



REACTANCE DIMMERS

Hysterset *Electronic* Control

For the Modern Stage Switchboard

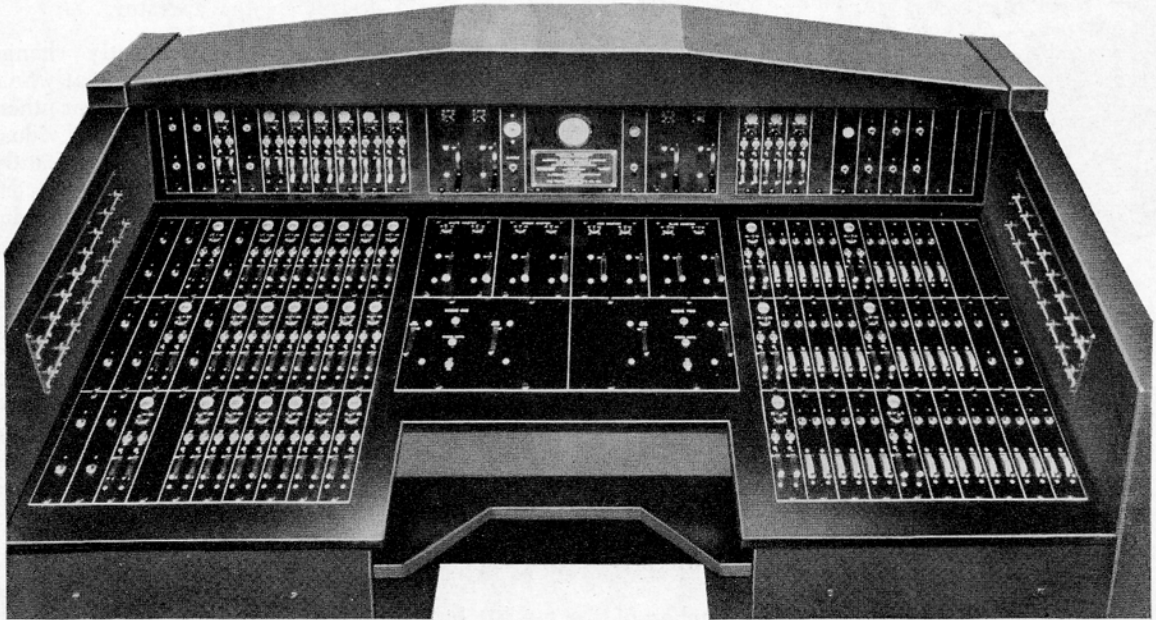


Figure 1. Typical Desk Type Stage Switchboard employing Hysterset Electronic Control of Reactance Dimmers. Dimming system provides Two Scene Preset control with dual master channels for cross control within each scene.

General Considerations Governing the Selection of a Theatre Switchboard and Dimming System

The design and arrangement of a theatre switchboard will be governed primarily by the use put to the theatre or auditorium. Experience with the legitimate theatres, particularly the experimental theatres being erected in the schools and colleges throughout the country indicates the following considerations govern the selection of the switchboard and dimming system for that particular type of installation.

1. *Ease of operation:*

- (a) The theatre switchboard controlling the lighting should be as compact as possible. First, because it is desirable to make all controls accessible to the operator; and second, because of valuable space on the stage or auditorium it should occupy as little space as possible. All parts should be readily accessible and movable with little effort.
- (b) The arrangement of the operating parts of the switchboard should be simple and

clear. Frequently, an operator unfamiliar with the board is required to use it without an opportunity to become acquainted with the system. Obviously, therefore, each part should be clearly marked and calibrated. Pre-set switches and dimmers should be related together in a control unit. Master control panels should be centrally located. Pilot lights should be used wherever they will assist in showing the set-up at any time. A well shielded operating light should be provided.

- (c) The stage switchboard should be located where the operator can see the stage in order to time cues and prevent mistakes. Regardless of the location of the switchboard, the operator must at all times be in a position to observe the effect created by the switchboard and dimming system.

2. *Flexibility:*

- (a) The dimming control system should be capable of controlling a wide range of connected loads on each circuit with the same degree of dimming control. The use

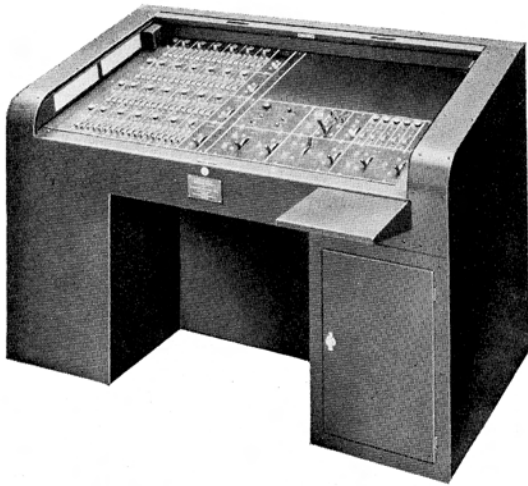


Figure 2. Desk Type Switchboard using Hysterset Control. Dimming System provides Three Scene Pre-set with dual Scene Masters, Scene Fader and selector switches.

of individual units in footlights, border lights and sectionalized control of other types of lighting instruments, require that the circuit be sufficiently flexible to control a wide variation in the number of lamps connected to each circuit.

- (b) It is desirable that master control be furnished so that changes in lighting effects may be effected by the operation of a single control lever instead of requiring the use of many hands. The number of sub-masters to be furnished depends materially on the total number of circuits involved in the system. All master controls should provide proportional dimming, thereby maintaining the same relative color values in any lighting effect while decreasing or increasing the overall intensity.
- (c) The ability to pre-select lighting intensity in advance is essential for the prompt response of the lighting system to cues. The number of pre-sets provided by a switchboard will depend on the multiplicity of control composing the dimming system. Time must be allowed to permit the operator to arrange a new selection of intensity. Therefore, if he has a large number of controls to re-adjust it may require three or even five pre-sets in order to accomplish the necessary changes.
- (d) Provision must be made for a dimming transfer from one pre-select scene to the succeeding scene, as frequently as this

operation must be cued with the action on the stage. The transfer control should provide a smooth continuous change from the existing lighting scene to the new pre-selected intensities at any rate of speed desired by the operator.

