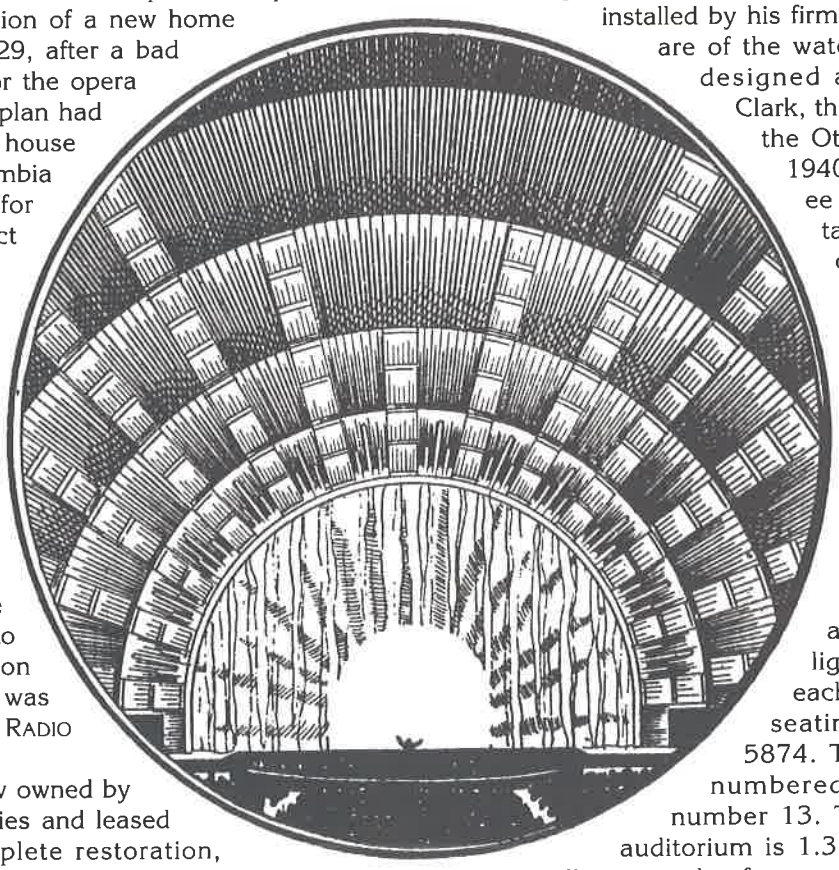
RADIO CITY MUSIC HALL
A TECHNICAL DISCUSSION
BY LYMAN C. BRENNEMAN

General

RADIO CITY MUSIC HALL opened on December 27, 1932, construction having been started in September 1931. The original designation for this theatre was "Metropolitan Square Theatre Number 10," and all construction drawings carry this title. "Metropolitan Square" was the original name for what became Rockefeller Center. This project was first conceived by the Metropolitan Opera Association as the location of a new home for the opera, but in 1929, after a bad market day, the funds for the opera house disappeared. The plan had been to build the opera house on land donated by Columbia University in exchange for naming the entire project Metropolitan Square.



Nevertheless, development of the theatre continued, with the name "International Music Hall" being considered. When NBC and RCA came into the picture the north end of the development was to be called "Radio City," but after the depression caused RCA to cut back, this designation mostly disappeared, but was retained by the theatre, RADIO CITY MUSIC HALL.

The MUSIC HALL is now owned by Tishman Speyer Properties and leased to Cablevision. A complete restoration, costing upward of $70 million began in March 1999 and is scheduled for completion in October 1999. A thorough restoration and renovation has not taken place since the theatre opened. Much of the mechanical and electrical building equipment as well as all stage facilities are badly in need of renovation and updating.

It is the intent of this article to discuss and outline the original stage facilities: it does not include any of the proposed renovations. Some of the modifications made throughout the years are noted.

The stage lighting installation was designed by Eugene Braun, who came to this country from Germany with Max Reinhardt to work on his production of *The Miracle*. Stanley R. MacCandless, a professor of theatre lighting at Yale University, and the author of several early textbooks on theatre lighting, was responsible for the auditorium lighting design. The stage and auditorium lighting control system was designed by E. D. Schneider of the General Electric Company in cooperation with Mr. Braun, and was manufactured by GE. The theatre uses 22,908 lamps and has a total electrical load of 3300 kilowatts.

