#454

DEPARTMENT OF WATER & POWER

MANUAL OF

STREET LIGHT PRACTICE

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1947

Revised 6-1-52

FUNDAMENTALS OF STREET LIGHTING

Purposes of street lighting:

Safety from collision.

Protection from criminals.

Convenience in recognition and in actions.

Advertising and civic value.

An ideal street lighting system is one which permits all normal daylight activities to be carried on at night.

Good street lighting should embody:

ADEQUATE QUANTITY -
Secured by installing proper size of lamp.

UNIFORMITY -
Attained by coordinated spacing and mounting height of lamp unit.

EFFICIENT DIRECTING -
Accomplished by use of suitable reflectors and refractors.

EFFECTIVE VISION (Absence of blinding glare)
Assured by correct mounting height and adequate area of light source.

The two general classifications of street lighting are:

a. Utilitarian (formerly "overhead")

b. Electrolier (formerly "ornamental")

CIRCUITS

Street lights are served through two types of circuits - multiple and series. The multiple circuits are the same as ordinarily used in house lighting and employ a constant voltage, 120 volts, two wire or 120/240 volts, three wire. In the series circuits, the lamps are connected in series and the same current passes through all lamps. The current must be maintained at a constant value and each circuit must be individually regulated by a constant current regulating transformer. The voltage of the circuit at the supply point is equal to the sum of the voltages across each lamp plus the line drop.

Line current is standardized at 6.6 amperes and the smaller size lamps operate on this current directly. Larger lamps are rated at 15 or 20 amperes because greater efficiency and longer life can be obtained with the heavier lamp filaments. To operate such lamps on the 6.6 ampere circuits, the current is stepped up by means of auto-transformers (called compensators) or insulating transformers. An individual transformer is used with each lamp and in making circuit computations the lamp and the transformer together are regarded as a unit.

The majority of the street lights in the city, both electrolier and utilitarian are series lights. In a series circuit since the same regulated current passes through each lamp, the brightness of the lamps throughout the circuit tends to better uniformity than in the case of a multiple circuit where the brightness of the lights diminishes with the distance from the feed point due to line drop.

The accompanying drawing is intended to convey a general idea of utilitarian and electrolier street lighting circuits and to illustrate typical installations of lighting equipment. Utilitarian and electrolier circuits are in some cases served from transformers installed on poles, although not so shown on the drawing.

UTILITARIAN STREET LIGHTING SYSTEM

The utilitarian system is supported on the same poles and crossarms that carry the distribution lines. Where economy and not appearance is the major consideration, this style of lighting is very satisfactory. In the utilitarian system, the Department of Water and Power owns the lines and fixtures, supplies the energy and maintains the equipment.

Utilitarian lights are installed upon order of the Street Lighting Engineer of the Bureau of Street Lighting of the Board of Public Works in accordance with the provisions of the rate ordinance. The Street Lighting Engineer determines the location, the lamp rating and the fixture style. Changes of existing installations are not made without his permission.

Utilitarian street lights are all series connected except a few isolated multiple installations where the cost of extending series circuits would not be economical. The series utilitarian circuits are supplied with energy from constant current regulating transformers installed either in distributing stations or on the distribution lines in the field. Switching at the station is performed manually; in the field by time switches, magnetic switches, carrier controllers, pilot wire controllers or photo-electric controllers.

All utilitarian street light wires are No. 6 solid weatherproof insulated except drops to fixtures which are No. 8 stranded weatherproof. The street light wire is ordinarily carried on the outside pin on the street side of the crossarm, or on a bracket attached to the street end of the crossarm. Near a station where the circuits concentrate, an entire arm may be occupied by street light wires. Between the station and the first pole, street light circuits are carried underground in 4 conductor No. 6 lead covered cable, terminating in 4-conductor potheads, each cable carrying two circuits from one constant current regulating transformer.

The standard rating of a regulating transformer installed in a distributing station is 50 kw. Each transformer serves two interconnected series circuits. The normal capacity of each circuit is half the transformer rating but at times one circuit may be temporarily overloaded and the other underloaded.

On field installations the maximum size of transformer for a utilitarian circuit is 30 kw, each transformer serving a single circuit. The full load operating voltage across the circuit of a 30 kw transformer is about 4500 volts.

UTILITARIAN FIXTURES

The word "fixture" is used in two senses: (1) the supporting fixture consisting of a pipe arm or span wire together with braces, insulators and hardware fittings; (2) the lamp fixture or luminaire consisting of metal or porcelain housing, lamp and lamp holder, reflector, glassware and if required, an auto-transformer.

It has been the policy insofar as possible to standardize utilitarian street lighting equipment to permit interchange of parts, to limit the number of stock items and to secure uniformity of appearance. However, because of competitive purchasing, advances in design and acquisition of former properties of two private utilities, the street lighting system contains equipment of many varieties.

The various standard fixture combinations are shown on the accompanying table, a copy of which is in every book of patrol maps.

SUPPORTING FIXTURES

Standard types of supporting fixtures for utilitarian street lights are shown in detail in the Electrical Standards handbook as follows:

Fixture	Electrical Standards Sheet No.
Suspension	0-801, 0-802
Mastarm	0-803
Upsweep Mastarm	0-804 A, B, C
Upsweep Bracket	0-807 A, B, C
Bracket	0-808
Long Bracket	0-809
Gooseneck	0-806

Sometimes luminaires are temporarily hung on distribution crossarms. This method of attaching is shown on Sheet 0-810 of Electrical Standards.

Supporting fixtures and luminaires near the ocean are subject to rapid deterioration from salt fog and parts must be specially selected or treated to resist the climatic conditions.

LUMINAIRES

Luminaires are of four general types:

1. For 6.6 amp. incandescent lamp
2. For 20 amp. incandescent lamp
3. For sodium lamp (See Page No. 13)
4. For mercury lamp (See Page No. 17)

LUMINAIRES FOR 6.6 AMPERE LAMPS

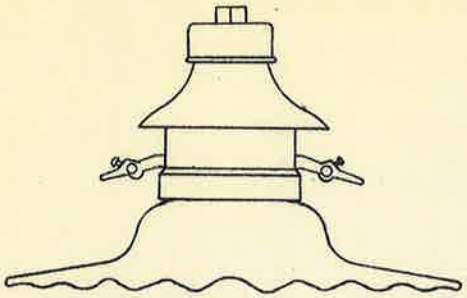
(a) Porcelain Heads: This consists of a high voltage porcelain head attached to the supporting fixture by means of a threaded canopy cemented to the top of the porcelain or by a horizontal clamp around the middle of the head. By means of angle bolts which enter holes in the skirt of the porcelain head and extend below, any of the following hardware parts may be attached to the porcelain head.

Adjuster for open reflector and 1000 or 2500 lumen lamp
" " collar type open reflector
Skirt and refractor holder
Adapter for enclosed reflector

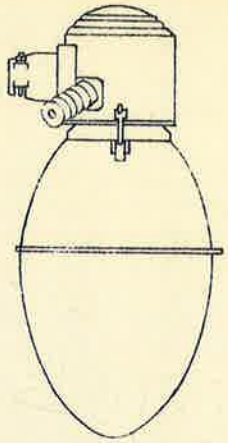
By using the proper hardware part, the luminaire can be assembled with radial wave reflector, enclosed reflector, symmetric refractor or B-way refractor. When attaching the reflector adapter to the top-mounted porcelain head, the adapter must be oriented so that the position of the latches is 90 degrees from the position of the terminal ears to provide electrical clearance. With the side-mounted head, the terminals are on top of the porcelain and the adapter may be set in any position except when deflectors are attached to the reflector, the deflectors must be on the house side of the fixture.

Within the porcelain head is a series receptacle for holding the series socket. The series receptacle is adjustable as to its vertical position. It is very necessary that the lamp center be properly positioned with respect to the particular type of reflector or refractor used and the following table is given to show the proper distance between the face of the series receptacle and the bottom of the porcelain head to obtain the correct lamp center position for the various reflectors and refractors.

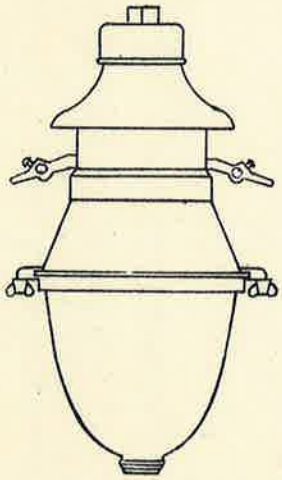
Fitting	Distance - Inches
Adjuster with flange type radial bowl reflector	2-1/2
Adjuster with collar type radial bowl reflector	2-1/4
Skirt and refractor holder with bowl refractor:	
General Electric	2-5/8
Line Material	1-15/16
Reflectolite	1-3/4
Westinghouse	1-13/16
Reflector adapter with shallow enclosed reflector	2-1/4
Reflector adapter with deep enclosed reflector	7/16
Reflector adjuster with copper case enclosed reflector	2-1/4



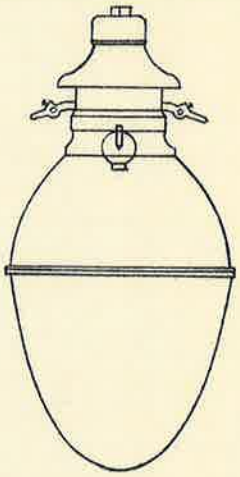
PORCELAIN HEAD
WITH
RADIAL BOWL REFLECTOR



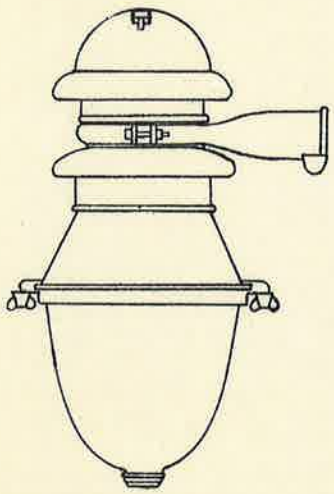
ALUMINUM HEAD
WITH
ENCLOSED REFLECTOR



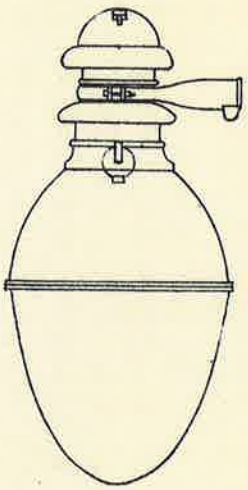
PORCELAIN HEAD
WITH
BOWL REFRACTOR



PORCELAIN HEAD
WITH
ENCLOSED REFLECTOR



PORCELAIN HEAD
WITH
BOWL REFRACTOR



PORCELAIN HEAD
WITH
ENCLOSED REFLECTOR

TYPICAL LUMINAIRES
FOR 6.6 AMP LAMPS

Rev. 6-1-52

Two styles of enclosed reflectors for the 2500, 4000 and 6000 lumen lamps are found in the ststem, deep (new style) and shallow (old style). The lamp center positions are different although both attach to the same porcelain heads and adjusters. To obtain the correct light distribution, each style must be matched with the proper receptacle setting in the head. To prevent interchange, a scheme has been devised, which while not foolproof will be a help to the maintainer. All adjusters on heads for the shallow reflectors are provided with a long screw (3/4 in.) which fastens the safety chain and extends inside the adapter. A notch is cut in the collar of the shallow reflector to match the position of the screw so that a shallow reflector will fit any adjuster with a long screw but a deep reflector without the notch will be blocked. This will not prevent the shallow reflector being fitted on a head adjusted for the deep reflector but the notch will serve as a reminder against it.