- (e) Inasmuch as actors frequently change their timing and sometimes cut out whole speeches or actions, intentionally or otherwise, it is essential that any individual unit should be capable of being instantly switched from pre-set control to direct control. Thus at all times, any individually controlled circuit is always under the supervision of the operator.

3. Maintenance:

The stage switchboard should be designed for long life, with all parts easily accessible and as free from wear as is possible. All parts of the switchboard and the dimmer system should require as little maintenance as is possible with any electrical apparatus of similar type.

4. Operation:

The dimming control system should provide as near as is possible, instantaneous response to the operation of the control element. Also, it should permit the operator to move the controls smoothly and continuously to obtain a continuous change of intensity over an appreciable period of time. All parts should be silent in operation.

These same considerations are applicable to practically every type of building used for public assembly. In all cases the essential features of the lighting control require the use of a dimming system which provides ease of operation, maximum flexibility of control, minimum maintenance and smooth control with instantaneous response to movement of the control levers.



Figure 3. Typical Circuit Panel with two controls on one panel. Each has Two Scene Presets, and a Rehearsal Control, switch and pilot indicating light for circuit contactor, selector switch for direct independent control, color master control or preset control through Scene Masters.

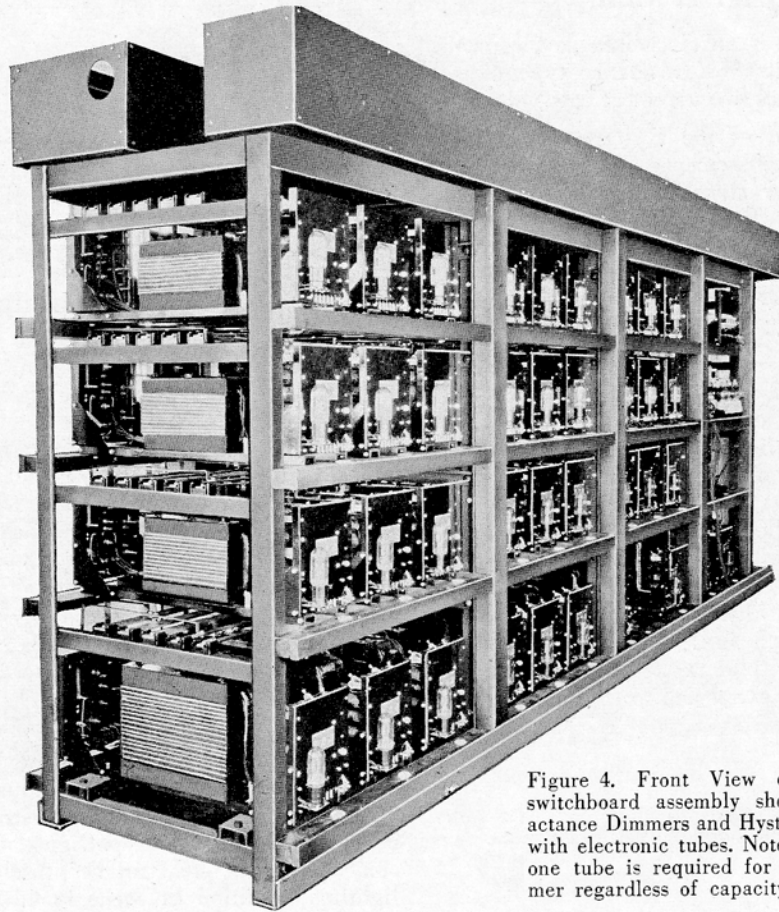


Figure 4. Front View of remote switchboard assembly showing Reactance Dimmers and Hysteresis units with electronic tubes. Note that only one tube is required for each dimmer regardless of capacity.

The Ward Leonard Hysteresis System of Control

The Ward Leonard Hysteresis Control of reactance type dimmers, provides the switchboard builder with the means of adequately meeting all of the noted considerations. Developments in the field of electronics, permit the use of small values of current and miniature control devices. These controls enable the theatre switchboard manufacturer to compact a large number of dimming and switching controls, for a theatre or auditorium, into a control board which may be operated by a single individual. The Color Master and Grand Master Control can readily be obtained by means of electrically interlocking the various control circuits, thus a control board of 100 circuits may be constructed to occupy the space of an ordinary library table.

The miniature, individual, and master controls, operate without undue friction and with a minimum of effort. All controls are legibly marked

and provided with graduated indicating scales, which are clearly visible. As many pre-set controls may be provided as the system and installation warrants. Likewise, the required number and type of masters and sub-masters are readily furnished. The reactance type dimmer with Hysteresis control can be provided with a wide range of dimming capacity to take care of varying load conditions.

The Ward Leonard Hysteresis system requires a minimum of maintenance as there are no heavy moving parts. The Hysteresis circuit is so designed as to insure immediate response to even the smallest motion of the pilot control unit. The pilot control assemblies are well constructed, and silent in operation. All parts are designed for long-life and are easily accessible for inspection. The pilot control assemblies are of sufficient size to provide continuous and smooth operation from full bright to "black-out."

The Hysterset Unit

The Hysterset unit is an electronic device providing means of control of reactance type dimmers with small values of current at low voltage.

The present design of the Hysterset Unit incorporates all of the refinements and features that have been developed since the first Hysterset installation made in 1935. Continuous experimentation in our development laboratory assures that the simplest, most efficient and modern electronic circuit and devices are used in the design of the Hysterset Unit.

The Hysterset unit requires the use of only one gaseous conduction, electronic rectifying tube to provide the necessary current for the control coil of the Dimmer. Long life is an inherent characteristic of this type of rectifying tube, usually exceeding 3000 hours at full load. The output of the rectifier is controlled by means of small reactors and other devices in the Hysterset unit. A small "dry disc" rectifier supplies the pilot current for "setting the hysteresis" curve of the control reactors, which in turn, determines the output of the rectifier tube and, subsequently, the intensity of the lamps connected to the dimmer.

