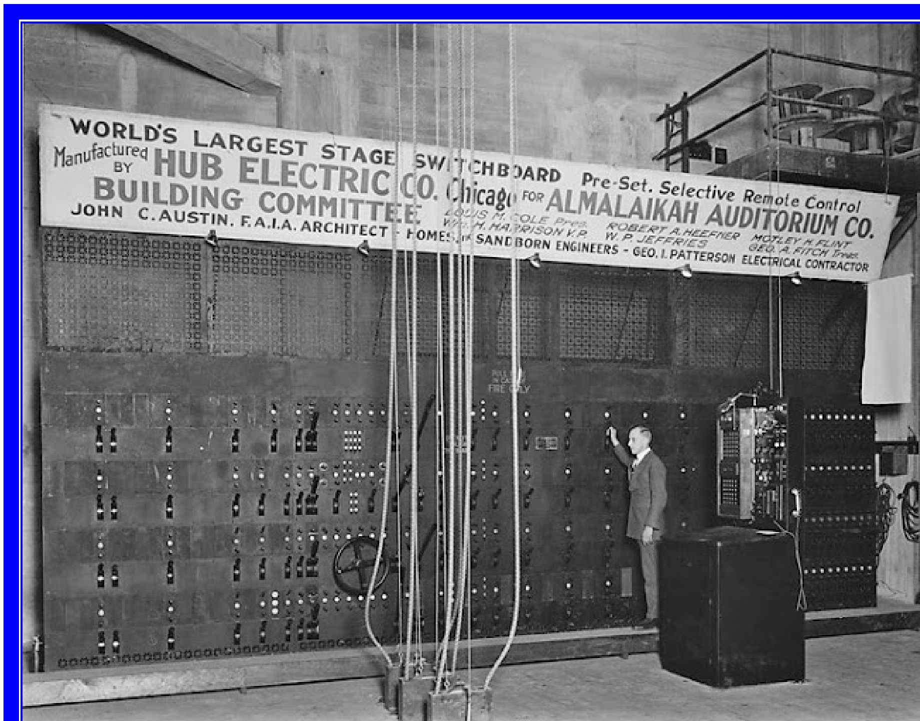
Public Address System

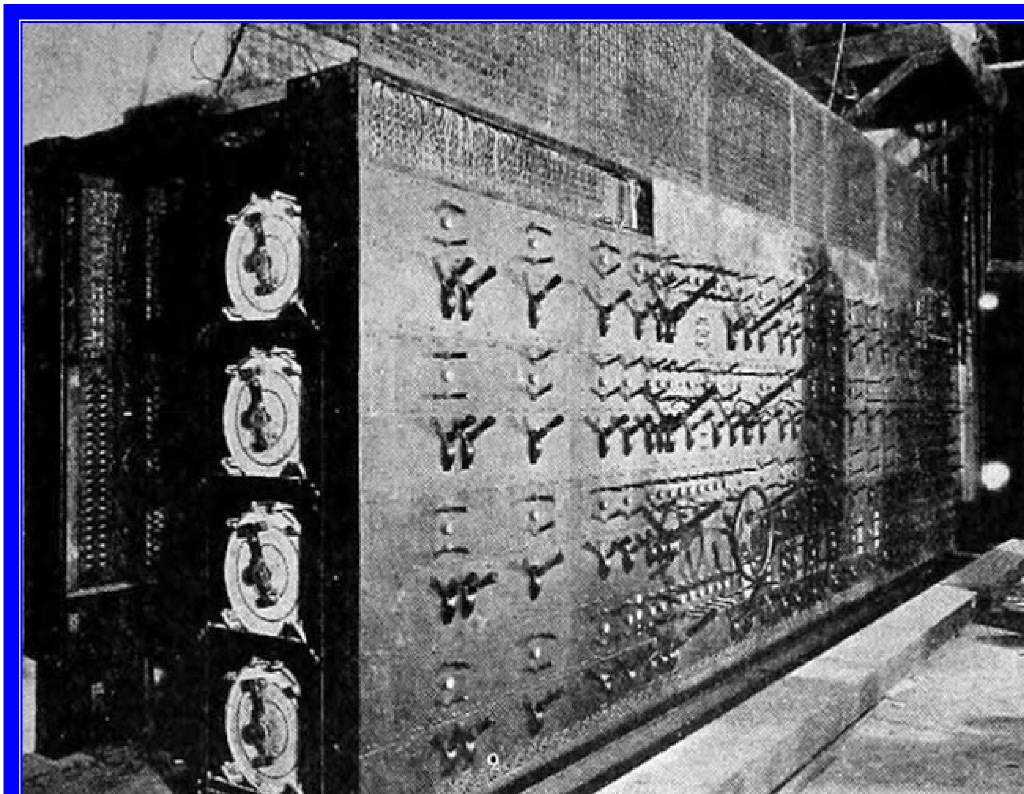
A public address system has been installed which makes it possible not only to amplify the oral action on the stage into the auditorium but into the banquet hall and exhibition hall at will. The system can be used in the banquet hall alone to amplify speeches and also can be used with outside horns at the main entrances of the auditorium and banquet hall to address overflow gatherings.