All stage rigging and mechanical equipment was designed by Peter Clark, and manufactured and installed by his firm The four stage elevators are of the water hydraulic type. While designed and patented by Peter Clark, they were manufactured by the Otis Elevator Company. In 1940, at the time an employee group picture was to be taken for a pictorial publication, there were 586 employees. When assembled on the stage elevators for this picture their total weight was in excess of what the elevators could lift at normal water pressure and the pressure had to be temporarily increased.

Originally the auditorium sat just under 6000, and there was a program light built into the back of each seat. Over the years the seating has been reduced to 5874. The MUSIC HALL has 103 numbered exits, but there is no number 13. The total volume of the auditorium is 1.3 million cubic feet; 27.6 million pounds of steam are required annually to heat the theatre.

Stage Features

The MUSIC HALL stage, often called the most perfectly equipped in the world, is 144 feet wide by 66.5 feet deep with a gridiron height of 105 feet. The stage has a curved proscenium arch 100 feet wide at floor level and 60 feet high. A main front contour curtain weighing 6000 pounds

PRECEDING PAGES: *RCMH stage plan. The MUSIC HALL had reams of these printed up on heavy stock. At least two were developed for each change of scene: one for the stagehands and another for the electricians.* ***THS Archive.***

ABOVE: *Art from the MUSIC HALL's opening night program.* ***THS Archive.***

is operated by thirteen electric motors individually controlled from the stage. This enables the proscenium to be opened to an infinite number of shapes and configurations. The main steel beam required to support this proscenium weighs 600 tons.

Just upstage of the contour curtain was an electrically operated gold traveler. Its motor had four speeds, enabling it to be opened or closed more quickly than the contour curtain. There was also a motorized portal, or inner false proscenium, with the side and top trims adjustable from a stage control board. The proscenium has an electrically operated, steel-framed fire safety curtain weighing 80,000 pounds. The projection screen is also mounted on an electrically operated steel frame, 107 feet wide by 47 feet high, with motor-driven top and side masking. The stage is also provided with a rain curtain and a steam curtain.

The grand lobby. ***Editor's Collection.***

The stage floor contains three elevator sections. Elevators 1 and 3 are 70 feet wide by 16 feet deep; elevator 2 is also 70 feet wide, but only 12 feet deep. In the center of these elevators is a turntable 43 feet in diameter. This combination of elevators and turntable can rise 13 feet above the stage floor and descend 27 feet below stage level to the basement.

A fourth elevator is provided for the orchestra pit. On this elevator is a band car driven by a five-horsepower DC motor, originally powered by seven large batteries, but later fed by trailing cables. With all four elevators at stage level, the band car can travel from the orchestra pit onto either elevator 1 or 3 (elevator 2 is too shallow for this maneuver), on which it can be raised above the stage or lowered into the basement and then traveled forward, back onto the lowered pit elevator. Similarly, with the pit elevator lowered, the band car can travel from the orchestra pit to the stage.

The water hydraulic system operating these four elevators normally operates at a pressure of 245 pounds per square inch. All hydraulic stage elevators installed since have been operated by oil rather than water. With all four elevators at stage level the available space is 84 feet deep. The four elevators weigh 380,000 pounds and can lift 96,000 pounds at their normal pressure.

The main projection booth, above and behind the top balcony, contained four 35mm projectors with 180 ampere carbon-arc lamps. A fifth 35mm projector has been added, and three of the others have been converted to a combination 35/70mm configuration. All lamphouses have been converted from carbon-arc to xenon. There is also a projection booth containing two 35mm projectors recessed into the back of the stage.

The stage rigging consists of eighty straight-lift counterweight sets plus ten electrically operated sets for general purpose use. The picture screen with its steel frame, the four 120-foot lighting bridges with borderlights, the gold traveler, the portal and the Movietone "I" beam are electrically operated sets with traction-drive motors. The big cyclorama, which has been removed, was winch-operated with two counterweight sets, one stage left and one stage right.

This may very well be the MUSIC HALL'S first "official" portrait. The blurb pasted to the back speaks of the theatre's opening as an event yet to happen. This and the lobby photo on the preceding page are from a set, showing both RADIO CITY theatres, distributed by A. & M. Karaghusian, Inc., supplier of the carpeting. ***Editor's Collection.***

Stage Lighting

While the stage lighting control system currently in use *(as of early 1999-Ed.)* is the originally installed apparatus, much of the stage lighting has been upgraded in keeping with modern stage lighting practices and equipment. This outline discusses the stage lighting as it was originally installed and used for many years, along with a few notes concerning some of the changes.