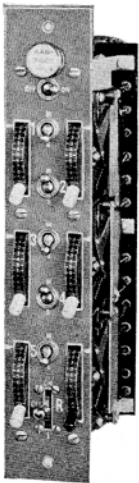


Figure 5. Circuit Panel which provides Five Scene Preset and a Rehearsal control. Selector switches are provided for each preset to select either of two master channels; Scene Master or Sub-Scene Master.

The Hysterset unit is quiet, efficient, has no moving parts and requires little or no maintenance. Adjustments are provided to permit setting of the dimming characteristics of the control circuit to suit the conditions of the load circuit. The "cut in" point can be adjusted to give the proper "black-out" voltage for the type of lamps used in the circuit. The shape of the dimming curve can be adjusted to provide the correct increments of light output for each point of control on the dimmer lever, from full bright to "black-out." Once they are set, these controls do not require

readjustment when a new rectifying tube is placed in the unit.

Each Hysterset contains a self-regulating circuit to automatically adjust the output current, when required by a change in the connected lamp load. Thus a correctly adjusted Hysterset unit will provide the same dimming control throughout the designed control range of the dimmer; that is, 100% to 50%, 100% to 25% or 100% to 10% of full load as the case may be.

Preset Dimming

Because the Hysterset Unit is controlled by small values of current and volts, it is possible to provide multiple pilot devices and switch the control circuit first to one, and then to another pilot control. It is therefore, possible to preselect the intensity of a circuit and then produce the desired lighting by transferring the control of the dimmers to the preset pilot controls.

In some cases, this may be limited to the master controls only. This is obtained by providing several master busses, the voltage of each being controlled by a master control. By transferring the individual circuit controls from one master buss to another, a degree of preselection is obtained.

For greater flexibility, multiple dimming controls are provided for each individual circuit. Thus the intensity of each lighting instrument such as border light, overhead spotlights, footlights, balcony spotlights, etc., can be preselected for each lighting condition or scene in advance, and can be brought into existence by transferring control to the desired set of pilot devices. Master controls may be provided for each set of pilot controls so that the general intensity of the entire scene can be dimmed as a unit.

Transfer from one set of controls, or lighting scene, to a second set or scene, may be accomplished by switches, or by operating the two scene masters in opposite directions, or by an additional device which accomplishes the duplicate master operation with one control handle. This control or "fader" permits a change at any rate which the operator desires, from one lighting scene to the preselected scene.

The number of individual preset dimming controls provided, is usually determined by the necessity for preselecting a number of scenes in advance. Thus, an auditorium in which concerts or stage plays are presented, the lighting changes are few and at appreciable time intervals, which permit readjustment of the pilot controls, and only one or two lighting scenes need be preset. A presentation house, featuring vaudeville or other short but numerous acts in quick succession, usually require many more lighting changes.

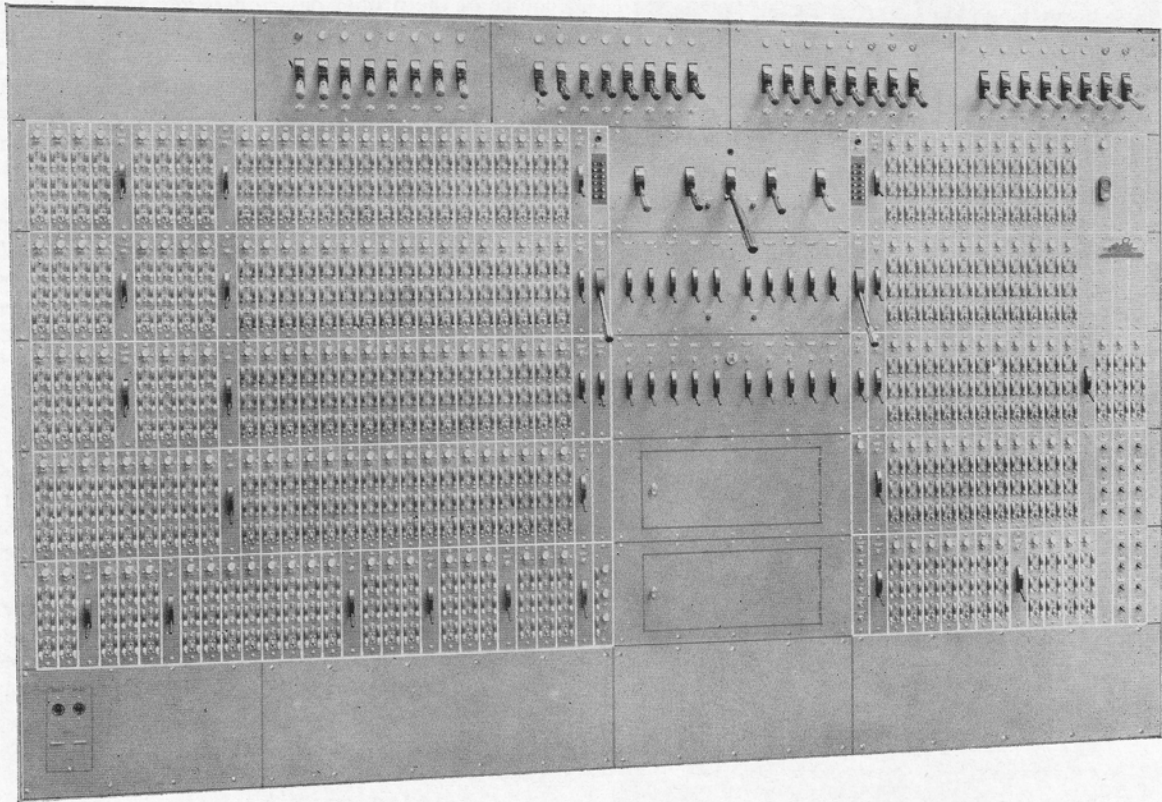


Figure 6. Free Standing Pilot Stage switchboard controlling reactance dimmers with Hysterset control. Five Scene Preset control with separate Rehearsal control for over two hundred control circuits of stage and auditorium lighting. This switchboard is readily controlled by a single operator.