A special copper case enclosed reflector is available for installations along the ocean front where corrosion conditions are especially severe. The reflecting surface is silvered glass and the reflector and enclosing globe are all one piece. For proper lamp position this reflector requires the same receptacle setting as the shallow enclosed reflector.

(b) Aluminum Heads: This consists of a universal cast aluminum head attached to the supporting mastarm or bracket by a slip-fitter which is provided with two leveling set screws for properly positioning the luminaire.

The high voltage leads from the spreader arm are brought into the head through two hollow 5000 volt bushings where they are connected to the permanently positioned series receptacle.

Any of the deep enclosed reflectors may be attached directly to any universal head by means of a latch on the reflector which engages lugs on the head. The shallow reflector referred to in (a) above, must not be used with the universal head as incorrect light distribution and glare would result.

LUMINAIRES FOR 20 AMPERE LAMPS

(a) Copper or Aluminum Case: This luminaire consists of a copper or aluminum housing with a cast iron canopy or top and contains a compensator (auto-transformer) to change the 6.6 amp. line current to 20 amps. for the lamp. The compensator secondaries connect directly to a mogul multiple socket to hold the lamp. When the lamp burns out, the secondary circuit opens but the line current continues to flow through the primary winding. Connections for the various compensators in use are shown on Sheet 0-880 of Electrical Standards. Lamps are interchangeable without changing compensator taps in some types of luminaires.

Before making temporary lamp size changes in these luminaires, further information must be obtained from the Street Light Superintendent's office.

(b) Aluminum Head: This luminaire when used with the 10,000-L. lamp is identical with the aluminum head for 6.6 amp. lamps except that a fiber washer is used in place of the film disc cut-out in the series socket and the luminaire is connected to the line through an external compensator mounted on the fixture pipe as shown on Standard Drawing Nos. 804A and 807A.

When used with a 15,000-L. lamp, a fiber washer and an external compensator is used as above. However, in place of the enclosed reflector, a cast aluminum housing with internal reflector assembly must be used because of the greater heat of the 15,000-L. lamp. This attaches to the head in the same manner as the enclosed reflector.

(c) Black Case: This luminaire is equipped with either a bowl refractor, a dome refractor within a rippled bowl globe when operating a 6000-L. lamp, or with an enclosed reflector when operating with a 6000-L. or 10,000-L. lamp.

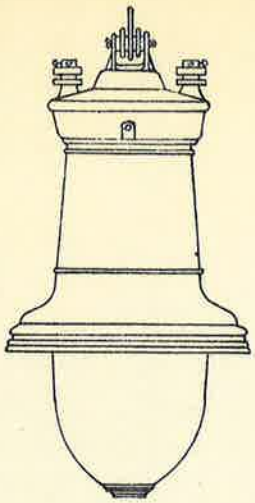
(d) Sodium Pendant Case: This luminaire, consisting of a sodium pendant case and a rippled globe, has a 15,000-L. compensator enclosed in the case and employs a mogul multiple socket. It is used for 15,000-L. incandescent lamps as well as for sodium and mercury lamps as described elsewhere.

DEFLECTORS:

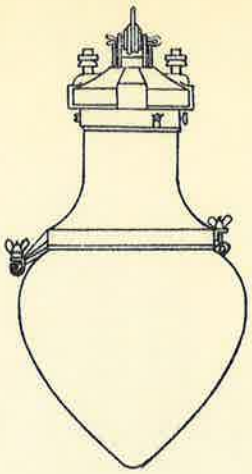
Any of the luminaires with enclosed reflectors may be equipped with deflectors to throw more light out on and along the street. They are also used to shade the light on the house side. Deflector luminaires are used only in specified locations and replacements must be made with identical equipment. Ordinarily the maintainer will notice the deflectors in the luminaire when he removes it but a further indication is given by the letter "D" following the lamp number, for example: 1-1-101D. Deflector luminaires are not installed on suspension fixtures. The reflectors must be mounted so that the deflectors are on the house side of the luminaire.

IDENTIFICATION:

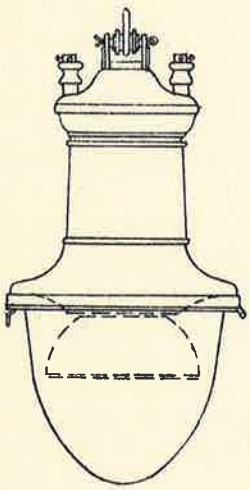
Formerly the size and kind of lamp to be replaced could be recognized from the shape of the luminaire. Since the same luminaires are now used for several lamp ratings, a scheme employing colored reflecting targets, mounted on the supporting fixtures, and a painting code, has been extablished for indicating the lamp rating. These identifications are shown on the table, "Utilitarian Standards", a copy of which is in each book of patrol maps. The targets brilliantly reflect their colors when lighted from the beam of a spotlight directly below.



BLACK CASE
WITH
BOWL REFRACTOR

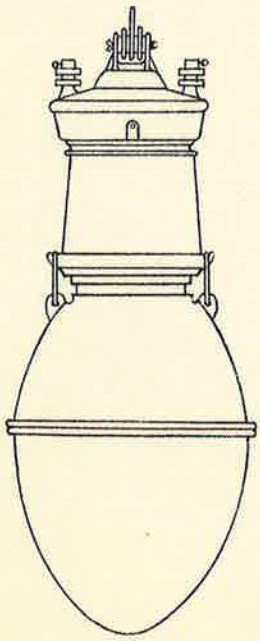


SODIUM PENDANT
CASE WITH LIGHT
ALABASTER GLOBE

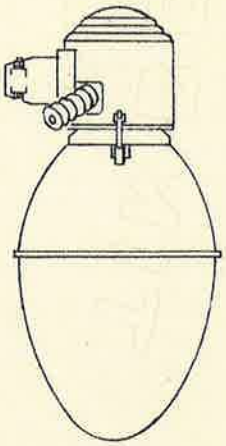


BLACK CASE WITH
DOME REFRACTOR
& RIPPLED BOWL GLOBE

COPPER OR ALUMINUM CASE
WITH ENCLOSED REFLECTOR
& RIPPLED GLOBE



BLACK CASE WITH
ENCLOSED REFLECTOR
& RIPPLED GLOBE



ALUMINUM HEAD WITH
ENCLOSED REFLECTOR
(COMPENSATOR ON FIXTURE PIPE)

TYPICAL LUMINAIRES
FOR 20 AMP LAMPS

UTILITARIAN STANDARDS

LAMP RATING LUMEN	AMP.	SUPPORTING FIXTURE	LUMINAIRE TYPE	GLASSWARE	IDENTIFICATION
1000	6.6	Gooseneck	Porcelain head	Open reflector-No glass	None-See Patrol map
2500	6.6	Gooseneck	Porcelain head	Open reflector-No glass	Green target
		Short Bracket Long Bracket Upsweep Bracket	Porcelain head	Symmetric bowl refractor or Enclosed reflector with rippled globe	Green target
		Upsweep Bracket	Aluminum head	Enclosed reflector with rippled globe	Green target
4000	6.6	Short Bracket Long Bracket Upsweep Bracket Mastarm Upsweep Mastarm Suspension	Porcelain head	Symmetric bowl refractor or Enclosed reflector with rippled globe	Red target
		Upsweep Bracket Upsweep Mastarm Suspension	Aluminum head	Enclosed reflector with rippled globe	Red target
6000	6.6	Short Bracket Long Bracket Mastarm Suspension	Porcelain head	Enclosed reflector with rippled globe	White target
		Upsweep Bracket Upsweep Mastarm Suspension	Aluminum head	Enclosed reflector with rippled globe	White target

NOTE: Where "B" type bowl refractor instead of enclosed reflector, or where deflector with enclosed reflector is used, B or D respectively is included on light number tag.

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UTILITARIAN STANDARDS

LAMP RATING LUMEN	AMP.	SUPPORTING FIXTURE	LUMINAIRE TYPE	GLASSWARE	IDENTIFICATION
6000	20	Upsweep Bracket Mastarm Upsweep Mastarm Suspension	Black case	Symmetric bowl refractor or Symmetric dome refractor with rippled globe or Enclosed reflector with rippled globe	Black case and double-white target
10000	20	Upsweep Bracket Upsweep Mastarm Suspension	Aluminum head	Enclosed reflector with rippled globe	Blue target
		Upsweep Bracket Mastarm Upsweep Mastarm Suspension	Copper or aluminum case	Internal reflector with rippled globe	Aluminum mid-section
15000	20	Upsweep Bracket Upsweep Mastarm Suspension	Aluminum head and cast reflector housing	Internal reflector with rippled globe	Amber target
		Upsweep Bracket Upsweet Mastarm Mastarm Suspension	Copper or aluminum case	Internal reflector with rippled globe	Amber target
		Mastarm Suspension	Sodium pendant case	Rippled acorn globe	Amber target
Mercury	-	Mastarm Suspension	Sodium pendant case	Rippled acorn globe	Green case
Sodium	-	Mastarm Suspension	Sodium pendant case	Rippled acorn globe	Aluminum case

Note: Where "B" type bowl refractor instead of enclosed reflector, or where deflector with enclosed reflector is used, B or D respectively is included on light number tag.

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ELECTROLIER STREET LIGHTING SYSTEM

The term "electrolier street lighting" is used to include the lighting of streets, parks, bridges, tunnels both vehicular and pedestrian where the lights are supported by some means other than by poles of the distribution system.

The service includes the furnishing of energy and maintenance but not the installation of posts or cable. Energy is furnished at 120 or 120/240 volts for multiple circuits or at 6.6 amperes constant current for series circuits. Service points for energy supply are selected by mutual agreement between the engineers of the Bureau of Street Lighting and the engineers of the Department of Water and Power. Serving of several circuits at one point is advantageous economically both as to installation and maintenance.

Maintenance includes:

Periodic inspection
Renewal of lamps
Cleaning of glassware
Replacement of damaged glassware and lamps
Maintenance of control and transformers
Cleaning and painting of posts
Minor repairs to wiring and electrical appurtenances under normal conditions

The electrolier lighting installation is designed essentially to meet the traffic conditions of the street. The designer determines the height, spacing and arrangement of the posts, the kind and rating of the lamp, the type of luminaire, the light distribution pattern, the kind of glassware and the position of the light relative to the street.

