Westinghouse
Photo-Electric Lighting Control Relay

Installation and Operation

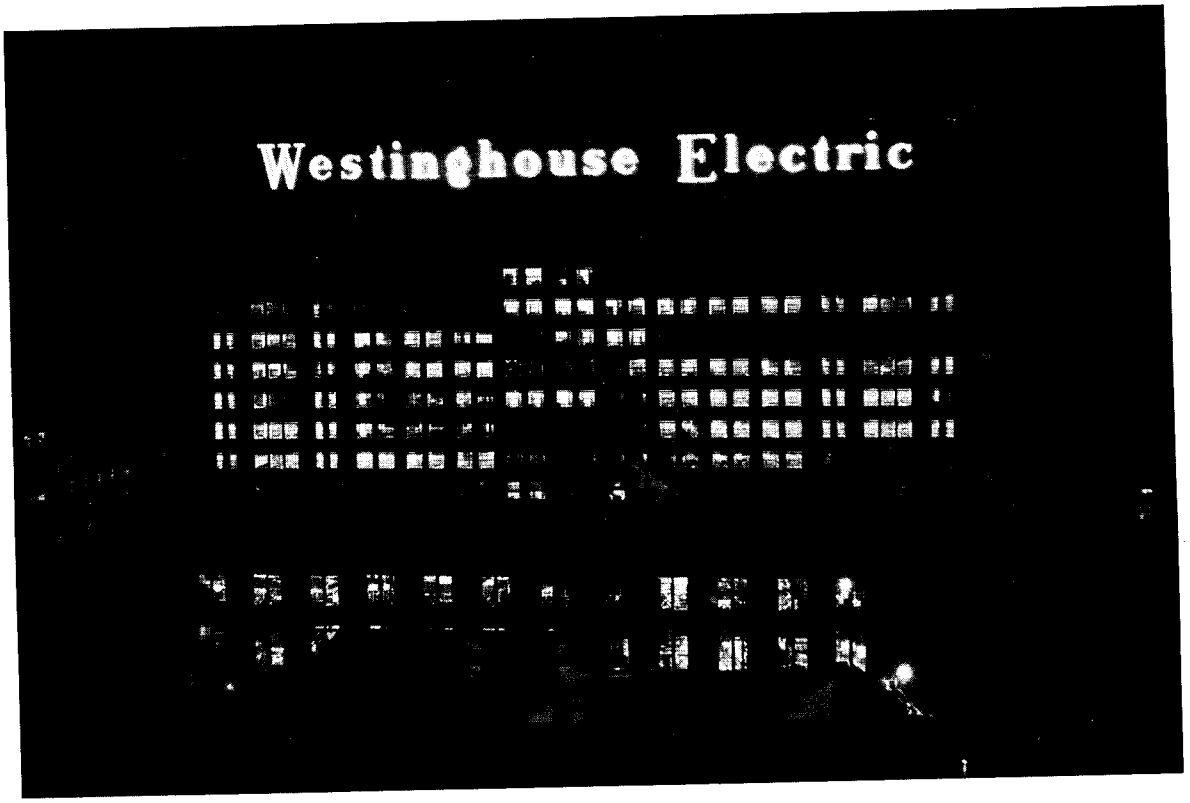
INSTRUCTION BOOK

Westinghouse Electric & Manufacturing Company

East Pittsburgh Works

East Pittsburgh, Pa.

I. B. 5572-A



AN INSTALLATION OF A PHOTO-ELECTRIC LIGHTING CONTROL RELAY IN SERVICE OVER TWO AND ONE-HALF YEARS

A Photo-Electric Lighting Control Relay controls this huge sign surmounting the East Pittsburgh Works of the Westinghouse Electric and Manufacturing Company.

This sign contains 4500, 25-watt lamps, with a total connected load of 112.5 kilowatts. The capital letters are sixteen feet high and the lower case letters 12 feet high. The sign is 260 feet in length and is visible at night for a distance of several miles.

Light intensity of natural illumination (daylight) causes the Photo-Electric Relay to turn this sign on or off, being independent of human hands and minds that may forget.

Westinghouse

Photo-Electric Lighting Control Relay

Introduction

The Westinghouse Photo-Electric Lighting Control Relay is a self contained device for controlling lighting circuits of any type through a contactor of proper capacity, and may be located without reference to the contactor other than convenience in wiring. It may be mounted by bolting to a suitable support through clearance holes provided, or by bolting into tapped holes provided in the bottom of the case.

The lighting control relay has been designed to satisfy a real need for a device that will eliminate the guess work and uncertainty in turning artificial lighting off and on and for an automatic control for electric signs that will increase their advertising value. In its most important group of applications, the control of illumination in factories, offices, and schools, it makes possible the most effective use of lighting installations thus increasing production, decreasing accidents, and giving people's eyes a square deal, to an extent never accomplished by manual control.