Therefore, the ability to preset five or more scenes in advance, is a great help in producing the required lighting effects "on cue".

It is desirable to provide one set of controls, usable in the conventional manner, with color and grand master controls. This is frequently termed a "rehearsal" control and provides direct control without reference to scenes.

This rehearsal control can be arranged to operate as a scene control, when a selector switch on the panel is closed to the proper position.

It is frequently required to add lighting effects to an existing scene during the action of a presentation. This can readily be accomplished by bringing a second scene master to full intensity on top of the one already in operation. This is termed "piling" scene on scene. Under this condition, where two or even more scenes are energized, the intensity control having the highest setting determines the intensity of the circuit.

Pilot Control Switchboards

The miniature types of pilot controls lend themselves to unique switchboard assemblies. In some instances the controls have been assembled

in a console similar to an organ console, but more frequently in a desk type control board. The conventional type of floor mounting free standing pilot board, is also readily constructed to accommodate the miniature pilot controls, and occupies much less valuable stage floor area than the equivalent resistance, or Autrastat type switchboard. Where a limited number of circuits are involved, the pilot control board may be assembled as a panel and mounted in a flush or surface type cabinet on the wall of the stage, adjacent to the proscenium opening.

The location for the pilot control board will determine to a great extent the type of construction. If the board is to be located out in front of the curtain, adjacent to the orchestra pit, the console or desk type board is most appropriate. If the board is located in the wing on the stage, or in the projection or spot booth, either the free standing floor mounting board, or wall mounting panel type board is more suitable.

Simplified Control Systems

Controlling devices for the Reactance Type dimmers are available in several forms. The

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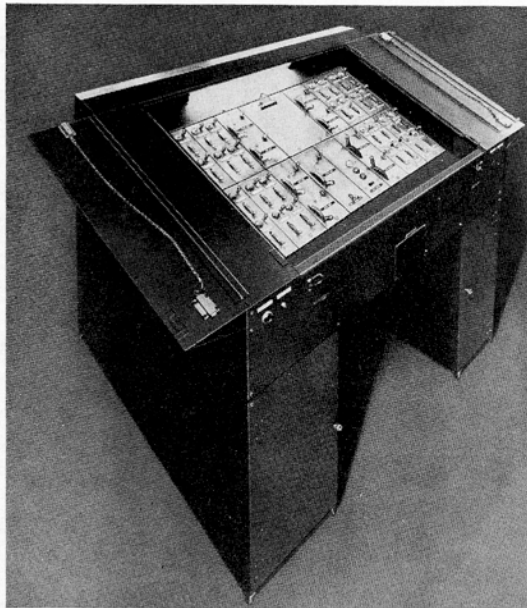


Figure 7. Desk Type Pilot Switchboard located in front of the curtain of a small experimental theatre.

choice of the proper device depends on cost, space available, refinement of control and flexibility.

The simplest control device consists of a Rheostat connected between a source of Direct Current and the control coil of the dimmer. This Rheostat is usually constructed in the form of a 15 inch diameter 110 step interlocking "Vitrohm" theatre dimmer. Thus the Rheostat can be assembled in any of the numerous types of framework available for resistance type dimmers and may be provided with individual interlocking levers, with color master, grand master, slow-motion controls in the same manner as shown in Bulletin 72 for the resistance type dimmers. Rheostat control plates may also be assembled in the same bank with Vitrohm resistance type dimmers or with Austra-stat Dimmers, as described in Bulletin 76.

The D.C. required for Rheostat control is usually obtained from a small motor generator set or rectifier having a constant voltage output.

To obtain the advantage of electronic tube control of Reactance Type dimmers for installations that cannot afford the refinements of the Hysteret unit with a pre-set pilot board, the Ward Leonard Electric Co. has developed a simple tube circuit controlled directly by a small rheostat in the pilot board.

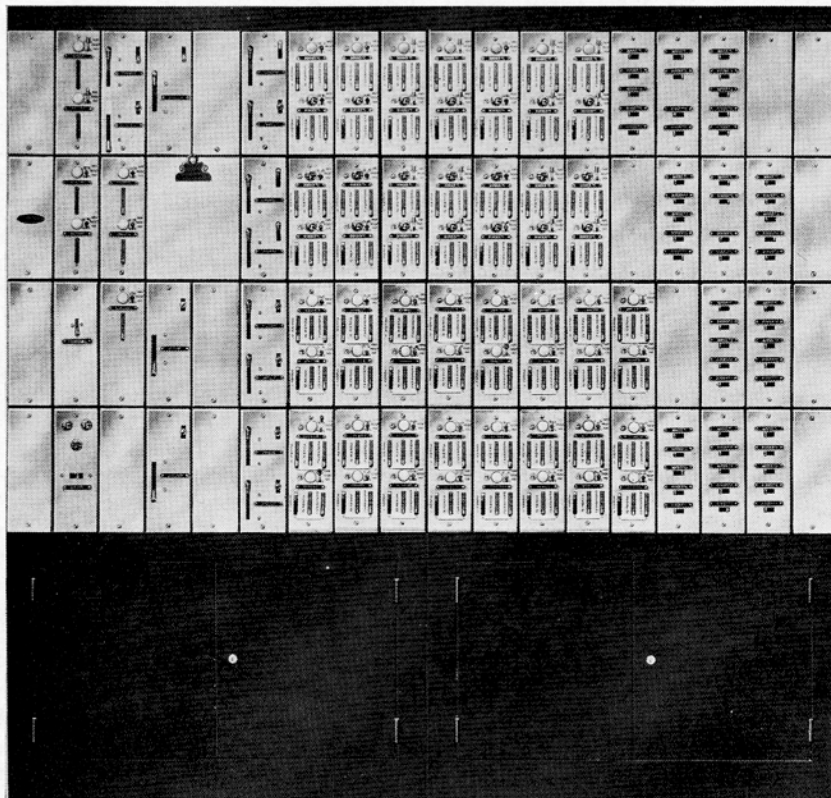


Figure 8. Free Standing Pilot Switchboard providing Two Scene Preset and a Rehearsal control for each circuit of stage and auditorium lighting.