Thus a large number of designs of electrolier installations exist in Los Angeles because residential streets, business streets, main traffic arteries, boulevards, highways and other types of streets each have different lighting requirements. Furthermore existing electrolier installations date back to as early as 1912 and as improvements have been adopted from time to time, many varieties of posts and equipment are now served by the Department. Recently at some important intersections, the original post installations have been removed and replaced with higher posts and larger lamps. With such a complex electrolier system, there is no definite rule by which lamp ratings can be determined in the field. The information is transmitted to the district superintendent's offices on loose leaf sheets which give all necessary maintenance information for each electrolier lighting district or installation in the area. In the Los Angeles Area the lamp information is

transferred to "route books" which the maintainers use in patrolling the circuits. In outlying districts an "electrolier lamp renewal guide" is furnished with each patrol map book so arranged that the size and kind of lamp can be determined for any post in the district.

Electrolier street lighting conductors between posts are installed underground in steel conduits. The standard conductor for all series circuits is No. 8 solid copper wire, varnished cambric insulated and lead sheathed. The number and size of lamps determines the voltage on the circuit and the voltage determines the thickness of insulation required. Conductors within the post are rubber or synthetic insulated wire except that in the residential posts, the lead covered cable of the line extends to the top of the post.

In the old multiple systems, many of which still exist, the wiring consists of ordinary rubber covered wire pulled into steel conduit.

Posts (or standards) are of three general types: cast iron, sheet metal, concrete. Cast iron is the material which has been used for street lighting posts over a longer period than any other material. It has passed through the days of the kerosene lamp, the gas light and is still used for electric lighting of streets. On nearly all the old multiple systems existing today, posts are of cast iron. Some of the larger posts are also of cast iron - Wilshire Boulevard, for example. Cast iron posts, being brittle may shatter readily when struck by motor vehicles. To prevent the post falling and the heavy top striking someone, it is usual to set a heavy iron pipe inside the post.

In the sheet metal post, the shaft only is of sheet metal, the base and top being of cast iron held together with steel rods. The sheet metal is fluted by pressing and is then rolled in one, two or three ply into the shaft shape. The plies are pressed firmly together and lock-seamed for strength. In recent years the steel rods are omitted and a heavy iron pipe, concreted into the foundation and extending the height of the column, is required in all sheet metal posts. In the earlier posts of this type, failure in collision occurred from the shaft kinking in its middle allowing the heavy top to crash to the ground or into the top of a parked automobile if underneath.

A later type of post such as around the Union Terminal is composed of a heavy cold rolled steel shaft with cast steel base and cast iron brackets. Where this type of post is also used as a trolley support, it is reinforced with an inside heavy iron pipe.

Concrete posts are made by spinning or jiggling concrete mixture in forms. The spinning process leaves a

hole through the center and produces a smooth, well formed exterior. The concrete mix contains granite chips which show on the surface producing a pleasing color and texture. The concrete post shatters upon severe impact requiring replacement but usually remains standing until it can be removed.

Throughout the city are a number of posts with lights for traffic safety purposes installed by the Street Traffic Engineering Division. Care must be taken not to work on such posts. In case of doubt as to which posts are maintained by the Department, the electrolier patrol maps should be consulted.

LAMPS

The street lighting system employs 120 volt multiple incandescent lamps, 6.6, 15 and 20 amp. series incandescent lamps, 10,000 lumen sodium vapor lamps and 400 watt mercury vapor lamps. The sodium and mercury lamps are described in other sections. The 15 and 20 amp. lamps have shorter and heavier filaments than 6.6 amp. lamps and consequently are more rugged and have a longer life.

Multiple incandescent lamps are similar to the ordinary lamps used indoor except that instead of 100 watt and 200 watt lamps, 106 and 211 watt lamps are used as these have a longer life (1500 hours rated) with the same lumen output. Lamps rated 211 watts and lower have medium bases; those 300 watts and higher, mogul bases.

Series lamps are preferred to multiple because they are slightly more efficient, have about double the life of multiple, tend to stay brighter longer and maintain a more uniform brightness when grouped on the same circuit. Series lamps operate on constant current which must be closely regulated. The 6.6 amp. lamps are connected directly into the series circuit. The larger lamps rated at 15 or 20 amp. require compensators (auto-transformers) or series insulating transformers between the circuit and the lamps to step up the current. The 15 and 20 amp. lamps have thicker and more rugged filaments and somewhat longer life than the 6.6 amp. lamps

Series lamps formerly were rated in candle power but now are rated in lumens. The lumen rating is ten times the candle power rating. The definition of a lumen is "the amount of light flux intercepted by a surface of area one square foot and at a uniform distance of one foot from a light source of one candle power radiating uniformly in all directions."

Both series and multiple lamps blacken as they age in service due to evaporation of the filaments. As the filament evaporates, its cross-sectional area decreases and consequently the resistance increases. In a lamp on a series circuit, because the current is maintained constant, the increase in resistance causes the wattage of the lamp to increase. The increase in resistance in a series lamp also increases the filament temperature and tends to increase the light output of the lamp but the blackening of the globe absorbs more light than the filament adds. In the case of the multiple lamp as the filament resistance increases with age, both the wattage and the light output decrease. Thus the light output with age is better with series lamps than with multiple.

Multiple lamps used on street lighting circuits may be used in any position. All series lamps rated 6.6 amperes may be used in any position. Those rated 15 and 20 amperes are designed either for base up or for base down and must be used only in the position for which designed. The burning position can be readily determined by noting the stenciling on the globe whether BU or BD, or by observing the filament at the point of attachment to the lead-in wires as it always leads off in a downward direction.

Multiple lamps are quite susceptible to damage from vibration such as might occur on a pole to which a trolley wire is attached. Series lamps, while somewhat affected by vibration, are more rugged due to the heavier filament.

SODIUM LIGHTS

Sodium vapor lights are generally used for highway lighting and as traffic hazard indicators. The characteristic intense yellow light, while admirable for such applications, is not generally acceptable elsewhere because of the distorted color appearance of the illuminated objects. The lights possess the further advantages of high efficiency and little glare. On the other hand, they take appreciable time to come to full brilliancy and require auxiliary equipment for their operation.

The lamp consists of a tubular bulb with electrodes at each end. Each electrode consists of a coil filament and a ring. The filaments at starting act as heaters and thereafter as the arc cathodes. The rings are the anodes. The bulb contains neon gas at low pressure and a quantity of pure sodium. The lamp must be operated in a flask or double cylinder of glass in which the space between the two cylinders is evacuated. The flask insulates the lamp so that it retains its heat and vaporizes the sodium which is normally a solid. When first started the lamp glows red, due to the neon. As heat is stored, the color gradually becomes yellow, the characteristic color of sodium, which takes about 30 minutes to reach full output.

The following forms of sodium luminaires are used in the Department of Water and Power system:

Multiple pendant, internally connected
Multiple pendant, externally connected
Series pendant, externally connected.

The difference between the series and the multiple luminaires is in the equipment and the connections, although the same lamp is used in both.

The series luminaire, because the high voltage circuit enters directly into the case, is provided with an insulator to insulate the luminaire from the supporting fixture. A film cut-out permits the series circuit to be closed when the lamp is out of service but does not insulate the luminaire from the line. In maintaining, the luminaire must always be regarded as of the same potential as the line.

Each series luminaire contains the following equipment: Receptacle and film cut-out, radio frequency choke and capacitor, thermal time delay relay, lamp socket, lamp and enclosing flask. The multiple luminaire contains the same equipment except that the receptacle and film cut-out are omitted and an external transformer must be used.

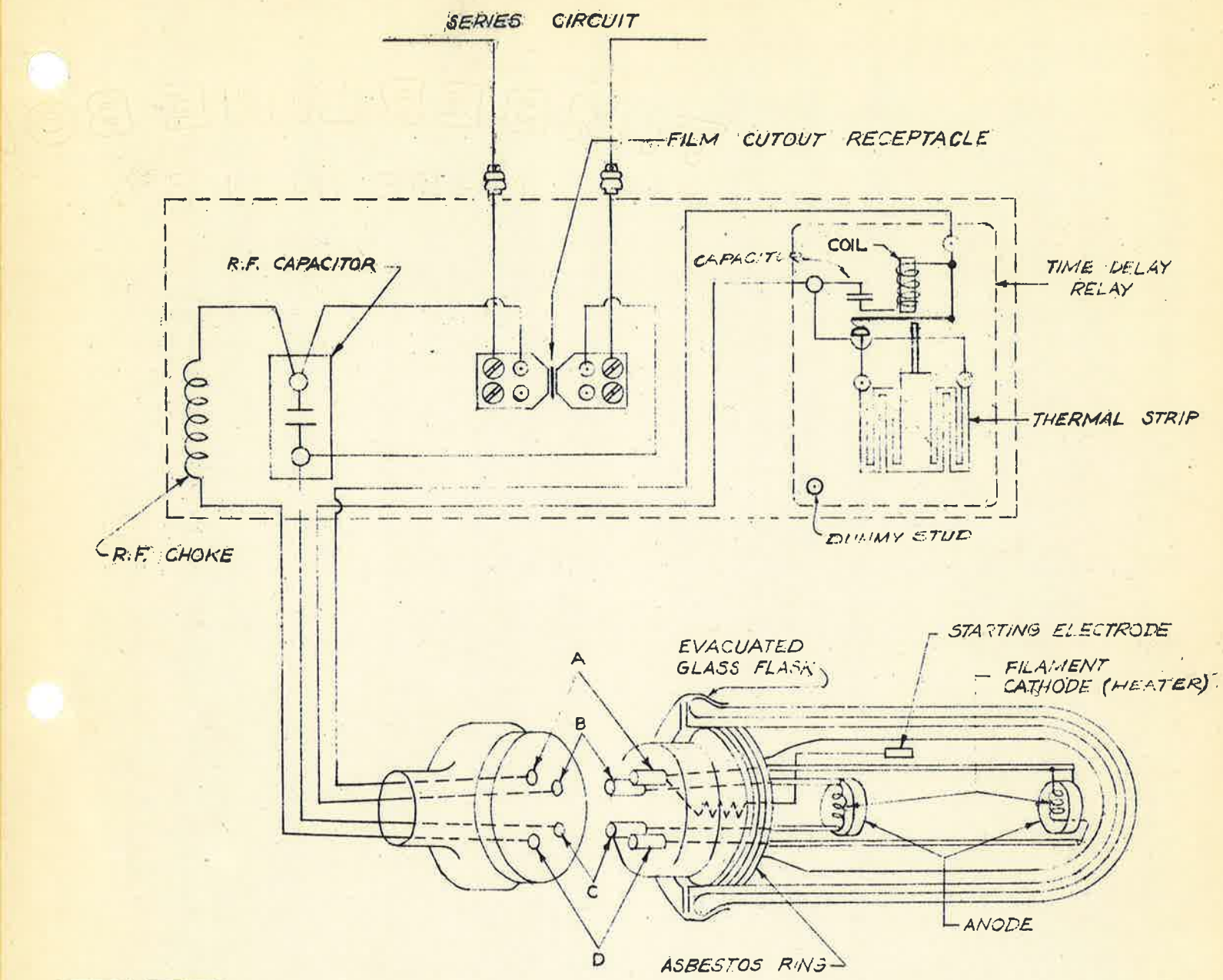
SODIUM LAMP OPERATION

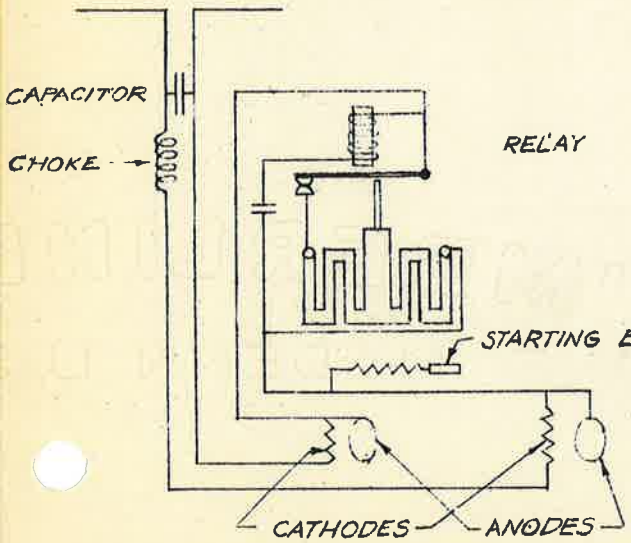
The accompanying diagrams of series and multiple sodium luminaires show the circuit arrangements. The operation is briefly described as follows:

Assume the circuit unenergized. The relay contacts are closed, the two heater coils in the lamp are in series, the arc circuit is short-circuited and the relay coil is short-circuited. At first when the circuit is energized, the cathode preheating current flows through the bi-metallic heater thermal strip which, expanding with the heat, after an interval of from 25 to 40 seconds, pushes open the relay contact. Opening the relay contacts opens the short circuit across the arc and the arc strikes. The voltage across the arc now energizes the relay coil and the relay picks up, holding the contacts in the open position as long as the power supply continues. The bi-metallic strip cools and is in readiness for another starting operation should the power supply be interrupted and immediately restored.

The electric characteristic of the sodium luminaires are as follows:

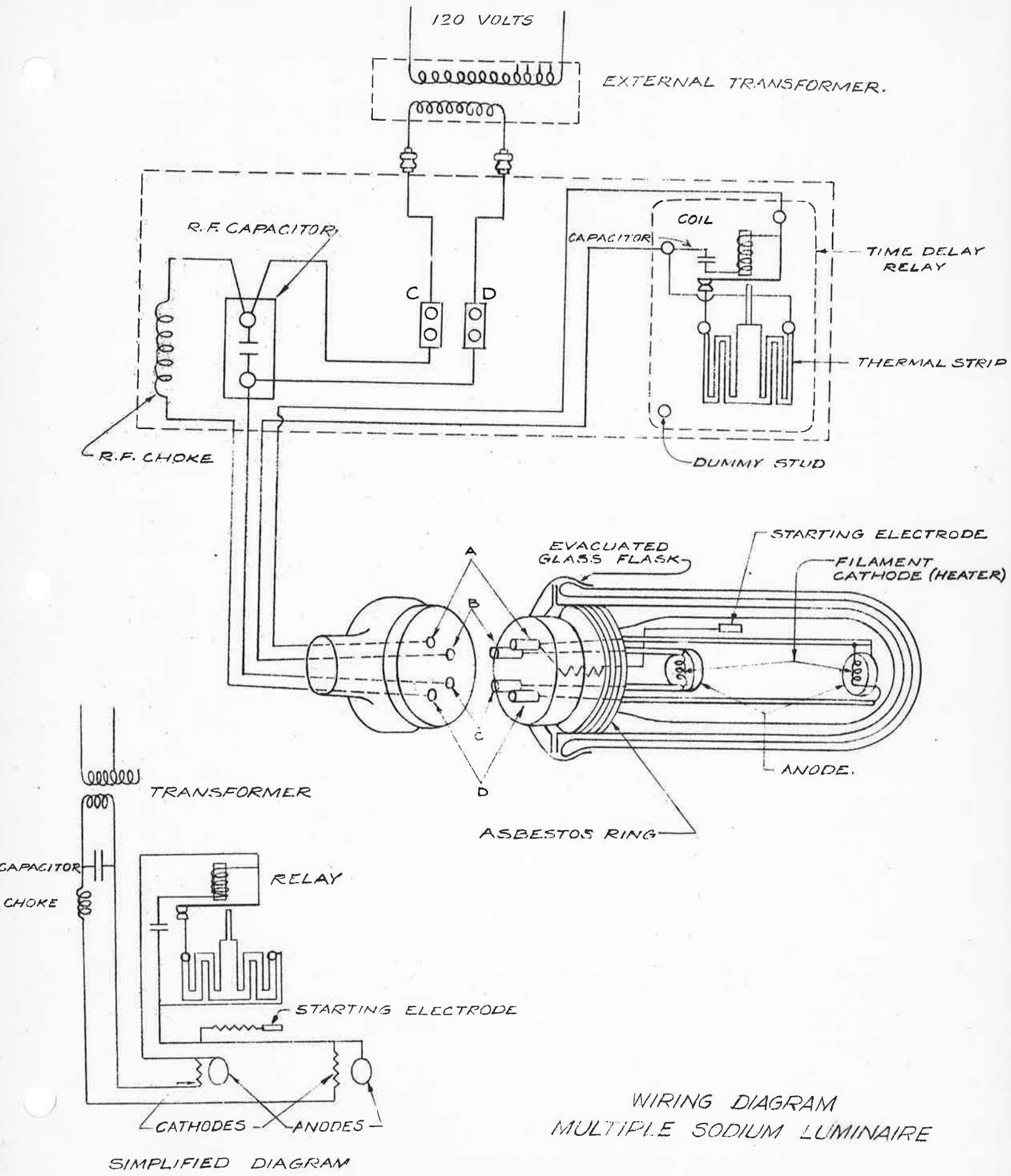
	Lamp Alone	Series	Multiple (Including Transformer)
Watts	180	195	255
Amps	6.6	6.6	5.1
Volts	28	31.4	120





SIMPLIFIED DIAGRAM

WIRING DIAGRAM
SERIES SODIUM LUMINAIRE



WIRING DIAGRAM
MULTIPLE SODIUM LUMINAIRE

SODIUM LAMP FAILURES

The common cause of sodium lamp failures is "deactivated cathodes." Cathodes are coated with a material which emits electrons when heated. Each time the lamp is started, some of this material is knocked off and during operation a certain amount is dissipated. When so much has been knocked off as to prevent starting, the lamp has reached the end of its life. Under normal conditions if the lamp is not switched too frequently, the lamp life should average about 4000 hours.

To obtain best operation the lamp current must be closely regulated. Low current causes low cathode (heater) temperatures with consequent short life and unsatisfactory starting.

Relays must be carefully timed to operated in not less than 25 seconds. If the timing is too short, the cut-out may break down or the lamp may start with considerable sputtering. Short timing causes short lamp life.

Whenever the lamp is renewed or a case of trouble investigated, the timing of the relay should be checked. This can be done in the case of the multiple lights by noting the time between the closing of the switch and the striking of the arc, and for the series lights by noting the time between plugging in the film cut-out and the striking of the arc. If the time is less than 25 seconds, the case should be immediately reported to Street Light Foreman's Office as the life of the lamp, which is expensive, may be materially shortened.

Flasks are very fragile and must be very carefully handled. Care must be taken not to push the lamp end into the bottom of the flask.

In case of a sodium lamp outage in the field, the ordinary procedure to restore service is to:

1. Replace the lamp. If the lamp does not light then:
2. Replace the cut-out film (series) or fuse (multiple). If still out then:
3. Replace the luminaire

Lamps and auxiliaries are more conveniently tested in the shop than in the field. Where a multiple installation is involved or if the switch is conveniently close, some troubles can be corrected in the field. The following notes cover the usual troubles.

Lamp out

If cathode heaters glow, relay has failed to operate and must be replaced.

If no glow visible, film cut-out has probably broken down (if series), or fuse may have blown (if multiple) and must be replaced in either case.

Lamp burns red

Current may be too low and lamp does not warm up.

Lamp may be old, indicated by heavy dark deposit on glass at either or both ends of lamp.

Vacuum flask may be defective and fails to maintain heat of the lamp.

MERCURY LIGHTS

Mercury lights are becoming increasingly popular because they are efficient and brilliant, have a high light output, and a color which is not objectionable for outdoor lighting. They are used in the utilitarian system at heavy traffic intersections because the distinctive color is a warning and the abundant light improves the visibility; and in the electrolier system on principal streets because of the brilliance and abundance of the light.

Three types of mercury lamps (A-H1 and B-H1 rated at 15,000 lumens, and E-H1 rated at 20,000 lumens) are in local use. The type E-H1 lamp may be burned in any position and field experience indicates a life in excess of 7,000 burning hours when used on the all-night schedule. Although requiring the same power for starting and operation as the A-H1 and B-H1, the E-H1 lamp generates one-third more light. Future lamp replacements will be made entirely with the type E-H1 lamp.

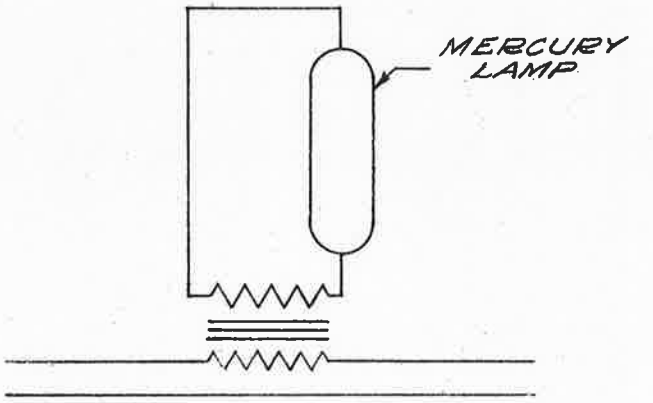
The mercury vapor lamp consists of a tubular bulb within an enclosing jacket which protects the bulb against drafts and the hazards of handling. The bulb contains a carefully measured quantity of mercury and a small amount of argon gas, the latter for starting the arc which is then maintained by the flow of current through the mercury vapor between tungsten electrodes.

The lamp requires from 7 to 10 minutes after energizing to come to full brilliancy. If the power supply is interrupted or the voltage dips excessively, the lamp is extinguished and must cool before it will re-start, which it does automatically in from 5 to 10 minutes.

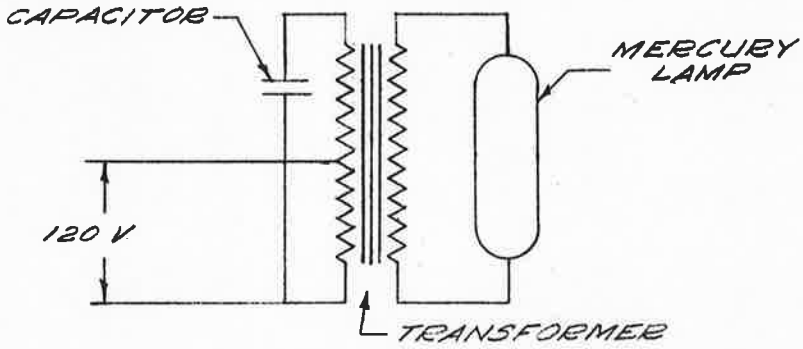
A transformer of high reactance is used between the line and the lamp not only to transform the current or voltage to proper values for the lamp but also to act as a ballast to stabilize the arc and prevent destruction of the lamp from too high current. The transformer for the utilitarian luminaire is usually mounted on a crossarm on the supporting pole; for the electrolier luminaire, in the base of the post. The same transformer is used on any of the H1 series of mercury lamps.