Application

The application of the lighting control relay that will show the biggest direct return economically is in the control of factory lighting in manufacturing aisles that have sky lighting. In one such installation, the energy consumed by one bank of lights controlled by a lighting control relay was metered and compared to the energy consumed by an equal and adjacent bank of lights in the same aisle under manual control. The manually controlled bank of lights consumed substantially twice the energy that the photo-electrically controlled bank consumed.

Such savings should be possible, in general, in any location that has good natural illumination, and that requires artificial illumination only a small part of the time.

The direct economic savings possible in some locations should not be allowed to overshadow the more important but less apparent advantage that accompanies the use of the lighting control relay in all locations,—the fact that the lighting control relay always turns on the lights as soon as they are needed.

In applications where the light intensity at the working level is within the control range of the lighting control relay, the lighting control relay should be located near the working level and away from windows. For the control of lower light intensities (such as in warehouses) the lighting control relay should be located near a window to take

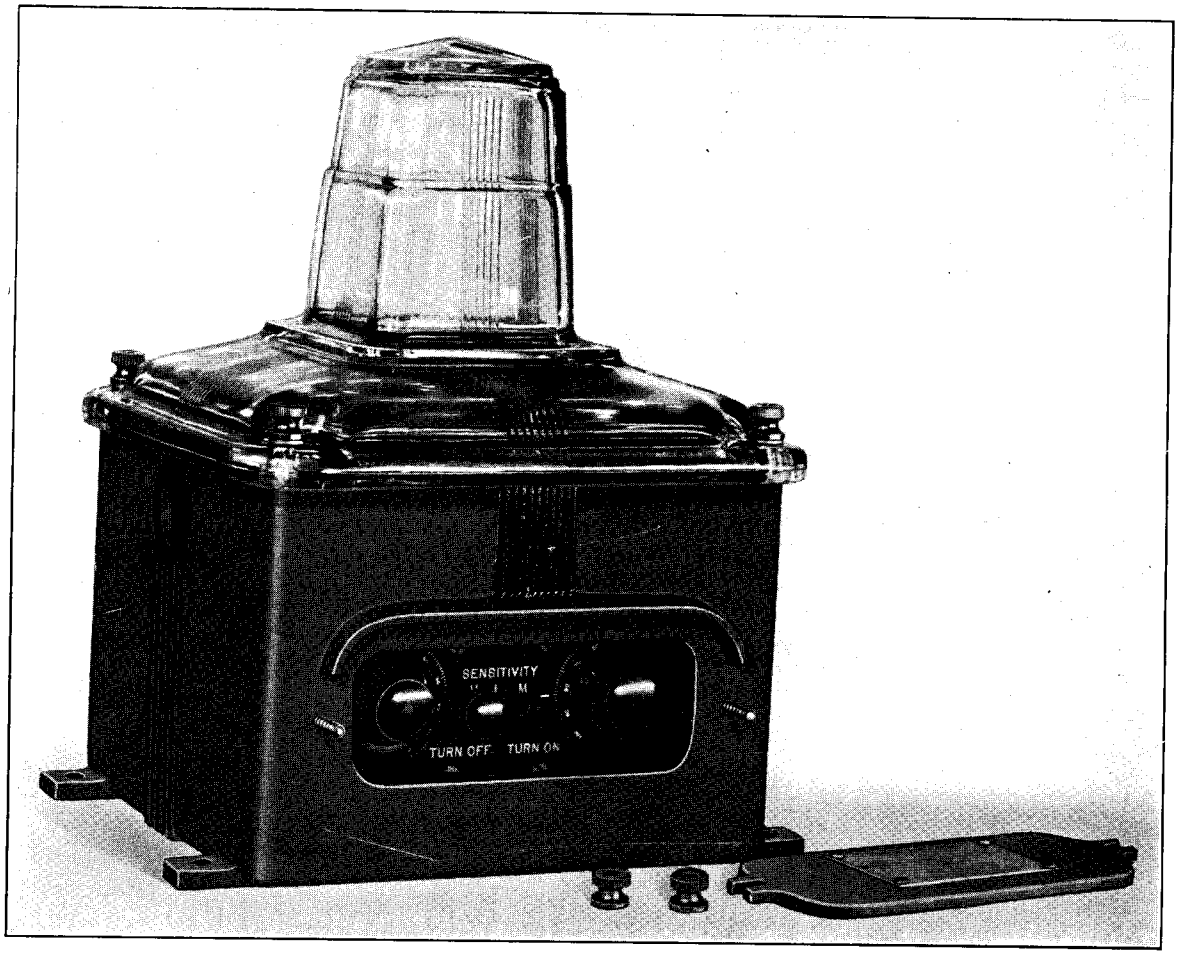


FIG. 1—PHOTO-ELECTRIC LIGHTING CONTROL RELAY WITH SIDE COVER REMOVED SHOWING ADJUSTING POTENTIOMETERS

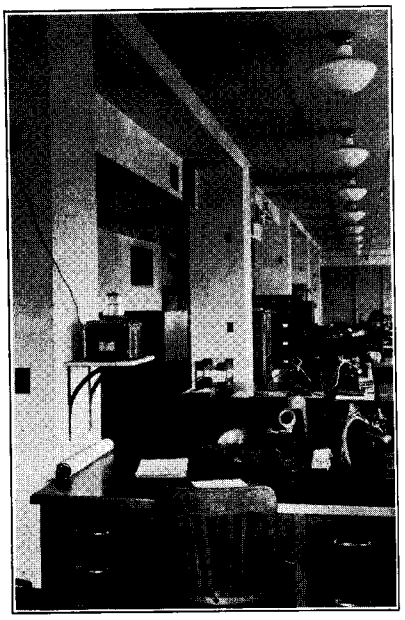


FIG. 2—AN INDOOR INSTALLATION OF LIGHTING CONTROL RELAY

advantage of the proportionately higher light intensity available there.

Installation

The lighting control relay should be located in a position where the illumination is fairly representative of the illumination over the area affected by the artificial lights to be controlled. It is desirable to avoid locations where direct sunlight will strike the unit, not only because direct sunlight will impair the accuracy of the device for a period of an hour or so, but also because the illumination in such a position is not likely to be representative. It should be noted in this connection, that it is not necessary to locate the lighting relay in the position receiving the least natural