(Even though the Kliegl Brothers catalog of 1930 showed ellipsoidal reflector spotlights, all the original spotlights installed at the Music Hall were of the 8 inch plano-convex type. These of course have since been replaced with modern ellipsoidal reflector types.)

The stage lighting cove in the auditorium ceiling contains twenty-four beam projectors and four spotlights, identified as musicians' floods and leader's spots, for lighting the orchestra pit and forestage area. These units are arranged on six dimmers and 28 circuits. The beam projectors were provided with electrically operated color boomerangs for four colors controlled from the main control console. In front of the main contour curtain are proscenium and portal side light spotlights and floodlights. These are arranged on six dimmers and thirty-two circuits and also have boomerangs for four colors.

The stage footlights consist of twenty individual sections, each having a double row of lamps with glass roundels in amber, red, green, blue and white. Between these sections are six spotlights and eleven microphone outlets. Each color uses a total of seventy-two lamps; the blue units are equipped with 150-watt lamps, the others with 100-watt lamps. The footlights are served by five dimmers and fifty circuits. The footlights and associated stage floor covers raise and lower electrically so the band car can pass over when they are in the lowered position. The combination footlight units and top cover rise 2.5 inches, while at the same time a 36-inch section of the stage floor pivots downward 5 inches, revealing the remainder of the footlights.

The eight borderlights are identified as borderlights C, D, E, F, G, H, K1, K2 and L. Each is ninety-six feet long, except for the valence borderlight (C) and the cyclorama borderlight (K1 and K2).

The valance borderlight (C) was dead-hung in the false ceiling space just downstage of the fire curtain and was only 80 feet long. It was hung in sections interspersed with twenty spotlights and floodlights. There were ten 500-watt amber, twelve 750-watt red, twelve 750-watt green and

fourteen 1000-watt blue units controlled by five dimmers on forty circuits. The twenty floodlights and spotlights were controlled by five dimmers on twenty circuits. This borderlight position has been discontinued.

Borderlight D, upstage of the main contour curtain, contained nineteen 500-watt lamps each for the amber, red and green circuits and thirty-six 500-watt lamps for the blue. There were also four worklights, two pointing up and two down. Five dimmers and 50 circuits served this borderlight, removed when a curved projection screen was installed.

Borderlight E is the same as was D except that it is suspended from a light bridge containing twenty floodlights and spotlights controlled by an additional eight dimmers on fourteen circuits. These lights were equipped with electrically operated boomerangs for four colors. Borderlight E has been modified to accommodate a large speaker enclosure at the rear of the picture screen. Borderlights F, G, and H are the same as was E.

Borderlight K1 and K2 is a double-row borderlight 105 feet long. In addition to the usual colors there is also a "daylight blue." There are forty-two 500-watt lamps each for the amber, red, green and daylight blue circuits and forty-two 750-watt lamps for the blue. There are also four 750-watt downlights used as worklights. Borderlight K1 and K2 is controlled by 10 dimmers on 140 circuits. Borderlight L was the same as D, and has also been removed.

Advertisement from the December 20, 1932 issue of Variety, *which featured extensive coverage of both the* Music Hall *and the RKO* Roxy. **THS Archive.**

Across the rear of the stage is a double row of four-color cyclorama footlights recessed in a trough in the stage floor. These units are in fourteen sections having a total of seventy 200-watt lamps per color controlled by eight dimmers on fifty-six circuits. The covers over these footlight hinge up, revealing the footlights, which are stationary. When closed, these covers cannot support the weight of the band car. These cyclorama footlights take up 5 feet of valuable stage floor space and are no longer being used.

All color filters are either glass roundels or flat glass panels in copper frames, with all colors matching exactly. The auditorium ceiling coves, urns, front stage footlights and the choral stair footlights use the round glass roundels, while all the borderlights and the cyclorama footlights use the flat glass panels. The cyclorama footlights and borderlight L used an 8-inch square frame while borderlights E, F, G and H use a 12-inch square frame and borderlight K a 15-inch frame.

Stage floor AC (alternating current) pockets are located along both sides of the stage, in the elevators and turntable, and upstage and downstage of the cyclorama footlights. Additional outlets on the gridiron and in the basement make for a total of seventy-three outlets and circuits controlled by thirty-nine dimmers. Some of these floor pocket outlets are rated at 6000 watts on a single circuit. There are also fourteen 100-ampere DC (direct current) floor pockets and DC outlets for follow spotlights on the light bridges.