The rating of the H1 series of mercury lamps is 400 watts. During normal operation this lamp takes 3.2 amperes at 135 volts. During the starting period, the voltage is initially between 185 and 200 but immediately drops to 20 and then gradually increases to 135.

On the line side of the transformer, a multiple luminaire including the transformer takes 455 watts and 5.9 amperes at 115 volts; and a series, 450 watts at about 98 volts. Because of the low power factor, greater constant current transformer capacity per lamp must be provided than for incandescent lamp loads of equal wattage.

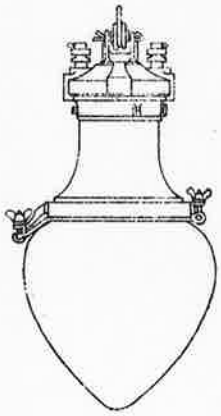


SERIES MERCURY LUMINAIRE

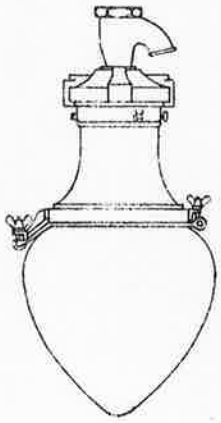


MULTIPLE MERCURY LUMINAIRE

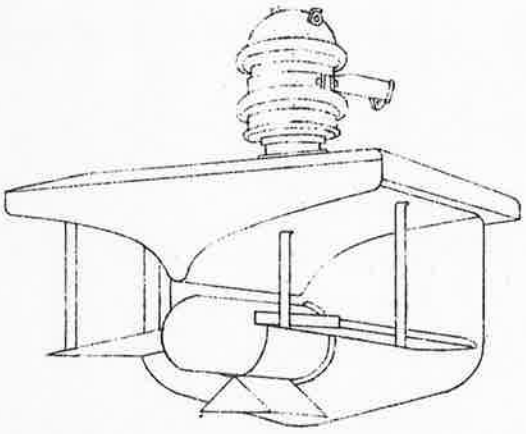
WIRING DIAGRAM
MERCURY LUMINAIRES



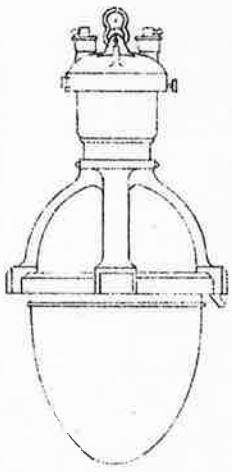
G.E.
SODIUM AND MERCURY
MULTIPLE AND SERIES



G.E. MULTIPLE SODIUM
OLD STYLE



G.E. SODIUM
REFLECTOR TYPE
(OBSOLETE)



WESTINGHOUSE
SODIUM AND MERCURY
MULTIPLE AND SERIES

SERIES LAMP DATA

The following data is from the lamp manufacturers' publications (July 1946).

Amperes	Rated Initial Lumens	Average Volts	Average Watts	Bulb Diameter -inches	Max. Overall Length -inches	Position of Burning	Lamp Center
6.6	800	7.9	52.3	3-1/16	7-1/8	Any	5-3/8
6.6	1000	9.4	61.5	3-1/16	7-1/8	Any	5-3/8
6.6	2500	21.7	143.0	3-3/8	9-3/8	Any	7
6.6	4000	31.9	210.0	3-3/8	9-3/8	Any	7
15	4000	13.5	205.0	3-3/8	9-3/8	(Base up (Base down	7 6-1/4
6.6	6000	46.9	310.0	5	9-3/4	Any	7
20	6000	14.7	295.0	5	9-3/4	(Base up (Base down	7 6-1/4
20	10000	24.3	485.0	5	9-3/4	(Base up (Base down	7 6-1/4
20	15000	35.7	715	5	9-3/4	(Base up (Base down	7 6-1/4

CHARACTERISTICS OF LAMP TRANSFORMERS

As used with the above 15 and 20 amp. lamps

Type	Efficiency	Power Factor
Auto Transformers (Compensators)	94	99.5
Insulating Transformer (Type IL)	93	98.5

GLASSWARE

Glassware used for street lighting consists of various forms of refractors, globes and panels.

In the utilitarian system, glassware in the form of refractors or globes is used on all luminaires except those with the smallest lamps. The types of refractors are symmetric bowl, B-way bowl or symmetric dome, the latter requiring an enclosing rippled globe. Globes are light alabaster rippled.

In the electrolier system are many varieties of glassware differing in form, shape, size, texture, color and density, each designed to conform with the height and shape of post, the size of lamp, character of street and the taste of the designer. Electroliers are equipped with either globes or lanterns. Lanterns are far more economical from the maintenance standpoint than globes because the replacement of a single broken panel is much less costly than the replacement of an entire globe. Globes are obtainable in single piece and two piece, the top part of the latter being known as the canopy. Lantern panels are either flat or globular, the latter costing several times the former. Lanterns and some globes with 4000 lumen lamps or larger are equipped with dome refractors.

Globes are manufactured by blowing or pressing molten glass into molds. Globular panels are cut from blown globes. Flat panels are cut from large sheets made by pouring the molten glass on a flat surface and then rolling with a roller to produce either a plain or a configured surface.

Texture refers to the treatment of the surface. Patterns of regular or irregular design are molded on the surface for the purpose of breaking up the light rays and reducing glare. Common forms of texture are rippled, granite, ribbed and maze.

The density of glass is produced by introducing into the glass mixture some finely ground opaque material. The density cannot be accurately controlled and it is customary to divide the glass after manufacture into light, medium or dense grades.

In each District Superintendent's office and each District Storekeeper's office is maintained a looseleaf binder containing:

(a) Prints which describe each piece of glassware used in the street lighting system.

(b) Prints showing dimensions of each panel and its code number.

(c) A list of panels arranged numerically according to code numbers.

Glassware breakage ordinarily occurs from three general causes, (a) malicious shooting or rock throwing, (b) accidents such as collisions or ball playing, (c) carelessness in handling during cleaning or installing. Unusual breakage occurs from windstorms, earthquakes and fires. Glassware on posts carrying trolley span wires usually breaks when the trolley pole slips off of the trolley wire and hits the span wire.

All ball globes and single piece globes used by the Department are required to have the edges covered with metal fitter rings either spun on or soldered on. Such rings prevent damage to the edge which might start a crack in the glass and also provide a cushion to take the thrust of the screws instead of allowing them to bind on the glass. Where globes without fitter rings are installed, some form of patented device designed to accomplish the same purpose, is placed in the fitter before the globe is mounted. Some makes of globes are furnished with a "seared edge" which forms a smooth surface over the edge and protects against the starting of cracks.

When replacing broken glassware, it is often desirable for reasons of economy or standardization, to install a similar design of another make. In such cases it is the rule to change all the glassware in one block to the same make for the sake of uniform appearance.

Some glassware units are designed to be ornamented with hardware as bands, side rods and pinnacles.

REFRACTORS

Refractors are used on street lights to re-direct the light rays of the bare lamp toward the most useful direction. Light that would shine upward is bent down to the street. Light that would be undesirable on houses or lawns is turned back to illuminate the street.

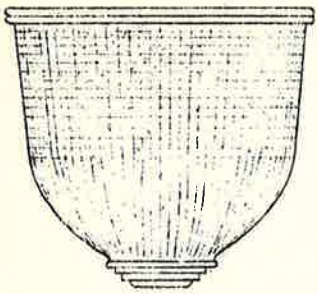
Refractors are of three forms: bowl, dome and upright. The three forms are illustrated on the accompanying sketch. Refractors of two types of light distribution are employed by the Department of Water and Power

(a) Symmetric
(b) B-way asymmetric

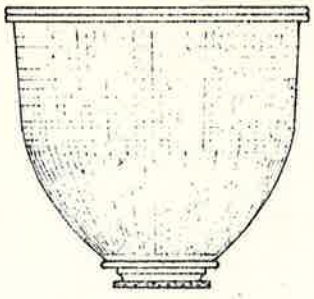
The term "B-way" is used as a general term in the Department's work to designate the type of refractors variously called by the different manufacturers "B-way", "B-sym-etric" and "Bi-lux". The patterns of light distribution are illustrated on the accompanying sketch. It will be noted that the pattern of the symmetric refractor is circular or equal in all directions in any horizontal plane while the B-way refractor throws its maximum beam along the length of the street.

The words "house side" and "street side" are molded on opposite faces of the B-way refractors to indicate the proper position of the refractor with reference to the direction of the street. Two clear circular spots diametrically opposite permit the vertical position of the refractor to be properly set with reference to lamp center. The spots are marked "70", "75" and "80", indicating the angle of maximum beam from the vertical axis of the refractor. All refractors on the utilitarian system should be set for 75 degrees. Luminaires equipped with refractors must be mounted plumb.

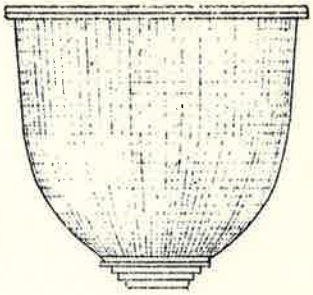
Recent lighting design has required the use of varying patterns of light and refractors are now commonly described by the I.E.S. Type (I, II, III, IV, or V) which they create. Type I is the narrowest and Type V is circular (Symmetric). Type II is now frequently used on the Freeway entrance and exit ramps and Type III(B-way asymmetric) is frequently used along the Freeways. Type IV lighting distribution is accomplished by the use of a deflector with the reflector, and no refractor is employed.



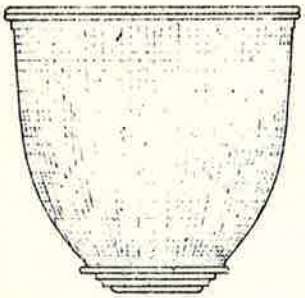
4138 S.F.
G.E.