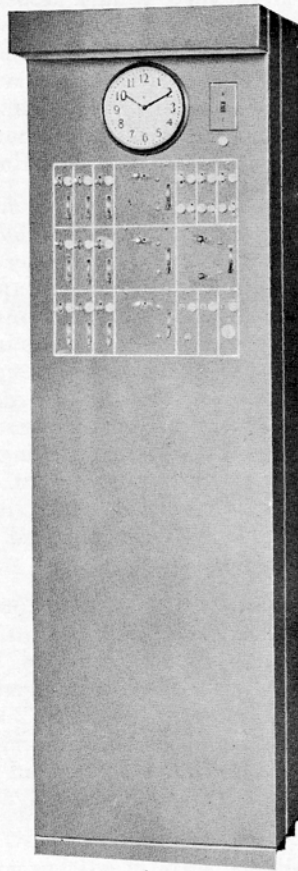


Figure 9. Free Standing Switchboard controlling a small number of large capacity circuits for a large arena.

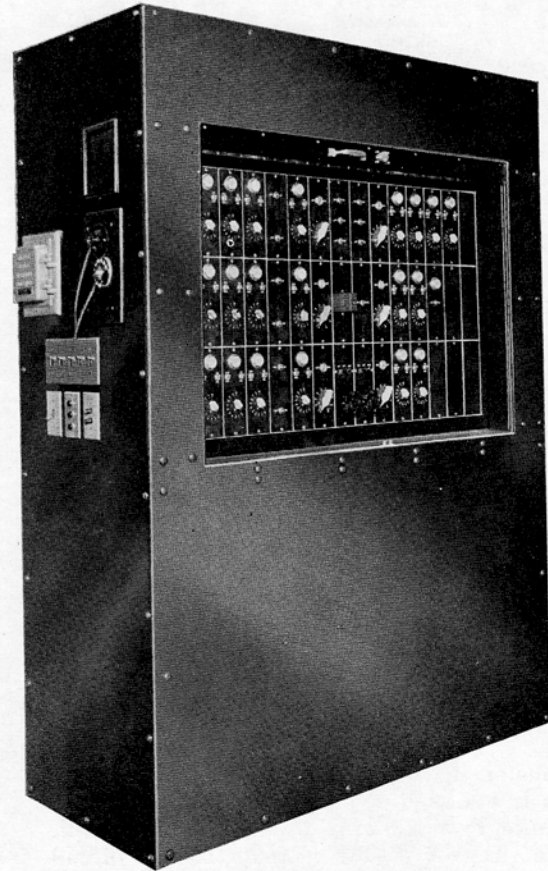


Figure 10. Free Standing Switchboard using a simplified Hysterset Electronic Control of Reactance Dimmers, installed in a high school.

The tube unit for this circuit consists of a single gaseous conduction rectifier tube, and a small transformer to supply the filament voltage. Resistors are furnished to provide adjustment of the dimming characteristics. The pilot control device consists of a small circular type power rheostat as described and illustrated in Bulletin 1105. Color master, and grand master controls, can likewise be provided to furnish the conventional type of control board. The size of the control board is considerably less than equivalent resistance type dimmer boards or Autrastat dimmer boards, and represents an appreciable saving in valuable floor space on the stage.

As the control devices are of substantial construction, they are quite suitable for installation in schools where students are permitted to operate the stage switchboard. The circuit is simple in operation, easy to maintain, and provides all the advantages of a remote control electronic Reactance Type dimmer system.

Additional Applications

Reactance Type dimmers with Hysterset controls are also suitable for installation in lecture rooms, churches, museums, lodge halls or club-rooms. Where a few controls are involved, they may be mounted in positions readily available for convenient operation. Installations have been made in the pulpit or in the organ console for operation by the organist. Duplicate stations can readily be provided with selector switches to transfer control to the desired location.

The use of an auditorium for motion pictures as well as stage presentations frequently calls for control of the lighting from the projection booth as well as the stage. If a few controls are involved, duplicate control boards may be installed in each location. If an appreciable number of controls are involved the cost of the duplicate control board would be excessive. However, the controls can be arranged with the complete board on the stage and a duplicate set of grand master con-

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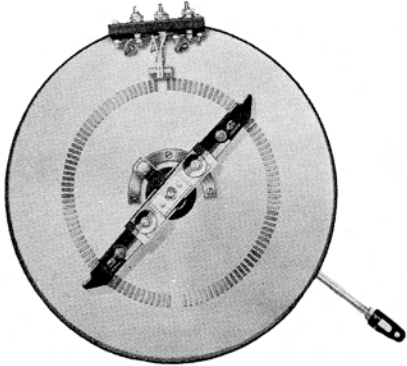


Figure 11. Vitrohms potentiometer plate for Rheostat Control of Reactance Dimmers.

trols furnished for the projection booth. Thus, the lighting can be preselected on the stage board and the controls extended to the booth for operation.

The master controls may also be extended to a portable set of master controls, which with a suitable cable and plug, may be carried to any desired location in the room.

Cycle Dimmers

A motor driven, cam operated, pilot control device is available to provide a cyclic control of Reactance Type dimmers with Hysteresis control. Such devices are desirable for the control of colored fountains, or floodlighting of buildings, gardens, etc. The periphery of the cams can be cut to provide a wide variety of effects, as each circuit may be dimmed and brightened several times in one complete cycle.