illumination, it is sufficient to locate the unit in a position where the natural illumination is proportional to that in the position of least illumination. It is not necessary to shield the lighting control relay from the artificial lights being controlled unless it is mounted so close to the lights that their intensity on the unit is considerably greater than the intensity of natural illumination on the unit at which it is adjusted to turn on.

The bottom of the cast case should preferably be mounted in a horizontal plane, but may be mounted in a vertical plane if the plane of the W-shaped amplifier tube filament is also in a vertical plane. The amplifier tube will then be vertical. It should be noted in this connection that the lighting control relay is responsive to light intensities as measured in a plane parallel to the bottom of the case, and that in the usual interior location the illumination on a vertical plane facing windows is several times the illumination on an adjacent horizontal plane.

The lighting control relay is suitable for operation in ambient temperatures up to 110°F. Vibration is unimportant unless of sufficient magnitude to be mechanically destructive, the limiting factor being the rugged design of amplifier tube employed.

The photo-electric lighting control relay will operate reliably from below 6 foot candles minimum turn-on, to above 150 foot candles maximum turn-off. The characteristics of the circuit employed are such that a variation in line voltage of 10 per cent from the calibrating voltage will be of little consequence.

The rated minimum turn-on of 6 foot candles is based on maintaining reasonably accurate operation when the line voltage changes 10 per cent from the voltage at which the unit was adjusted, and when the temperature changes 50 degrees Fahrenheit from the temperature at which the unit was adjusted. When the temperature and voltage are substantially constant, the accuracy of the lighting control relay is such as to permit operation with a minimum turn-on of four foot candles or lower. It is possible to set the lighting control relay to turn on at light intensities as low as one foot candle but the operation of the unit at such a setting would be reliable for short periods of time only.

Special Instructions for Outdoor Installations.