4238
G.E.
(OLD)



4338
L.M.



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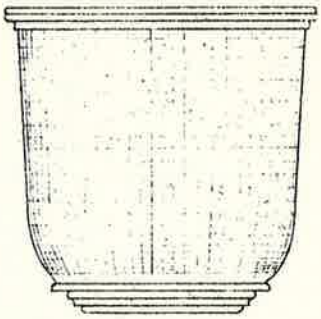
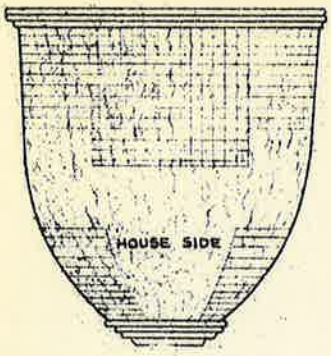


4336 V.F.

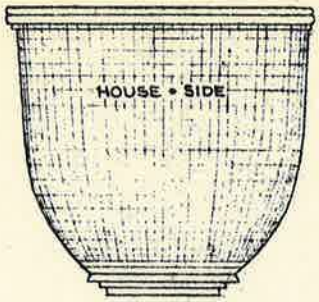
WESTINGHOUSE

SYMMETRIC BOWL REFRACTORS



4173

G.E B-SYM-ETRIC
RIPPLED



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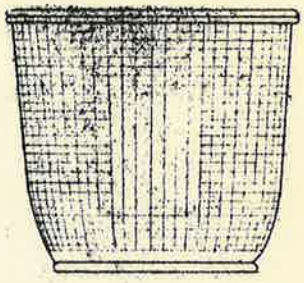
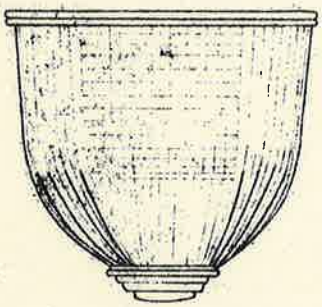
BI-LUX



4473

BI-LUX

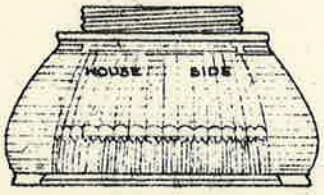
WESTINGHOUSE



4377

L.M. B-WAY

ASYMMETRIC BOWL REFRACTORS



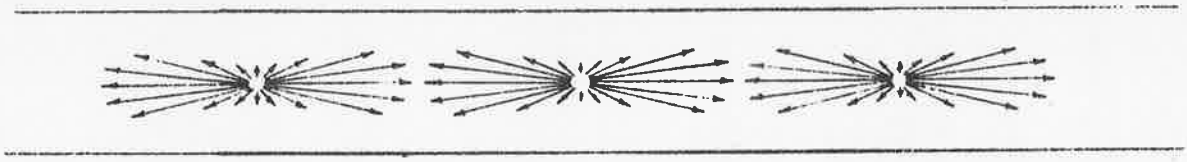
4634

G.E. B-SYM-ETRIC

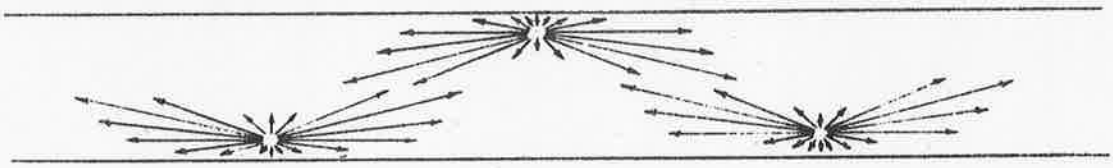
4632

G.E. SYMMETRIC

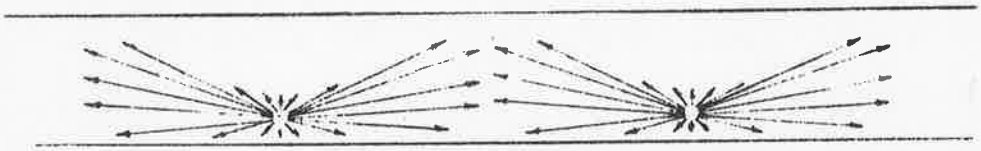
DOMF REFRACTORS



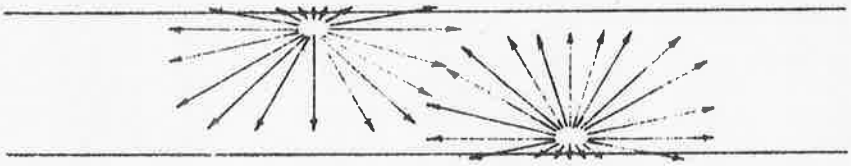
TYPE I



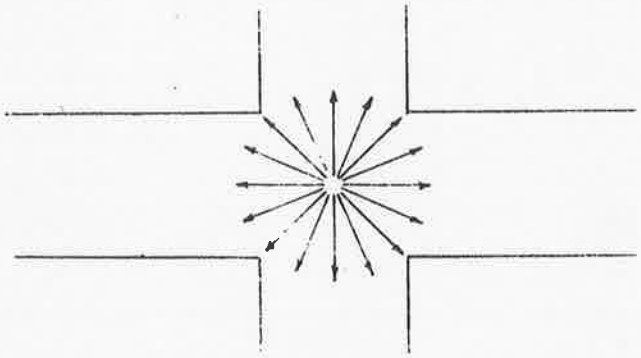
TYPE II - C WAY



TYPE III - B WAY



TYPE IV - LATERAL



TYPE V - SYMMETRICAL

I.E.S. LIGHT DISTRIBUTION PATTERNS

STREET LIGHTING SCHEDULES

The Los Angeles street lighting schedule as revised October, 1945, is as follows:

ON, 30 minutes after sunset from April 1 to September 30, and 15 minutes after sunset from October 1 to March 31.

OFF, one hour before sunrise from April 16 to September 15, and 30 minutes before sunrise from September 16 to April 15.

The changes between the summer and winter schedules are not made abruptly on the dates shown but gradually through a period starting 15 days before and continuing to 15 days after the dates.

1:00 A.M. lights are lighted at schedule time in the evening but extinguished at 1:00 A.M.

Many lights throughout the city, such as those in parks, tunnels and in privately owned systems operate on odd schedules, ranging from OFF at 10:00 P.M. to continuous lighting.

Electrolier lights in the Hollywood area are controlled by a carrier current system from the distributing station. The station is equipped with a photo-electric cell controller which indicates to the operator when natural daylight fades to a point at which the street lights should be lighted. He then applies the carrier current impulse to the distributing system which turns on the lights throughout the area.

The total operating hours of the street lighting schedule are:

All night	3918
1:00 A.M.	2427

Copies of the street lighting schedules showing time of lighting and extinguishing for each day in the year may be obtained from the Street Light Engineer's office.

CONTROL OF STREET LIGHTS

METHODS

Street light circuits in Los Angeles are controlled by the following methods:

1. Manually operated switch.
2. Time switch
3. Magnetic switch.
4. Photo-electric switch.
5. Carrier current control.
6. Pilot wire control.

MANUALLY OPERATED SWITCHES

A large part of the utilitarian lights and the downtown portion of the electrolier lights are controlled directly by manually operated switches in distributing stations. The utilitarian circuits are controlled individually; the electroliers by feeder switches controlling primary circuits serving large numbers of street lighting transformers.

This is the simplest control method and permits precise timing on regular schedule or varying the schedule as desired. It is, however, not as economical as other methods because the conductors and equipment cannot be used for any service but street lighting and consequently are idle throughout daylight hours.

TIME SWITCHES

In serving street lighting from established commercial supply lines, the time switch is employed. The device is only fairly satisfactory as it is subject to time variation, requires regular attention, switches lights according to time rather than light or weather conditions and occasionally fails to trip. Modern switches are equipped with astronomic dials which automatically change the time of ON and OFF operation each day to correspond with the daily change of sunset and sunrise.

Too many forms and makes of time switches are found in the Los Angeles system to be described individually.

However, the following descriptions cover a sufficient variety of switches that the fundamental principles of any switch may be understood. The ratings shown are those of the manufacturers but the switches are used in the Department's 4800 and 240/120 volt circuits.

Both high voltage and low voltage time switches are in service. The high voltage switches contain both the clock mechanism and the high voltage contacts all in one case. The low voltage switches are used directly in low voltage multiple street light circuits or more frequently as control time switches which, through low voltage wiring, control solenoid operated high voltage switches. This scheme permits the high voltage switch to be mounted close to the primaries and to the transformers, and the control switch to be mounted close to the ground in a position easily accessible to the maintainer.

ASTRONOMIC DIAL

All time switches in the system are equipped with an astronomic dial, a device which changes the daily time on ON and OFF operation to correspond with the daily change of sunset and sunrise. The dial is provided with adjustments so that the daily time of operation relative to sunrise and sunset may set as desired and when once set the switch will follow the sun variations throughout the year. The Los Angeles schedule however requires operation closer to sunset and sunrise during the winter months than during the summer months, and each spring and fall it is necessary to change the adjustments which is accomplished by shifting tripping pins or tripping arms in slots on the dial. Instructions for setting the pins is given in the bulletin "Street Lighting Schedules and Time Switch Setting Instructions" and the schedules in the bulletin show the dates for shifting the pins for each make of switch in service.

TYPE RC SWITCH

The Type RC (for "Remote Control") switch is a solenoid operated oil switch for installation on the primary side of street lighting transformers and is remotely controlled by a low voltage control time switch or other controller. The Type RC Switch is constructed in three forms:

Form A for controlling one schedule either all night or part night.
Form B for controlling an all night and a part night schedule.
Form E for controlling two transformers or groups from a three phase supply on one schedule.

The switch operates on the "latch-in" principle. When the ON solenoid is energized for a period of one second or longer, the switch closes and locks-in by a toggle mechanism. Energizing the OFF solenoid trips the toggle and opens the switch. In the Form B switch a third solenoid trips open the part night contact while the all night contact remains closed. An advantage of the toggle switch over a contactor is that no energy is used except during the brief period of energizing the solenoid.

The RC switch is enclosed in a water tight case which is suitable for installing in a vault or mounting on a crossarm on a pole. For pole mounting the switch is fitted with porcelain bushings and for vault use with wiping nipples. For controlling the RC switch any one of the following may be used: Any timer controller, carrier current controller, or pilot wire controller. These control switches are installed in readily accessible places such as a cast iron curb pedestal or a wooden or iron box on a distribution pole.

Control circuits of RC switches are protected with special slow acting fustats which will carry the initial rush of current of the solenoid but will open the circuit and prevent burning out the coils should they accidentally be energized too long. Special fuse receptacles are provided which will take only the slow acting fuses.

GOULD-ANDERSON LINE SWITCH - 25 Ampere, 6600 Volt

This switch (abbreviated G-A) consists of an Anderson time switch which has been rebuilt by substituting a single latch-in solenoid with two coils for the clock. In this form it operates in a similar manner to the RC switch except that it is capable of switching only one circuit and is suitable for pole mounting only. It is operated by momentary ON and OFF pulses by any of the controllers used with the RC switch and requires the same control circuits. No provision is made to operate the G-A switch manually and this should not be attempted.

As this switch is not weatherproof, it was formerly mounted 10 feet above ground in a wooden meter box. This type of switch has been modernized by enclosing it in a reinforced class MF meter box which is provided with suitable hangers for mounting the switch on the same level as the transformers. This arrangement is identified as a Gould Anderson High Mount (abbreviated G-A/H-M). To prevent spilling, oil must be added to the switch after it is in place.

SAUTER TIME SWITCH - Type HZE, Double Pole, 25 ampere, 4600/2300 volt

This switch is used to control street lights by switching constant current transformers on the primary side. The entire mechanism is enclosed in a weatherproof case and the switch is suitable for mounting on distribution poles.