A total of eight sidestage spotlight towers, four on each side, were originally provided; they were served by thirty-two dimmers on thirty two circuits. On the top of each was a carbon-arc follow spot. The towers were reduced to six and then to four before being completely eliminated in favor of spotlights hung from ladders on each side of the stage.

The two levels of side bridges extending up and down stage on each side of the stage have a total of fifty-six outlet circuits on fifty-six dimmers. There are also eighteen dimmers and twenty-nine circuits assigned to stage chandeliers, organ spotlights, organ recess lights, choral spotlights, music stand lights, cyclorama stars, stage worklights, side orchestra arches, music rail spotlights and the miniature stage. A fireworks batten was added, but this has now been removed along with the cyclorama stars. The ten circuits of stage worklights are connected to a single dimmer in such a manner than when the main curtain is opened the worklights go off.

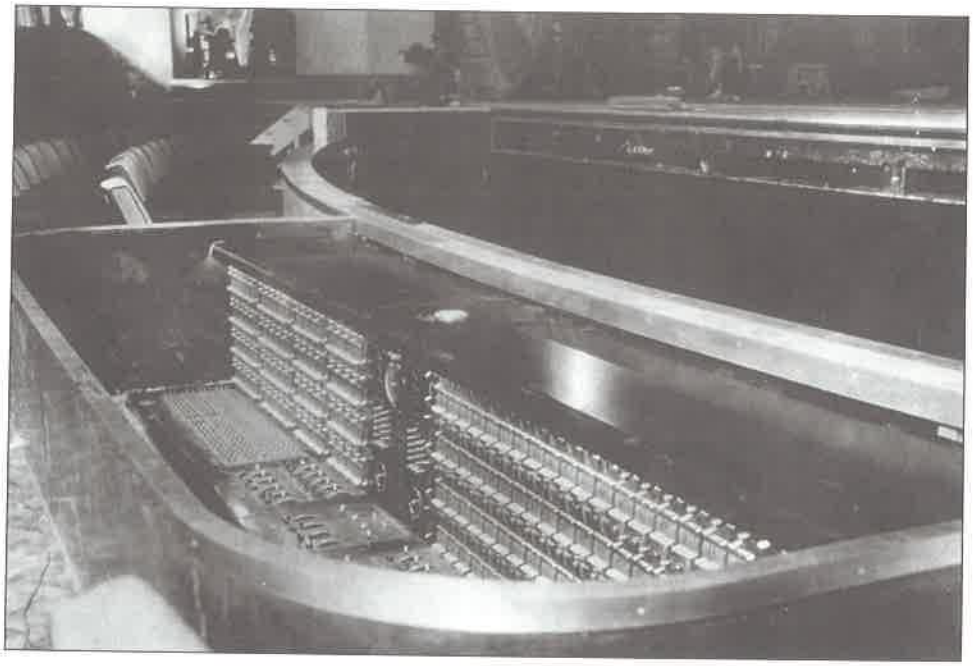
Located on the projection floor above the upper balcony are three follow spotlight booths: north and south booths, each with six spotlights and a center booth with four. These follow spotlights were originally 150-ampere DC carbon-arcs. A booth in the middle of the auditorium ceiling contained an additional six similar units, and there was a high-intensity booth containing special effects machines. All follow spotlights have been converted to either Xenon or HMI lamps. Each contains an electrically operated dowser, operated from the main control console, for simultaneous blackout.

All of this adds up to 942 stage lighting circuits under the control of 262 dimmers having a total capacity of 1319 kilowatts, connected to three main electrical feeders with a capacity of 3200 amperes.

Auditorium Lighting

The auditorium lighting consists basically of sixteen groups of lights arranged in amber, red, green and blue. It is interesting to note that there are no white lighting circuits in the auditorium. The eight main ceiling coves are identified as coves A through H and are controlled by thirty-two dimmers and account for 376 of the branch circuits. The first, second and third mezzanine soffits account for twelve dimmers and seventy-two of the branch circuits.

The Prompt and Opposite Prompt (stage right and stage left) runways use eight dimmers and forty-four circuits; the P and OP choral borders use four dimmers and sixteen circuits. The sidewall perforations require five dimmers and account for sixty-four of the circuits. (The blue lighting requires the use of two dimmers in order to stay within the maximum dimmer size of sixteen kilowatts.) Wall urns utilize four dimmers and a total of forty circuits while the side orchestra arches require only one dimmer and two circuits.