Representing some of the more interesting features of the Shrine auditorium electrical equipment: (1) A close-up of one of the Sundh semi-automatic transfer switches on the main switchboard (shown elsewhere). (2) A view from mezzanine floor of the banquet hall in the pavilion building, showing the Western Electric public address system horns installed, and the fixtures on columns from which the ceiling is floodlighted. (3) Because of the extreme stage width borders have been designed to accommodate smaller stage use. (a) Shows full proscenium concert border, (b) the center section of another border separated for short proscenium use, with (c) the two end sections of the same border drawn up. (4) The immense chandelier which hangs from the center of the auditorium, weighing 5 tons, 20 ft. in diameter, 28 ft. in length, and having an electric load of 65 kw. (5) Front view of the remotely controlled contactor panel, operated by the stage switchboard. This board is 24 ft. long and contains 142 contactors. (6) Rear view of the same contactor board, showing the busing.

SHRINE AUDITORIUM, LOS ANGELES





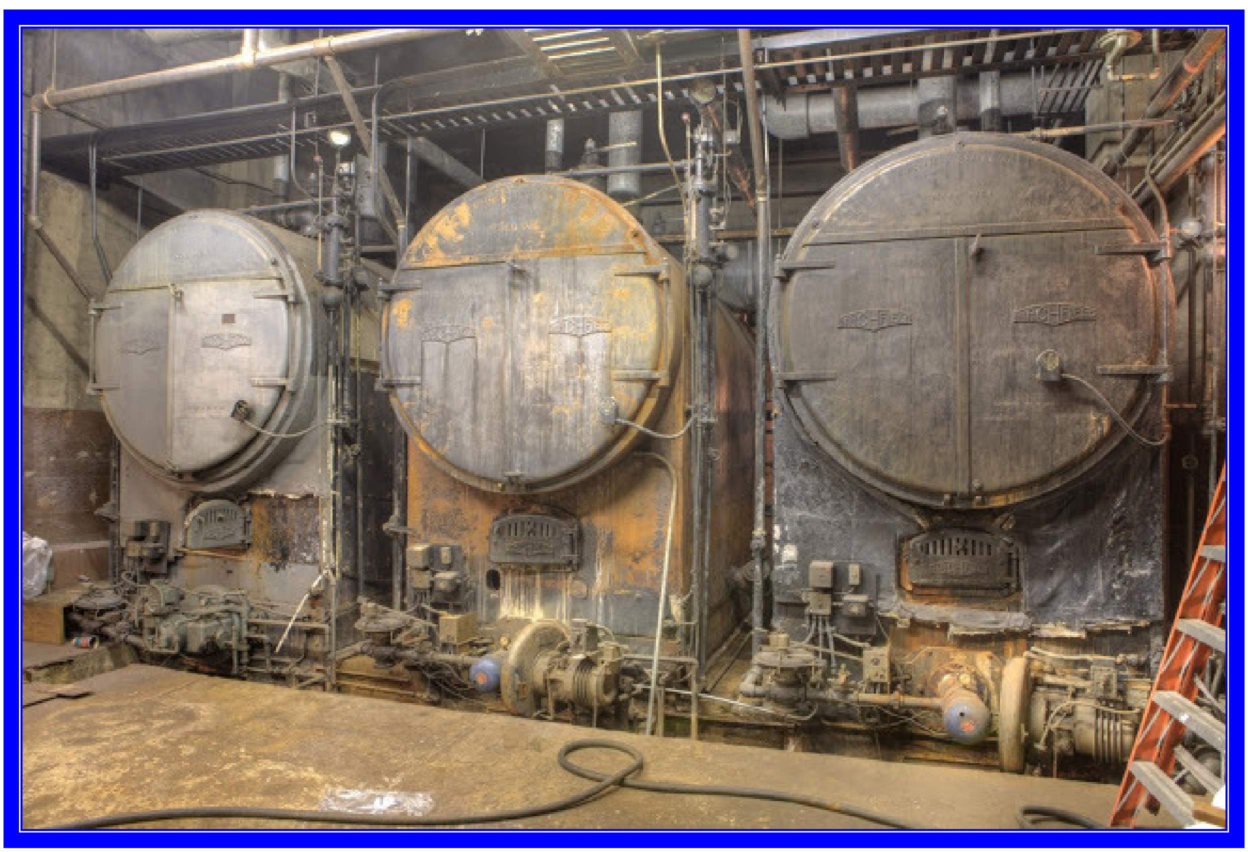
The Hub stage switch board 1926, then the world's largest