This switch contains a 50 volt-ampere transformer for supplying motor energy. The transformer is connected across the high voltage leads which enter the case on the left side (line leads).

The motor windings are brought out to a terminal to permit connecting the motor for 120 or 240 volts. When the primary voltage is 4800, the motor must be connected for 240 volts.

A single universal motor simultaneously winds the clock spring and the operating spring. When sufficiently wound, the clock spring is automatically disconnected from the motor. The operating spring slowly winds to a certain tension and suddenly trips the switch. Switch actions alternate in and out. The motor is started by the timing mechanism and stopped by the operating mechanism, the control circuit being connected through two double throw switches in series, as shown in one of the Sauter diagrams on Sheet 0-834 of Electrical Standards. This is similar to the familiar 3-way switch connection used in house wiring. Blocking the switch by means of the blocking bar opens the motor circuit and indicates that the switch is not operating, but does not interfere with the time movement.

To set astronomic dial - Turn the five-point star wheel in either direction until the current date is indicated under the small date pointer, noting that the division lines of the date dial are for the 1st, 11th and 21st of the month. Intermediate dates may be set by turning the star wheel one point for each day.

To set clock - Turn the 24-hour dial clockwise or to the right until the proper time shows under the red pointer, noting that the black half circle on the dial indicates night time and the opposite half day time. For further checking of accuracy of clock time, a small 60 minute dial is provided which may be set by turning clockwise or to the right until indicating correctly.

To set time of operation - With a small screw driver loosen the pin in the slot at the rim of the dial and shift so that the center of the pin is opposite the desired tripping time for the date indicated by the astronomic dial. Shifting clockwise gives earlier operation and counter clockwise later. One division is equivalent to 15 minutes change. The settings for each day in the year are given in the bulletin, "Street Lighting Schedules and Time Switch Setting Instructions". To meet the Los Angeles schedule, pins must be shifted every spring and fall.

To set the OFF time for midnight or 1:00 A.M., it is necessary to remove the OFF pin from the dawn slot and place it in the middle slot where it can be permanently set at 12 midnight or 1:00 A.M.

When all adjustments have been made, it is advisable to check operation by rotating the dial manually through one revolution and noting the times indicated when the switch trips ON and OFF. If the times do not check with those shown for Sauter switch in the bulletin, readjust the pins until tripping time agrees. Finally reset astronomic dial to current date and reset clock to correct time.

To operate manually - If the control circuit is energized, the switch may be tripped by means of the toggle switch located above and behind the time pointer, moving the switch to the right for "ON" and to the left for "OFF".

CAUTION: DO NOT USE METAL OBJECT to operate the toggle switch. The blade of the switch and the frame are of opposite polarity and an accidental contact of the metal object between them will cause a short circuit.

If energy is not available, the switch may be tripped by attaching the crank to the cross pin stem in the lower left corner of the time mechanism and winding about 20 turns or until the automatic release trips. A small screw driver can be used instead of the crank. The switch trips "ON" with one winding and "OFF" with the next.

To block switching operation - Fasten the blocking bar in horizontal position which blocks the switch in the position it happens to be at the time. Timing is not affected by the blocking device.

SAUTER TIME SWITCH - Type HZ, Double Pole, 25 ampere, 6600 volt.

This switch is identical to the above Sauter Type HZE time switch except that the 50 volt-ampere transformer is omitted and an external 120 volt supply is required to operate the universal motor.

SAUTER LINE SWITCH - Type HZE, Double Pole, 25 ampere, 4600/2300 volt or Type HZ, 6600 volt

This switch is a conversion of the Sauter time switch-Type HZE or Type HZ in which the self contained clocks have been mechanically disconnected from the universal motor. Both types of switches are then mounted at the transformer level on the pole. The universal motor is then controlled by a single pole double throw Sangamo Type WZX-12 time switch in a cast iron control cabinet readily accessible from the ground for servicing.

Where line secondaries are not available and the low voltage source of the type HZE switch is used to operate the time switch, a 240 volt motor must be used in the time switch.

SAUTER-ANDERSON TIME SWITCH - 25 ampere, 6600 volt double pole.

This switch (abbreviated S-A) is a modernization of the hand wound Anderson switch in which the clock and operating mechanism have been removed and replaced with a unit containing a synchronous motor timing mechanism and induction motor operating mechanism furnished by the manufacturer of Sauter time switches. The motor leads must be connected to 120 volt supply.

The instructions for setting and operating the S-A switch are exactly the same as for the Sauter type HZE switch, except that since the hour and minute dials of the S-A switch are rigidly geared together, the time must be set approximately by the hour dial and then accurately by the minute dial.

CAUTION: DO NOT USE METAL OBJECT to operate the toggle switch. The blade of the switch and the frame are of opposite polarity and an accidental contact of the metal object between them will cause a short circuit.

SAUTER-ANDERSON HIGH MOUNT LINE SWITCH - 25 ampere, 6600 volt, double pole.

This switch (abbreviated S-A/H-M) is the same as the Sauter-Anderson time switch except that the switch is installed in a reinforced Class M-F meter box which is mounted in the same manner as the G-A/H-M switch. The switch is then controlled by a single pole double throw Sangamo WZX-12 time switch in a cast iron control cabinet readily accessible from the ground.

SAUTER TIMERCONTROLLER - Type ZMU or SY1FW, 15 ampere, 115 volt with momentary contact.

This controller, locally called "four point Sauter" is used only for controlling the Type RC or Type G-A solenoid switch. It is synchronous-motor timed and induction-motor operated.

The synchronous motor drives the time dial, marked into two 12-hour periods, in the direction of the arrow. Projecting beyond the rim of the dial are three slotted arms carrying pins which may be shifted the length of the slots. In addition there is a fixed fourth pin near the 2 P.M. point on the dial.

As the dial rotates, the pins trip a double-throw toggle switch located behind the red pointer - to the right at dusk and dawn, and to the left at midnight (or 1:00 A.M.) and 2 P.M. Tripping the toggle switch starts the motor which slowly winds a spring. When the spring is wound to a certain tension, it suddenly trips the main switch contacts which engage for four-second periods. At the same time a second

double throw switch in the motor circuit is tripped stopping the motor and preparing the motor circuit for the next action of the pin trip. The diagram of connections is shown on Sheet 0-834 of Electrical Standards.

To set astronomic dial - Turn the five-point star wheel in either direction until the current date is indicated under the small date pointer, noting that the division lines of the date dial are for the 1st, 11th and 21st of the month. Intermediate dates may be set by turning the star wheel one point for each day.

To set clock - Turn the milled wheel on right side of the dial until the proper time shows under the red pointer, then continue until the correct minute is indicated on the small minute dial, noting that the black half-circle on the dial indicates night time and the opposite half day time. Always turn the dial clockwise in the direction of the arrow except for slight adjustments which may be made by turning backward providing the backward movement does not pass a tripping point.

To set time of operation - The relation of tripping time to sunset and sunrise can be adjusted by shifting the ON and OFF pins. With a small screw driver loosen the pin in the slot at the rim of the dial and shift so that the center of the pin is opposite the proper tripping time for the date indicated by the astronomic dial. Shifting clockwise gives earlier operation and counter-clockwise later. One slot division is equivalent to 15 minutes change. The settings for each day in the year are given in the bulletin "Street Lighting Schedules and Time Switch Setting Instructions". To meet the Los Angeles schedule, pins must be shifted every spring and fall.

The midnight pin must be set for 1:00 A.M. unless 12 midnight is specially ordered. The day reset pin is permanently fixed.

When all adjustments have been made, it is advisable to check operation by rotating the dial manually through one revolution turning the milled wheel and noting on both the hour and minute dials when tripping occurs. If the ON and OFF times do not check with those shown for Sauter switch in the bulletin, readjust the pins until tripping time agrees. At the same time observe if the tripping point on the dial matches with the corresponding switch contact (1-dusk, 2-midnight, 3-dawn, 4-day reset). If out of step, the switch must be repeatedly tripped manually until the two are together. Finally reset astronomic dial to current date and reset clock to correct time.

IMPORTANT: if working on the switch during the day time, be sure that contact 4, the day reset, has or has not tripped according to whether the time of day is after or before the day reset tripping time.

To operate manually - The switch may be tripped manually by throwing the toggle switch located behind the red pointer either with the finger or more safely with a piece of wood or other non-conductor.

> CAUTION: DO NOT USE METAL OBJECT to operate the toggle switch. The blade of the switch and the frame are of opposite polarity and an accidental contact of the metal object between them will cause a short circuit.

STATES TIMER CONTROLLER - Type SZ, 10 ampere, 110 volt with momentary contacts.

This controller is used only for controlling solenoid switches, either the Type RC or Type GA. The motor consists essentially of an armature rapidly vibrating in a magnetic field and connected to a ratchet device which transforms the vibrating motion to rotation in one direction.

The motor winds the clock spring and drives a shaft carrying rotating contacts which engage with stationary contact fingers for five-second periods. The shaft mechanism is provided with a spring to give a snap action in making contact. The motor is controlled by two double throw switches connected in series as shown in the States diagram on Sheet 0-834 of Electrical Standards. This is the familiar 3-way switch connection used in house wiring. The clock trips one double throw switch which starts the motor. The other switch is tripped by the rotating shaft at the end of its travel, stopping the motor.

Tripping is accomplished by pins in four arms which extend beyond the rim of the dial. The pins engage the trip lever alternately tripping the double throw switch, first in one direction and next in the other. The reset arm is not rigidly fastened to the dial but rests against the OFF arm and trips approximately one and one-half hours before OFF time.

To set astronomic dial - If necessary, first clear the arms from nearness to tripping lever by turning the clock. This must be done by means of a screw driver in the screw in the upper right corner of the time mechanism, always turning counter-clockwise or to the left. Then with a screw driver, turn the friction plate at the center of the small gear wheel until the point on the small dial indicating the current date is opposite Division 12 on the main dial. The small dial is marked into divisions representing the first day of the month and into subdivisions representing the 11th and 21st of the month.

To set clock - Before setting clock the astronomic dial should be set as instructed in the foregoing paragraph. With a screw driver turn the screw in the upper right corner of the time mechanism counter-clockwise or to the left until the correct time is indicated by the dial scale opposite the pointer at the bottom of the dial, noting that the black half-circle indicates night time and the opposite half day time.

To set time of operation - The relation of tripping time to sunset and sunrise can be adjusted by shifting the ON and OFF arms. With a small screw driver, loosen the screw pin in the slot at the base of the arm, and shift arm until the index mark is opposite the proper tripping time for the date indicated by the astronomic dial. The screw pins are delicate and must be tightened very lightly. The settings for each day in the year are given in the bulletin, "Street Lighting Schedules and Time Switch Setting Instructions". The switch follows the Los Angeles schedule fairly accurately and the arms when once set do not require any readjustments throughout the year.

The midnight arm must be set for 1:00 A.M. unless 12 midnight is specially ordered.