For outdoor use the lighting control relay should be mounted with the bot-

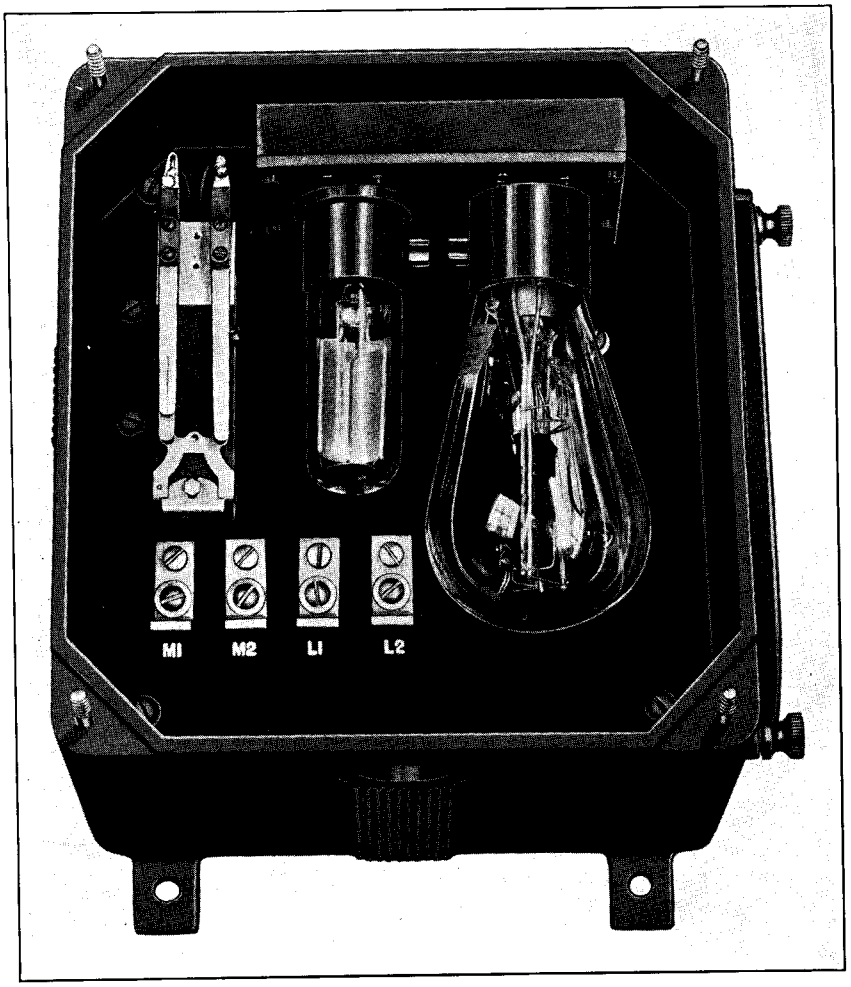
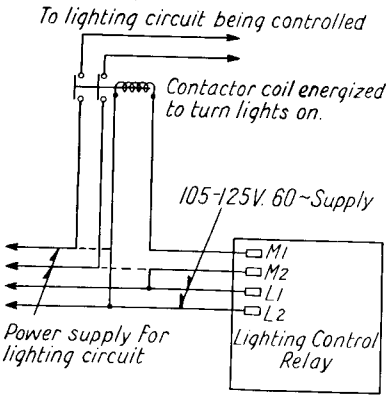


FIG. 3—LIGHTING CONTROL RELAY WITH GLASS COVER REMOVED



(Dotted lines indicate alternate connections)

FIG. 4—EXTERNAL WIRING DIAGRAM FOR LIGHTING CONTROL RELAY

tom of the cast case in a substantially horizontal plane. Otherwise the unit may not be weatherproof.

The conduit connection should be made with the usual locknut and bushing, and should be lined up carefully enough so that a weather-proof connection may result. It is desirable to provide a breathing opening in the conduit near the lighting control relay, so that sudden changes in temperature will not cause condensation within the lighting control relay case. This breathing opening may be simply a "T" in the conduit with its bottom extending downward and left open.

Under usual conditions found in temperate climates, the lighting control relay will operate satisfactorily even though it is exposed to direct sunlight throughout the day. Greater accuracy of operation will be obtained however, if a location is selected where the unit will be shielded from direct sunlight during that part of the day when the sun is more than 45° above the horizon. This can frequently be accomplished by mounting the unit on the north side of a building. In case a choice is available between exposure to morning and afternoon sunlight, exposure to morning sunlight is preferable since in this case a greater length of time will be available for the unit to recover from the extreme effects of sunlight before its usual evening operation.

In cases where trouble is experienced, that can be directly attributed to the unit reaching a high temperature due to exposure to direct sunlight, a canopy may be arranged to shield the unit. This should not be necessary unless the case temperature exceeds 150°F.

The unit should preferably be shielded from the lights it controls, but this is not necessary unless the effect of these lights, as measured at the unit, is greater than twice the intensity of natural light at which the unit is set to turn the lights on.

For outdoor service the lighting control relay is suitable for use between the limits of 10 foot candles minimum turn-on, and 150 foot candles maximum turn-off. For usual outdoor service such as sign control, the natural illumination intensity corresponding to turn-on should be set at 20 foot candles or higher, although this is only a rough guide, and the most effective operating point for any installation will have to be found by experiment.

It should be noted that the glass top of the lighting control relay is designed so that the photo tube can receive light from almost any direction above the horizon, and advantage should be taken of this fact when the lighting control relay is used to control street lighting circuits that are only to be energized when the natural light intensity is very low, by locating the lighting control relay so that it receives as much natural light as possible.

Connection

The energy supply to the unit should be connected to terminals L_1 and L_2 on the main panel. The voltage and frequency of this energy supply should correspond to the name plate rating.

Leads from the lighting circuit power supply (if less than 250 V. D-C. or A-C.) or from the line supplying terminals L_1 and L_2 should go to the terminals M_1 and M_2, Fig. 3, with the magnet coil of the contactor being controlled in series with one of these leads. Fig. 4 shows an external wiring diagram of the lighting control relay. A pair of contacts on the auxiliary contactor in the lighting control relay establishes a connection between M_1 and M_2 to energize the main contactor and turn on the light.