The lighting console, just outside the orchestra pit. Low-voltage remote-control allowed the electricians to see the stage as the audience saw it. Today's technology makes this simple, but it was brand new when the Music Hall opened. ***Author's Collection.***

This lighting requires a total of 614 branch circuits controlled by sixty-six dimmers, having a total capacity of 612 kilowatts, connected to one main electrical feeder with a capacity of 1200 amperes. The majority of these dimmers are ten and sixteen kilowatt.

Stage and Auditorium Lighting Control System

The lighting control system installed in the Music Hall in 1932 remained in use until early 1999; it is described here as it existed until then. This system is of the electronic remote-control, saturable-core-reactor type, with 328 dimmers ranging in size from two to sixteen kilowatts. In cases where the individual connected load was in excess of sixteen kilowatts, multiple dimmers are used. The 328 dimmers control a total of 1556 lighting circuits. This was the largest theatre lighting control system ever built up to that time, and it remained so for many years. The concept was not new: the first such system was installed in Daly's Theatre, at 29th Street and Broadway, New York City, in 1888. Of course, this was not with electronic-tube control. The Music Hall scheme involves one or more dimmers per color group of like circuits rather than a dimmer per circuit, as is the standard practice in theatre lighting control today. There is no patch panel.

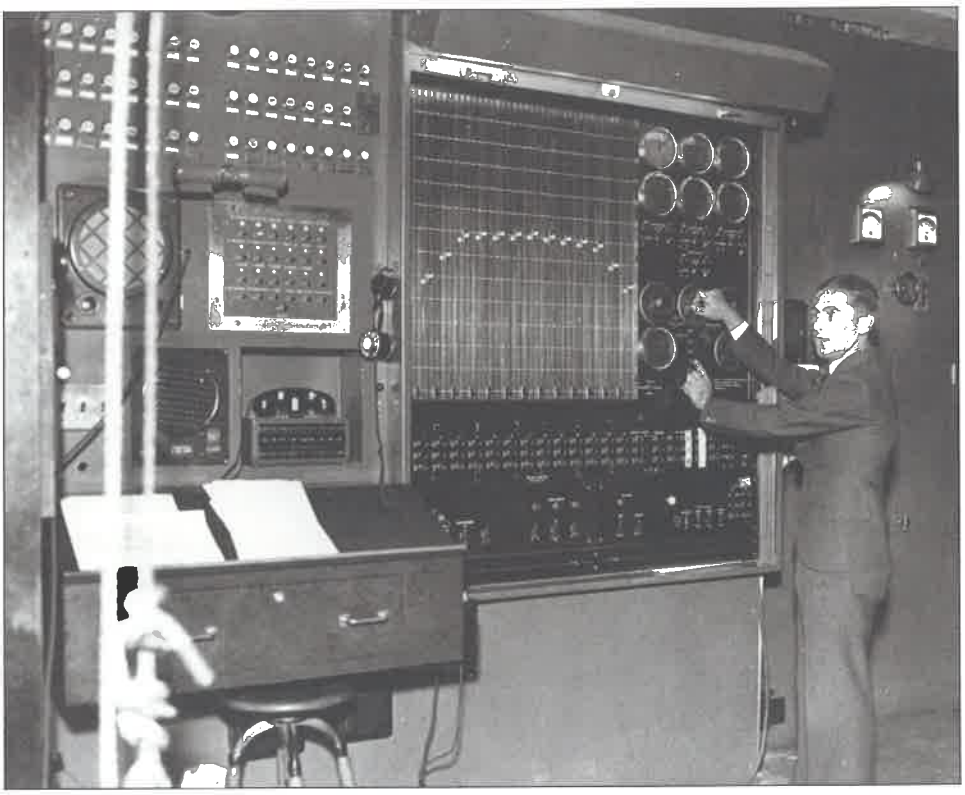
The reactors are located in four large rooms: three, with 178 dimmers, in the attic, near the stage, and a fourth, with 150 dimmers, in the basement. All are controlled from a central console centered in front of the orchestra pit, with a hood so arranged that the console is not plainly visible to the audience. This console, which will remain in place, is 16 feet wide, 5.33 feet high and 4 feet deep. It contains a total of 4305 control devices.

The saturable core reactors are built into nine large angle-iron frames, seven in the attic rooms and two in the basement room. Associated with each reactor dimmer is an electronic-tube control panel on one face of the frame and a contactor (a large electrically-operated switch) and fuse panel on the other, with the reactor between them.