SHRINE AUDITORIUM, LOS ANGELES

Theatre switchboard

Dimmers and Supply Company switches

SHRINE AUDITORIUM, LOS ANGELES



Boiler plant

SHRINE AUDITORIUM, LOS ANGELES

The organ blower

Centrifugal chilled water refrigeration machine

SHRINE AUDITORIUM, LOS ANGELES

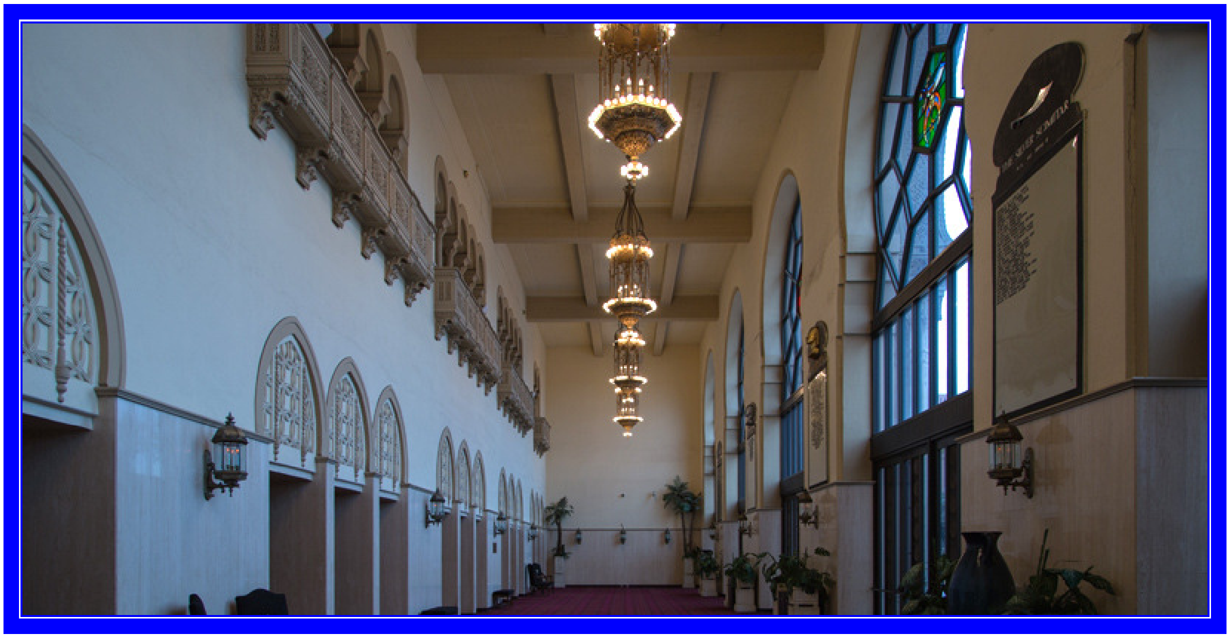
Centrifugal fan sets

SHRINE AUDITORIUM, LOS ANGELES

Centrifugal fan and drive guard