The interrupting capacity of these contacts on the auxiliary relay is 15 amperes at 220 volts A-C. (60 cycles with inductive load) and ½ ampere at 115 volts D-C. with inductance up to 7 henries. (7 henries is the approximate inductance of the 110 V. solenoid of a 72-C contactor, 600 ampere capacity, in the closed gap position). Maximum closing current for which the auxiliary contactor is suitable is 40 amperes, corresponding to the closing current of a directly controlled Mazda lamp load of 500 watts at 115 volts.

Another method of connecting the lighting control relay that will frequently be found useful in the control of existing installations is shown in Fig. 5. This arrangement combines the energization circuit and the control circuit, so that if a single idle circuit (such as an unused fan outlet circuit) is available no rewiring will be necessary. This circuit requires a series type MC relay at the distributing panel and a 6 ampere 115 volt reactor at the lighting control relay unit. (The figures given are for 115 V. 60 cycle operation). Then, in order to turn on the lights, the lighting control relay connects the reactor across its supply terminals (L_1 and L_2) increasing the current drawn from the supplying circuit from about .5 ampere to 6.5 amperes. This increased current through the series relay closes its contacts, thus energizing the contactor controlling the lighting circuit. When the reactor is disconnected from the terminals L_1 and L_2 of the lighting control relay, the remaining current in the supply circuit is insufficient to keep the contacts of the series relay closed, and the lights are turned off.

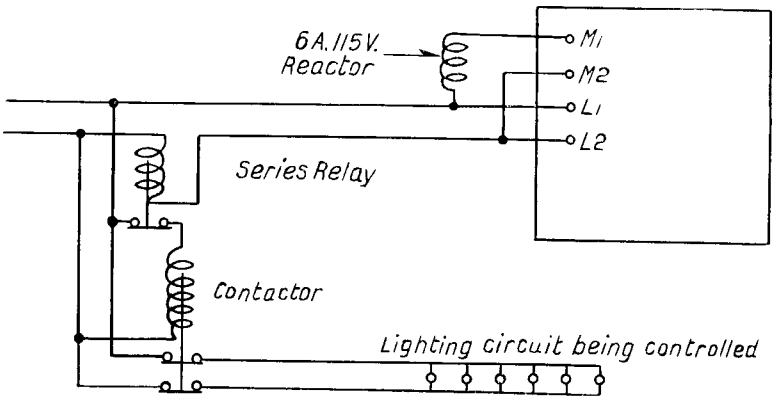


FIG. 5—EXTERNAL WIRING DIAGRAM FOR LIGHTING CONTROL RELAY CONTROLLING EXISTING LIGHTING INSTALLATIONS

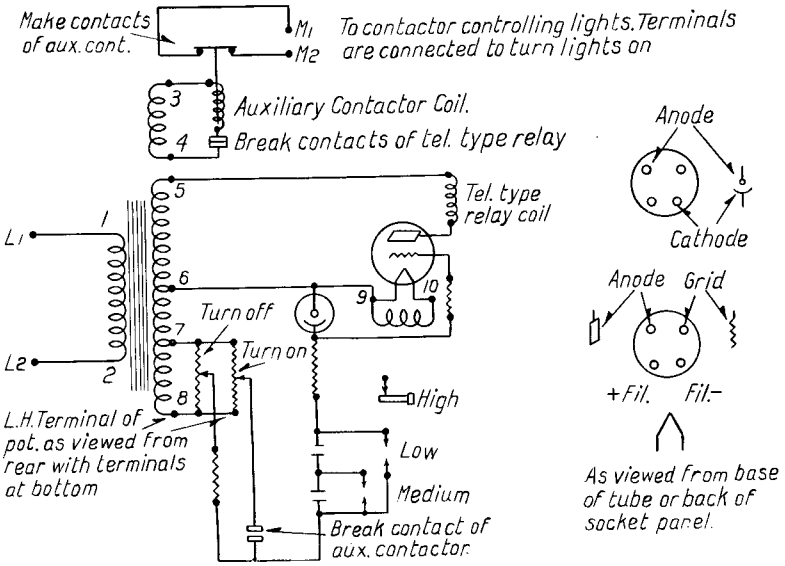


FIG. 6—INTERNAL WIRING DIAGRAM FOR LIGHTING CONTROL RELAY

The lighting control relay should be continuously energized, and a series switching arrangement should be provided to turn the lights off at night, independently of the lighting control relay. For control of signs, the manual control should be in parallel to permit location and replacement of burnt out lamps by day.

For control arrangement shown in Fig. 5, use a 6-ampere, 115-volt, 60-cycle reactor, Style No. 766837 and Type MC Relay, with coil Style No. 476892. Contact arrangement of the Type MC Relay may be selected from those shown in the Westinghouse General Catalog.

Operation

The operation of the photo-electric lighting control relay is best explained by reference to the internal wiring diagram, shown in Fig. 6.

The circuit employed is of the self rectifying type, in which alternating current is fed to the amplifier tube, which naturally has a rectifying characteristic, and passes pulsating D-C.