Reactance Type Dimmers

The dimmer unit consists of copper windings on a laminated iron core. One winding is connected in series with the lighting circuit or circuits. The second, or control winding, is connected to a source of current through some means of controlling the current flowing. With little or no control current flowing, a counter voltage is induced in the main coil of the dimmer sufficient to reduce the voltage impressed on the connected lamp load to "black-out" voltage. As control current is allowed to flow in the control winding, the self-induced counter voltage is reduced, thereby increasing the voltage impressed on the connected lamp load. When a point is reached where it requires a large increase in control current, to secure a small change in output voltage, the iron core of the Dimmer has reached the "saturation" state, and it is uneconomical to further reduce the induced voltage.

Normal practice is to design the Dimmer and its control winding to obtain a voltage across the load, 10 per cent less than input voltage at maximum direct current excitation. To compensate for this loss in voltage, it is customary to raise the input voltage to the Dimmer by means of booster transformers, thereby obtaining normal lamp voltage at full control current excitation.

Ward Leonard Reactance Type Dimmers are of the air cooled type and are designed to provide the required control, with a minimum of copper and iron loss. The windings of the Dimmers are so arranged and connected, to prevent any instantaneous induced voltage in the control circuit under any condition. The Dimmers are designed for continuous duty at full load in accordance with the A.I.E.E. Transformer Standards. Because greater economy results from matching the design of the Dimmer to the actual circuit conditions and requirements, Ward Leonard Reactance Type Dimmers are specially designed and constructed for each installation.

Many lighting circuits, such as stage pocket circuits or sectionalized borderlight circuits, do not have a constant value of connected load. This requires a dimming control of flexible capacity. Designs are available for control ranges of 2 to 1, 3 to 1, 4 to 1 and 10 to 1, that is: Dimmers which will control the maximum lamp load and also control to "black-out" 1/2, 1/3, 1/4 or 1/10 of full load.

Reactance Type Dimmers are usually provided with mounting rails which permit assembly in a simple floor mounting angle iron frame. These frames also provide support for remote control switches, fuse or circuit breaker panels, wire raceways and other devices which constitute a complete remote dimmer control switchboard. As there is the possibility of 60 cycle mechanical vibration being transmitted from the dimmer to the mounting, it is desirable to locate the switchboard in a room where the noise will not be objectionable.

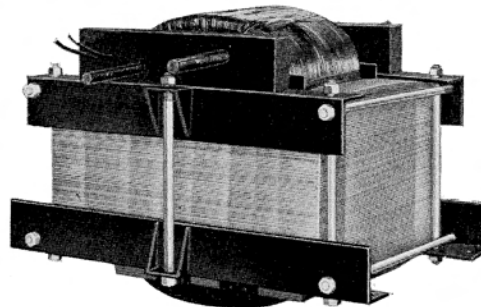


Figure 12. Typical Reactance Dimmer of large capacity.

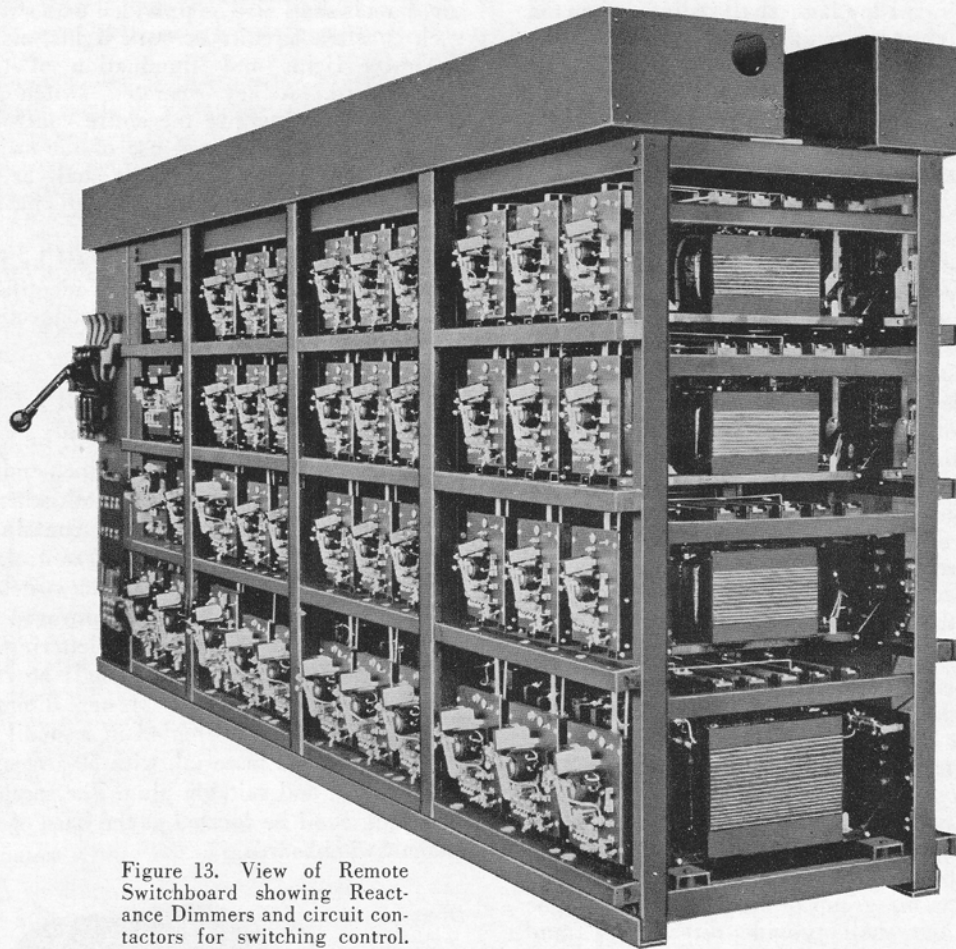


Figure 13. View of Remote Switchboard showing Reactance Dimmers and circuit contactors for switching control.

Typical Specifications

The contractor shall furnish and install, where indicated on the electrical plan, a complete electronic theatre switchboard as manufactured by the "Switchboard Co." for control of all stage and auditorium lighting as hereinafter specified.

The system shall consist of a pilot stage switchboard, and a remote contactor and dimmer switchboard. All magazine panels, auxiliary transformers, etc. shall be a part of the remote contactor switchboard. The system shall be designed to control the lighting circuits listed in the schedule attached to these specifications.