The saturable core reactor looks like a large transformer. It is actually a three-legged laminated iron core with two electrical windings. One winding, on two legs of the core, is the AC power winding, which is connected to the power source and the associated lamp load through the main and branch circuit fuses. The other is the DC control winding, wound around the middle leg of the core. To compensate for a twelve-volt drop through the core and AC windings, the normal supply voltage of 120 volts is boosted to 132 volts by large booster transformers. These transformers are provided for groups of reactor racks.

The control winding supplies thirty-five volts DC to the core, causing magnetic saturation of the iron. When there is no current flowing in the DC control winding only a small excitation current flows through the AC winding, and the associated lamp load is out. As the voltage is increased in the DC winding the iron core becomes more magnetically saturated and more current is then permitted to flow through the AC winding, resulting in an increase in lamp load intensity. As the DC voltage reaches a maximum of thirty-five volts the iron core becomes completely saturated and the full load current flows in the AC winding; the lamp loads are then at maximum intensity.

The electronic-tube panels contain five tubes: two thyratrons, one panotron and two kenotrons. These tubes, along with the electronic components within the tube panel, permit the operating-lever control devices at the console to vary the DC flowing in the reactor core winding, thus varying the resulting light intensity as well as turning the power contactor on and off.



The control station for the thirteen-line coutour curtain. ***Terry Helgesen Collection, THS.***

The contactor panels contain the power contactors used to turn the associated dimmer and lighting circuits on and off. The panels also contain main and branch circuit fuses, providing protection from overloads and other possible electrical faults. When the contactor is closed (in the on position) the associated dimmer is turned on, and a pilot light becomes illuminated on the control console. The saturable core reactor is directly connected to the neutral conductor of each group of circuits. The contactor is connected to the main and branch circuit fuses and is served from the phase or line side of the electrical system.

The pilot control console is of the five-scene preset, plus rehearsal, control type. It provides complete control for all 328 dimmers through 313 individual control units. In several instances, where multiple dimmers are provided for a single group of circuits, two dimmers are controlled by one control unit. The console also provides remote control for the many spotlights having electrically controlled boomerangs as well as the blackout dousers attached to all the carbon-arc spotlights.

This system becomes quite involved, yet provides a very flexible arrangement of lighting control. Each of the 313 individual control panels contains five intensity controllers for the five preset scenes, along with five selector switches to select scene mastering. There is also a single intensity controller for the rehearsal and unit control scheme plus a three-position main selector switch selecting Group, Unit or Preset control, as well as a circuit pilot light. Each of these six individual intensity controllers is actually a lever arranged to operate the magnetic core of a solenoid which, coupled with two capacitors, provides a variable output voltage to control the electronic-tube unit, which in turn controls the DC winding of the saturable core reactor.

With the main selector switch indexed to the down, or Preset, position the five-scene preset intensity controllers come into play. Each preset controller can then be subject to the next higher order of master control by selecting either the scene master or supplemental scene master intensity controllers, of which there are five each. By means of a series of selector switches these scene and supplemental scene master controllers are connected, one or more at a time, to a scene fader which is operated to transfer the lighting from one scene to another.

With the main selector switch indexed to the middle, or Unit, position the single intensity control lever is in control and is subject to a next higher order of master control only by a grand master intensity controller.

With the main selector switch indexed to the up, or Group, position the same single intensity controller is still in control, but it is then subject to a next higher order of master control by a color group or group master intensity controller. This master controller can in turn be selected for unit or rehearsal master control. In the unit position this color or group master controller is then subject only to the grand master control, but when in the rehearsal position the rehearsal master becomes the next higher order of control.

A grand master intensity controller ultimately exercises control over all individual, color master and group master controllers, as does the main blackout switch.

The stage and house sections each have their own scene fader controls, scene and supplemental scene master controllers and sets of scene selector switches. To accomplish all this there are a total of thirty-nine color and group master controls, plus twenty-six other masters including two scene faders (one stage and one house), stage rehearsal, stage grand, house rehearsal, house grand, five stage scene, five stage supplemental scene, five house scene and five house supplemental scene masters.

All this makes for a very large and, at first, a very complicated control system, but as an operator becomes accustomed to where everything is located and how it functions the system is quite straightforward and easy to operate. Those of you accustomed to modern computer memory control consoles with a dimmer per stage lighting circuit may ask yourselves how anyone could ever accomplish a top-quality lighting presentation with such a system, yet over the years the MUSIC HALL has presented hundreds of productions with outstanding stage lighting that has been the envy of lighting designers everywhere. After the renovation has been completed it will be very interesting to examine the new stage lighting and control installation.