The current through the photo-electric tube is proportional to the light on the tube within its operating range, and since this tube is also a rectifier it passes pulsating D-C. and must be connected so as to operate on the same half cycle as the amplifier tube.

The current through the photo tube is measured by its voltage drop across the impedance composed of a resistance and two condensers, all in series. This voltage is impressed on the grid of a special design of amplifier tube, so that the amplifier tube current varies proportionally to the light on the photo tube, between those light intensities at which the device is adjusted to turn on and turn off.

A plug switch is provided to short circuit one condenser (M), or both condensers (L), or the plug may be placed in a storage position (H), Fig. 1. This arrangement, in connection with the two potentiometers, furnishes a simple and reliable control having maximum versatility. One of these potentiometers controls the residual bias (i.e., the bias that would exist with the photo tube dark) when the lights are on, and the other potentiometer controls the residual bias when the lights are off. The actual grid bias on the amplifier tube is the sum of this residual bias and the voltage drop across the impedance.

In order to avoid overloading the photo electric tube in sunlight or at high illumination intensities, a resistance is connected between the cathode of the photo tube and the grid of the amplifier tube. Ordinarily the voltage drop across this resistor is negligible, since at those light intensities at which the relay is adjusted to turn the lights on and off, the grid current taken by the amplifier tube is only a small fraction of a microampere. At light intensities that are relatively high, however, the grid current that the amplifier tube will take increases suddenly, and since this grid current would come from the photo tube, the photo tube would be seriously overloaded if some arrangement was not made to limit the photo-electric current.

Adjustment

The best method of adjusting the lighting control relay is by the use of an Adjusting Device, Fig. 7. When using the Adjusting Device to adjust the lighting control relay, the sequence of operation is as follows:

(1) Remove cover plate giving access to adjusting potentiometers.

(2) Set turn-off dial at 100, turn-on dial at 0, and put plug switch in "H" position.

(3) Place adjusting device in position on lighting control relay, and by successively adjusting the rheostat to give the light intensities at which turn-on and turn-off are desired and adjusting turn-on and turn-off dials, find which sensitivity position can best be used. Try the sensitivity positions in the order H, M, and L, and use the first one that is suitable.

(4) The sensitivity position having been selected, and the lights being turned on, set the turn-off dial at 100 once more and the turn-on dial at 0. Then set the rheostat to give the light intensity at which turn-off is desired, and turn the turn-off dial **slowly** until the lights are turned off. Then set the rheostat to give the light intensity at which turn-on is desired and turn the turn-on dial **slowly** until the lights are turned on.

(5) Check turn-on and turn-off adjustments, remove the adjusting device, and replace cover plate.

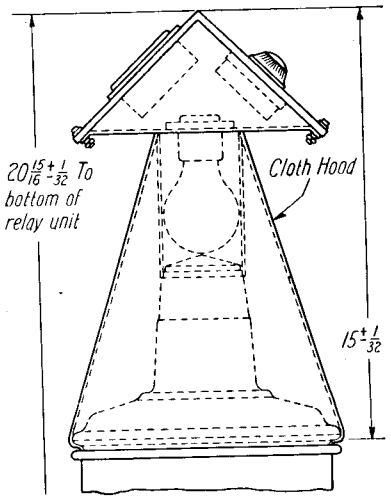


FIG. 7—ADJUSTING DEVICE FOR LIGHTING CONTROL RELAY, FOR 115 VOLTS SERVICE

In order to obtain the most satisfactory results always observe the following precautions:

(1) Always adjust the turn-off first; the turn-on adjustment has no effect on the turn-off, but a change in the turn-off adjustment will have a slight effect on the turn-on.

(2) The lighting unit may be adjusted immediately after installation but should be readjusted after the first two days of operation, In making an initial adjustment always make it on the highest sensitivity range on which it can be secured. The sensitivity is controlled by a plug switch with the positions marked H, M, and L, to designate high, medium, and low, sensitivities. See Fig. 1. This arrangement makes it unnecessary to specify the sensitivity of the photo tube when reordering, and increases the useful life of the photo tube.

(3) In general, the value of the natural illumination corresponding to turn-off should be approximately twice that for turn-on. The reason for this is three fold. In the first place natural light sometimes varies quite rapidly and when it does, the lights will be turned on or off with annoying frequency unless there is a reasonable differential allowed between turn-on and turn-off. Another reason is that a lighting control relay is not a device of absolute accuracy, being subject to small errors on account of variations in line voltage, ambient temperature, amplifier tube aging, etc. These errors usually affect the turn-off and turn-on points of the unit to approximately the same extent and in the same direction. In rare cases they will be in opposite directions and in order to guard against trouble from "hunting" in these cases, a differential on the order of 50% of the turn-on foot candles is necessary. A third reason for the recommended differential is that a variation in the line voltage of the lighting circuit of only 10% will cause an actual change in the artificial illumination of 35%, so that if the differential between turn-off and turn-on is too small, a change in the line voltage may cause hunting, due to this increase of artificial light.