Pilot Stage Switchboard

The pilot stage switchboard shall be of the free standing floor mounting type, and shall be installed on the stage where indicated on the electrical plan. The pilot stage switchboard shall be constructed on a rigid angle iron framework

and shall contain all pilot devices for complete control of the lighting system. The face of the board shall consist of individual control panels, one for each circuit listed in the schedule. The panels shall be of approved material and finish, and shall have engraved lettering. Each panel for use with a dimmed lighting circuit shall contain three intensity controls, a three position transfer switch, an "on and off" silent action switch, and a pilot indicating lamp. The intensity controls shall consist of miniature rheostats, each operated by a slot closing lever moving in a vertical direction, which shall be provided with a numbered indicator plate, graduated from one to ten, to enable the operator to select the desired light intensity. Each lever shall be provided with a knob the same color as the light in the circuit controlled.

The pilot indicating lamp shall indicate when the associated lighting circuit contactor is energized. The switch shall connect or disconnect the coil circuit of the lighting contactor. The three position transfer switch shall provide "independent," "master" or "pre-set" control. The identity of the lighting circuit shall be clearly indicated on the face of each panel.

The three intensity controls shall provide "two scene" preselective control with an independent rehearsal system. The control levers shall be properly identified by engraved lettering on the panel. Operation of the transfer switch in the "independent" position will energize the rehearsal control direct, which shall not be affected by the operation of any master. With the transfer switch in the "master" position, the rehearsal control shall be energized subject to the position and the operation of a color master control hereinafter described. With the transfer switch in the "preset" position, either Scene 1 or Scene 2 intensity controls, or both, may be energized subject to the position and operation of scene master controls hereinafter described.

For each color of stage lighting and each group of house lighting, there shall be a panel containing color or group master intensity controls and transfer switches. For each control there shall be one intensity control consisting of a miniature auto-transformer dimmer, operated by a slot closing lever moving in a vertical direction. The lever shall be furnished with a colored knob, the same color as the group of lights controlled. The transfer switch shall provide direct or "grand master" control and shall have an "off" position.

A grand master control panel shall be provided for the control of all stage lighting rehearsal controls, and a similar panel for the control of all auditorium lighting rehearsal controls.

Two scene master control panels shall be provided for the preset controls previously specified. Grand master and scene master control panels shall each contain an intensity control, consisting of a miniature auto-transformer dimmer, operated by a slot closing lever moving in a vertical direction, equipped with a black knob. Also, each master control panel shall be furnished with a transfer switch providing direct control, extended control, or "off."

All switching and dimming controls on the pilot stage switchboard shall be designed for operation at low voltage alternating current.

In addition, control panels shall be provided, similar in design to those previously described, but containing silent action tumbler switches for individual control of spot lights, and sectionalized control of border lights as indicated in the sched-

ule. Panels shall also be provided with switches for such constant circuits as work lights, aisle lights, orchestra lights and illumination of the stage switchboard. A key operated switch shall be provided to deenergize the entire control system, and prevent unauthorized use of the switchboard and the control system. Space shall be provided for cue sheets, and a return call push button system to the dressing rooms.

The pilot stage switchboard shall be furnished completely wired, with properly identified terminals, located for convenient connection with outgoing wires.

Extended Control

An extended control station shall be furnished, assembled in a flush mounting cabinet, and installed in the wall of the projection booth where shown on the plans. This station shall contain a Stage Master dimming and switching control, and an Auditorium Master dimming and switching control, all mounted on a panel of approved material, suitably marked with engraved lettering. A portable extended control station shall be furnished, consisting of two Scene Master dimming and switching controls assembled in a small portable box of approved material, with 50 feet of flexible rubber cord and suitable plug. The receptacle for this plug shall be located at the base of the Pilot Stage Switchboard.

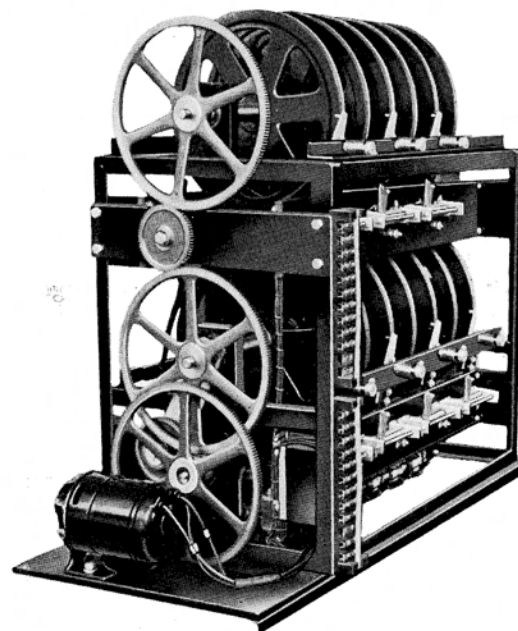


Figure 14. Motor Driven Pilot Control assembly for Mobile Color application of Reactance Dimmers with Hysteresis Electronic Control.



Remote Switchboard and Dimming System

The remote contactor switchboard and reactance dimmer bank shall be assembled in a rigid angle iron floor mounting framework. On the face of this framework shall be mounted all remote control contactors required for the operation of the system. The circuit contactors shall be of the electrically held type, of ample capacity, and designed to insure long life and minimum maintenance. Group circuit fuse (circuit breaker) protection shall be provided for each circuit contactor.

For each dimmed circuit there shall be provided a Reactance Type Dimmer of the proper capacity as indicated in the schedule. All dimmers shall be of the air-cooled type, with laminated iron cores as manufactured by the Ward Leonard Electric Co. The windings of the dimmers shall be arranged and connected so that there is no instantaneous induced voltage in the control circuit, under any condition. The dimmer shall be capable of operating continuously, at their maximum rated load, without exceeding a temperature rise of 55°C. The dimmers shall be designed to blackout any connected load from 100% to 25% of their maximum rating. The dimmers shall be designed to have not more than 12 volts drop at full saturation and full load. The construction of the dimmers shall be in accordance with AIEE Transformer Standards.