SHRINE AUDITORIUM, LOS ANGELES

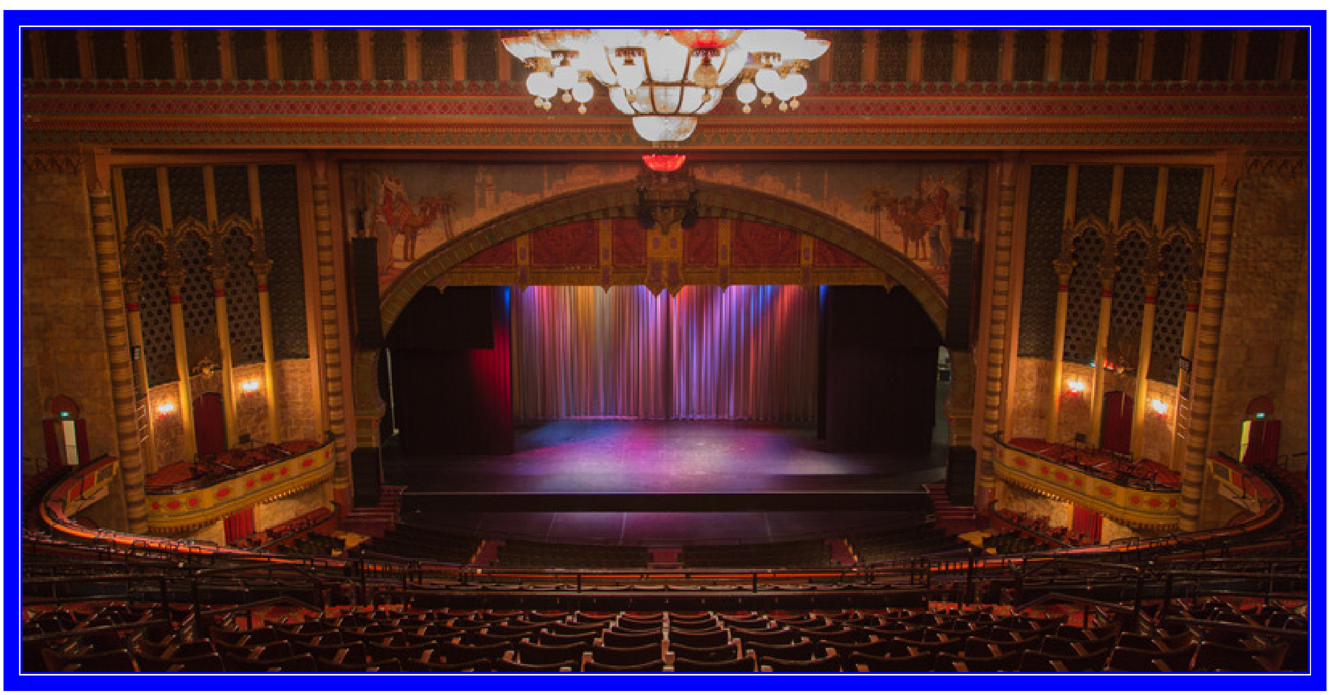
SHRINE AUDITORIUM, LOS ANGELES



Row of chandeliers

The adjacent Exposition Hall

SHRINE AUDITORIUM, LOS ANGELES



The elaborate Auditorium chandelier

SHRINE AUDITORIUM, LOS ANGELES

The auditorium chandelier weighing 4 tons with 500 light bulbs in four colours, rated at 64 kW

SHRINE AUDITORIUM, LOS ANGELES