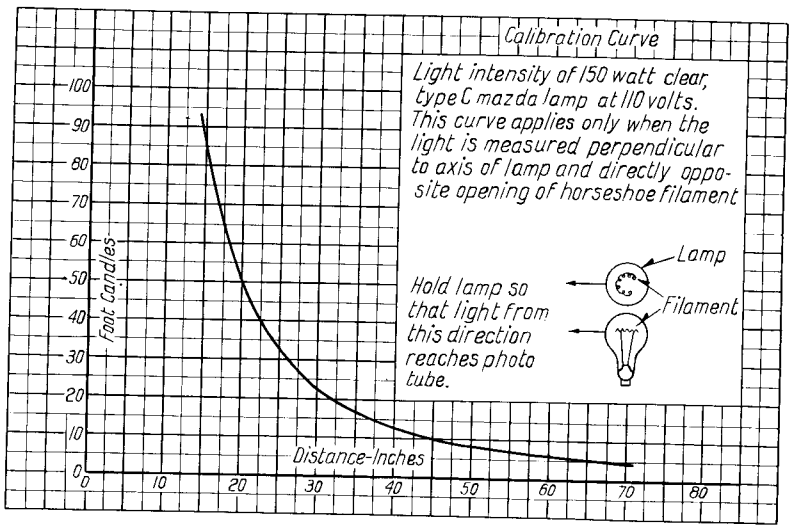


FIG. 8—CALIBRATION CHART FOR ADJUSTING LIGHTING CONTROL RELAY WITH A 150-WATT LAMP

For the reasons stated it is recommended that the differential between turn-off and turn-on shall be equal to the turn-on foot candles plus the artificial lighting foot candles as measured by the unit. As an example assume that the effect of the artificial lights is 15 F.C., both at the unit and at the working level of the room. Then the turn-on should be at 15 F.C., and the turn-off should be at 45 F.C. (30 F.C. natural illumination + 15 F.C. artificial). Experience has shown this adjustment to be practical and economical. In case the artificial lighting intensity as measured by the unit is substantially greater than the natural light intensity corresponding to turn-on, a correspondingly increased differential should be used, or (at least) partial shielding from the artificial lights resorted to. This will only be necessary when the unit is considerably closer to the source of artificial light than is the working level. Suppose that in the example given above the effect of the artificial light on the unit was 30 F.C., then the proper setting would have been 15 F.C. turn-on, and 65 F.C. turn-off (30 F.C. natural + 30 F.C. artificial + 5 F.C. extra margin).

In order to find the effect of the artificial light on the unit the best procedure is to adjust the unit to turn the lights **slowly** on and off in the absence of natural illumination, or at some time when the natural illumination is low. Then by using the adjusting device find the foot candles at which the unit

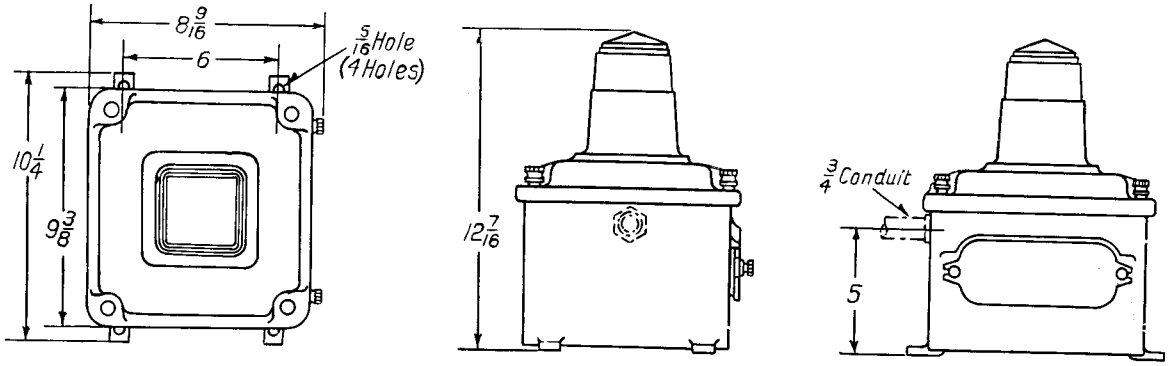


FIG. 9—DIMENSIONS IN INCHES FOR PHOTO-ELECTRIC LIGHTING CONTROL RELAY

will turn the lights on and off, and the difference is the effect of the artificial lights on the unit. This value, once obtained may be recorded.

If the lighting control relay is to be adjusted without using the adjusting device, the best time to adjust it is after dark, when a 150-watt lamp on an extension cord may be used to conveniently simulate the values of natural light at which it is desired to have the unit operate. The distances from the lamp to the unit for various illumination intensities are given in Fig. 8. which is an average curve for the type of lamp specified. The test lamp should be held directly above the unit, and distances measured to the bottom of the glass top, when the unit is mounted in the normal position.