With each dimmer there shall be furnished, and mounted adjacent to it, a Hysterset unit as manufactured by the Ward Leonard Electric Co., consisting of a controlled rectifier with its associated control transformers and reactors. The Hysterset unit shall be designed to supply current to control the associated dimmer, as determined by the position of the pilot control rheostat in the pilot control switchboard. Each Hysterset shall require not more than one, gaseous conduction rectifier tube having an expected life of not less than 3000 hours at full load. It shall be possible to replace the rectifier tube with a new tube without readjustments of any resistors, condensers or chokes which may be a part of the Hysterset unit. Adjustments shall be provided for blackout voltage and for dimming characteristics throughout the range of control of the associated dimmer. A regulating circuit shall be included in the Hysterset unit to maintain the same characteristics on the lighting circuit for any connected load between 25% and 100% of the maximum rating of the dimmer.

Booster transformers of the proper capacity shall be furnished and assembled as a part of the remote switchboard. The booster transformers shall be of the air-cooled auto transformer type

designed to compensate for the dimmer drop at full saturation. Taps shall be provided to adjust the booster voltage for the incoming line voltage. All auxiliary transformers required for the proper operation of the dimming control system shall be provided and mounted in the framework. All transformers shall be properly identified and shall be furnished with taps for adjustment of voltages where necessary. A cathode protective panel shall be furnished to protect the rectifying tubes, by delaying the application of the plate voltage to the tube until the cathode has reached operating temperature. The time delay required shall not be longer than 45 seconds.

Branch circuit fuse (circuit breaker) protection shall be provided for each circuit of the lighting system, and shall be assembled in a magazine panel mounted on the end of the switchboard framework. Each circuit fuse (circuit breaker) shall be properly identified, and an index card shall be mounted on the door of the cabinet listing all circuits connected to the magazine panel.

Bus bar connections shall be provided where practical between the booster transformers and circuit contactors. Covered wiring troughs shall be furnished on the front and back of the angle iron framework for all load and control wiring.

Terminal blocks shall be arranged for convenient connection with outgoing wires. All dimmers, booster transformers, Hysterset units and other parts shall be so constructed that they can be readily assembled in the angle iron framework after installation by the electrical contractor.

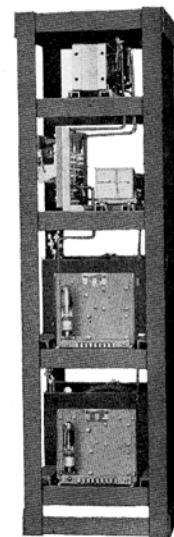


Figure 15. Small remote switchboard assembly for house circuits of a school auditorium.

INFORMATION REQUIRED

When requesting a quotation, ordering material, or requesting engineering recommendations for installation of Reactance type dimmers, the following information should be included.

1. Voltage, frequency and type of system of the available service.
2. Schedule of individual circuits, giving:
 - (a) Name and color of each control
 - (b) Total wattage of each control
 - (c) Number of branch circuits and wattage of each
 - (d) Whether branch circuits are two, three or four wire
 - (e) Sectionalized switching control for each circuit, if specified.
3. Type of pilot control system, giving:

- (a) Number of intensity controls for each circuit
 - (b) Master control system required
 - (c) Scene control system required
 - (d) Control voltage specified
 - (e) Any additional control features specified.
4. Requirements for remote switchboard and dimmer bank, giving:
 - (a) Available space
 - (b) Range of dimming control desired
 - (c) Voltage of Direct Current available, if any.
 - (d) Auxiliary controls required.
 5. Accessories, special features or details required by the specification.

Engineering recommendations or specifications will be prepared by the Ward Leonard Engineering Department upon request and receipt of complete information.

List of Representative Installations of Reactance Type Dimmers

Hystereset Control

RAINBOW ROOM, Radio City, New York City.
CENTER THEATRE, Radio City, New York City.
KANSAS CITY ARENA, Kansas City, Mo.
KANSAS CITY AUDITORIUM, Kansas City, Mo.
STANFORD UNIVERSITY, Palo Alto, Calif.
KERN COUNTY UNION HIGH SCHOOL, Bakersfield, Calif.
MICHIGAN STATE UNIVERSITY, East Lansing, Mich.
STATLER HOTEL, Detroit, Michigan.
HATCH MEMORIAL BANDSHELL, Boston, Mass.
CENTRAL HIGH SCHOOL OF NEEDLE TRADES, New York City.
CHRISTOPHER COLUMBUS HIGH SCHOOL, New York City.
WYANDOTTE HIGH SCHOOL, Kansas City, Kansas.
WM. CULLEN BRYANT HIGH SCHOOL, New York City.
LAFAYETTE HIGH SCHOOL, New York City.
WOODMINSTER PARK FOUNTAIN, San Francisco, Calif.

PARAMOUNT THEATRE, Miami, Fla.
ESCOLATA THEATRE, Manila, P. I.
OLDS AUDITORIUM, Lansing, Mich.
UNIVERSITY OF ARIZONA, Tucson, Arizona.
BARBERTON HIGH SCHOOL, Barberton, Ohio.
VETERANS ADMINISTRATION HOSPITAL, Sawtelle, Calif.
UNIVERSITY OF DELAWARE, Newark, Delaware.

Rheostat Control

CLEVELAND MUNICIPAL AUDITORIUM, Cleveland, Ohio.
ROXY THEATRE, New York City, N. Y.
VINE STREET THEATRE, Los Angeles, Calif.
GRAUMAN'S METROPOLITAN THEATRE, Los Angeles, Calif.
ATLANTIC CITY CONVENTION HALL, Atlantic City, N. J.
PHILADELPHIA CONVENTION HALL, Philadelphia, Pa.
SHOREHAM HOTEL, Washington, D.C.
MUNICIPAL AUDITORIUM, Long Beach, Calif.

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SQUARE D COMPANY.
STANDARD SWITCHBOARD COMPANY.

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