The procedure will be similar to that described for adjusting with the adjusting device, but in this case the adjustable illumination is required to give only the value of natural light at which turn-off is desired when adjusting the turn-off of the lighting control relay, rather than the total of natural plus artificial illumination, since the unit is not shielded from the artificial lights when the adjustment is made in this manner.

Maintenance

The lighting control relay will require little maintenance other than an occasional readjustment and dusting off of the glass cover. Readjustment should be made once a month in order to get the most satisfactory operation and the cover should be dusted off at the same time. The expected life of the amplifier tube is about one year of continuous operation. This is necessarily an average and is based on line voltage variations of less than 10% from the rated voltage on the unit. The expected average life of the photo tube is in excess of one year.

Testing

The lighting control relay is thoroughly tested at the factory. It is impossible to safeguard against all troubles that may develop and particularly since some of these troubles will be a function of the adjustment or of the conditions of operation.

The more common troubles that may occur, with their remedies are as follows:

Relay will not turn lights off

(1) Amplifier tube burned out; replace if filament does not light.

(2) Photo tube insensitive (try readjusting).

Relay will not turn lights on

(1) Unit has in the last previous half hour been exposed to strong direct sunlight. Usually this will only occur in hot weather and at certain adjustments.

(2) Amplifier tube filament shorted to grid; try replacing amplifier.

(3) Photo tube shorted by "getter capsule" breaking from its support. This has not happened in any known cases but it is possible if the photo tube has been handled roughly.

Relay turns lights on and off—"hunting"

(1) Turn-on and turn-off adjustments are too close together. Check adjustment—See also (1) below.

Relay is inaccurate—loses adjustment too soon.

(1) Adjustment is on wrong sensitivity range. Try readjusting on the next higher sensitivity range. Note that in general any adjustment can be secured on at least two sensitivity settings; always use the highest.

(2) Photo tube has become too insensitive for use with this device. Check photo tube sensitivity with adjusting device as follows: On the high sensitivity range adjust the lighting control relay for 20 F. C. turn-off and 12 F C. turn-on. Note dial settings and readjust for 20 F.C. turn-off and 6 F.C. turn-on. The difference between the turn-on dial settings should be greater than 9 divisions. This is approximate only.

(3) Amplifier tube insensitive; replace with an amplifier tube of satisfactory sensitivity.

If the tests listed above do not disclose the source of trouble, the unit should be returned to the factory for inspection and repair, since some of the component parts have been specially treated at the factory and it is not advisable to make field replacements. Field adjustments should not be attempted on the telephone type relay.

RECOMMENDED STOCK OF RENEWAL PARTS

This list of Renewal Parts is given only as a guide. When continuous operation is a primary consideration, additional insurance against shut-downs is desirable. Under such conditions more renewal parts should be carried, the amount depending upon the severity of the service and the time required to secure replacements.

Style Number of Lighting Control Relay Complete					115V. 25Cy 799836	115 V. 50Cy 799838	115 V. 60Cy 753089	230 V. 25Cy 799837	230 V. 50Cy 799839	230V.60Cy 799840
For Relays in use up to and including		1	5	15	Style Number of Part					
Name of Part	No. Per Relay	Recommended For Stock								
Type SR-50 Photo-Electric Tube	1	1	1	2	SR-50	SR-50	SR-50	SR-50	SR-50	SR-50
Type RJ-553 Amplifier Tube	1	1	1	2	RJ-553	RJ-553	RJ-553	RJ-553	RJ-553	RJ-553
Transformer	1	0	0	1	799821	799821	791234	799822	799822	799823
Telephone Type Relay	1	0	1	1	791235	791235	791235	791235	791235	791235
Secondary Relay	1	0	0	1	797841	719435	719434	797841	719435	719434
Front Contact	2	1	1	2	720949	720949	720949	720949	720949	720949
Back Contact	2	1	1	2	476939	476939	476939	476939	476939	476939
Front Stationary Contact	2	1	1	2	476935	476935	476935	476935	476935	476935
Back Stationary Contact	2	1	1	2	680986	680986	680986	680986	680986	680986
Contact Spring	1	0	1	2	717723	717723	717723	717723	717723	717723
Coil	1	0	1	2	476905	476904	476903	476905	476904	476903
Potentiometer	2	0	0	1	791238	791238	791238	791238	791238	791238
Resistor—50,000 Ohms	1	1	1	2	791236	791236	791236	791236	791236	791236
Glass Cover	1	0	0	1	716070	716070	716070	716070	716070	716070
Felt Gasket—Used between Cover and Case	1	0	1	2	791237	791237	791237	791237	791237	791237

Parts indented are included in the part under which they are indented.