To trip manually - Push down on the pin projecting through the hole in the plate just under the dial. This starts the motor and in from 30 to 60 seconds the switch trips one operation in its cycle. The switch cannot be manually tripped during the 30 minute period before its tripping time as the pin is locked. Tripping the switch manually causes the sequence of the switch contacts to drop out of step with the clock trippings. To remedy this it is necessary to repeat the manual trips until the two are again in synchronism. This can be checked by noting which clock pin will next trip and the switch contact which will next close. The middle contact corresponds to dusk, ON, the front to 1:00 A.M. and the back to dawn, OFF.

To avoid the delay of the motor operation, it is customary to trip the Type RC switch by momentarily closing the circuit across the front, back, or middle contacts above mentioned, using a short piece of wire.

> IMPORTANT - If working on the switch between midnight and dawn, be sure that the contact corresponding to the extra tripping pin which is set for shortly before dawn, has or has not passed, according to whether the time of night is after or before the time setting of the tripping pin.

SANGAMO TIME SWITCH - (Various Ratings)

This is a synchronous motor timed and driven switch for controlling 120 volt or 120/240 volt multiple circuits on either standard or tunnel schedule. As the motor is wound for 120 volts, an independent neutral leg must be provided for the motor when the switch is connected in the outside legs of a three wire 120/240 volt circuit.

The synchronous motor drives the time dial in the direction of the arrow. Projecting beyond the dial rim are slotted arms carrying pins which may be moved along the slots. As the dial rotates, the pins trip "ON" and "OFF" levers operating the switch. The load carrying contacts are of special material which permits heavy currents to be broken through a small gap. The gap has been carefully adjusted at the factory and should not ordinarily require adjustment in the field.

CAUTION: SWITCH MUST ALWAYS BE IN A VERTICAL POSITION WHILE ROTATING DIAL, otherwise tripping levers may jamb and become damaged.

To set astronomic dial - Set date indicator for current date by turning the milled wheel just under the upper dial plate or by turning the star wheel projecting from under the rim of the lower dial plate, noting that the indicator division lines are for the 1st, 6th, 11th, 16th, 21st and 26th days of the month. Intermediate dates may be set by turning the star wheel one point for each day.

To set clock - Turn the small knob on the extended stem clockwise or to the right until correct time is indicated by both the clock dial and the small minute dial, noting that the black half-circle indicates nighttime and the other half daytime.

To set time of operation - The relation of tripping time to sunset and sunrise can be adjusted by shifting the ON and OFF pins. With a small screw driver loosen the trip pin in the slot and shift so that the center of the pin is opposite the proper tripping time for the date indicated by the astronomic dial. Shifting clockwise gives later operation and counter-clockwise earlier. One slot division is equivalent to 15 minutes change. The settings for each day in the year are given in the bulletin, "Street Lighting Schedules and Time Switch Setting Instructions." To meet the Los Angeles schedule, the pins must be shifted every spring and fall.

To set the OFF time for midnight or 1:00 A.M., it is necessary to remove the OFF pin from the dawn slot and place it in the middle slot where it can be permanently set for 12 midnight or 1:00 A.M.

When all adjustments have been made, it is advisable to check operation by rotating the dial through one revolution manually, noting the time on both the main dial and the minute dial when tripping occurs. If the times do not check with those shown for Sangamo switch (Standard or Tunnel) in the bulletin, readjust the pins until tripping time agrees. Finally reset astronomic dial to current date and reset clock to correct time.

To operate manually - The ON and the OFF levers are readily recognized and can be operated with a finger.

SANGAMO TIME SWITCH - Type WZX-12, 35 ampere, 120 volt, single pole, double throw.

This has a synchronous carry-over motor, timed and driven. It is used in the Sangamo KAZ 61S6, Time-O-Matic and Type MTS controllers. It is also used to directly control the Sauter and Sauter-Anderson types of line switches. Instructions for the use of the above Sangamo time switch apply to the Sangamo WZX-12 switch.

SANGAMO KAZ 61S6, TIME-O-MATIC AND MTS TIMER CONTROLLERS
35 ampere, 120 volts with momentary contacts

This controller consists of a combination of a single pole double throw Sangamo WZX-12 time switch and a motor driven cam contactor in a single case. The controller is used in connection with the Type RC or Type G-A solenoid switch. Although four operations are provided, No. 1 dusk, No. 2 midnight, No. 3 dawn and No. 4 noon (the No. 4 noon contact is omitted in the MTS controller), the controller may be connected for only those required for any particular installation.

The instructions for the Sangamo time switch apply to the time switch in these controllers. It is very important that the cam shaft of the cam contactor and the tripping positions of the time switch be synchronized. Because it is difficult to see the position of the cams, marks have been placed on the collar at the left end of the shaft of the Sangamo and Time-O-Matic controllers, the number corresponding with the conventional numbers used for the four operations. Similarly, the type MTS controller is provided with a circular arrow indicating direction of cam rotation, and a straight arrow indicating cam position with respect to the above controller operations. Numbers representing these operations are embossed in the lucite cover plate.

MAGNETIC SWITCH IN THE FIELD

When installing a constant current transformer in the field to serve a new street light circuit, it is often possible to tie the control into a nearby existing street light circuit which is controlled at a distant source. This scheme is known as "cascading" and employs a magnetic switch in which the solenoid is a 6.6 amp. coil connected in series in the existing circuit. The contacts close between a primary circuit and the constant current transformer.

The switch which is used in Los Angeles is an RCOC Switch manufactured by the South Bend Current Controller Company, and is rated at 35 amperes at 4600 volts. The contacts which are under oil remain closed only while the solenoid is energized. The switch is provided with an auxiliary lever on the switch tank for hand operation. For normal automatic operation the hand lever should be set in the "AUTO" position. Moving the lever to the "OFF" position shunts the operating coil and opens the load contacts. Moving the lever to the "ON" position locks the load contacts closed.

CARRIER CURRENT CONTROL

Nearly all of the electrolier systems connected to circuits from Distributing Stations 6, 10 and 15 are carrier current controlled.

In each of these stations is installed a generator for producing a current of 700 cycles and control equipment for controlling the length of time of application. The high frequency is superimposed on the 4800 volt buses for period of a few seconds by means of coupling apparatus and travels over the feeder and primary system passing through the distribution transformers to the secondaries.

In the field are the controllers tuned to respond to the 700 cycle impulses so that when the impulses are received in the proper sequence, the controller will cause the closing and opening of the switches on the street lighting circuits as desired by the station operator.

The installations at Distributing Stations 6 and 10 are shunt coupled and that at Distributing Station 15 is series coupled. The field equipment is also different.

This is a brief description of the carrier current control. A detailed description is given in a bulletin issued by the Street Light Engineer's office which is available to any who wish further information.

PILOT WIRE CONTROL

A pilot wire street light control is in operation at Distributing Station 28 and Distributing Station 35. From a master controller in the station a single line conductor extends to the field controllers. A ground return completes the circuit. The scheme of operation depends upon timed and spaced impulses which permit selecting the ON or OFF operation desired.

A different type of pilot wire street light control is in operation at Distribution Station 8. A master Type MPW-ST Station controller sends out a 3 second 120 volt D.C. impulse over pilot communication pairs to the various field control points, the pulse closes a relay which starts the operation of a Type MPW field controller which in turn operates a Type RC or G-A solenoid line switch. For operation of a Sauter or Sauter-Anderson type line switch, a Type MPW-SA field controller is used. This controller has a double-throw latch type relay which acts as a substitute for the clock operated switch in the control circuit of the Sauter or Sauter-Anderson line switches.

Each of the above pilot wire control schemes is fully described in a bulletin issued by the Street Light Engineer's office. This bulletin is available to those needing further information.

A third type of pilot wire for the control of multiple circuits consists of a 120 volt pilot wire, using a ground or neutral return, energized from the master time switch which operates one or more 120 volt contactors. These contactors control additional multiple circuits energized from convenient distribution secondaries.

TRANSFORMERS

Transformers used in series street lighting systems are of three general types:

Series Auto-transformers
Series Insulating Transformers
Constant Current Regulating Transformers

SERIES AUTO-TRANSFORMERS (also called compensators) are used to change the line current from 6.6 amperes to 15 or 20 amperes for the lamp circuit. The auto-transformer consists of only one winding with taps taken off at the proper points. The lamp circuit is thus metallically connected to the line and carries the same potential. Diagrams of connections of the various makes of compensators are shown on Sheet 0-880 of Electrical Standards.

SERIES INSULATING TRANSFORMERS besides stepping up current also insulate the lamp circuit or branch circuit from the main circuit. This transformer is used where it would be dangerous to life if the line potential were at the lamp fixture or where it is desired to operate a circuit insulated for low voltage in connection with a circuit carrying a high voltage. The series insulating transformer contains two separate windings similar in principle to the ordinary constant potential transformer used on distribution lines.

When the series insulating transformer is used for one or two lamps, it is generally known as "Type IL" and when for a branch circuit as "Type SL". These, however, are catalogue designations of the General Electric Company.

Both auto-transformers and insulating transformers lower the power factor of the circuit besides introducing losses into the circuit. Because of poor regulation characteristics, series insulating transformers should be operated nearly fully loaded.

CONSTANT CURRENT REGULATING TRANSFORMERS are designed in three types - pole, subway and station.

The pole and subway transformers are automatic in action while the station transformers require some attention in starting. Pole and subway transformers are enclosed in tanks. The subway tank is waterproof and adapted for connection to lead covered cable. The station transformer is open but protected with a wire screen.

A simple view of the operation of a constant current circuit may be gained from the following:

Assume that the transformer primary induces a constant voltage which forces a current through the circuit consisting of transformer secondary coil and lamp load. The current will remain constant as long as the impedance (resistance plus reactance) remains constant. Now if the lamp load is reduced, the resistance of the circuit decreases and to maintain the current constant it is necessary to add into the circuit a compensating amount of impedance at the station. This is just what the constant current transformer accomplishes by automatically moving the secondary coil relative to the primary.

The primary current also remains constant. This is because the secondary current is constant and the ratio of transformation is fixed. With changes in load, the only change in the primary input is the power factor.

The principle of the transformer is as follows:

The transformer consists essentially of a fixed primary coil connected to a constant potential source of power, an iron core and a movable secondary coil counterbalanced with weights. The primary coil induces a magnetic flux through the iron. If the secondary circuit is open, the flux in the iron will induce a voltage in the secondary coil just the same as in an ordinary constant potential transformer. If the secondary circuit is closed, a current will flow. This current sets up a magnetomotive force opposed to that of the primary, and a part of the magnetic flux will be forced across the opening between the two coils instead of following the iron circuit.

Two reactions result. First the voltage in the secondary coil will be reduced on account of the reduced flux which links it and second, there will be a mechanical force on the secondary or movable coil tending to raise it. This force is caused by the reaction of the leakage flux on the current in the secondary coil. The counterweight is normally adjusted so that the weight of the coil is just equal to the counterweight plus the mechanical reaction when the coil is carrying the desired current.

If a part of the load is suddenly short circuited, there will be an instantaneous rise in the secondary current and consequently in the leakage flux. This results in an increased mechanical force between coils, and the secondary coil moves upward. The leakage space between the coils is thus increased and the secondary voltage is diminished to a point where it will again send only the desired current through the decreased resistance of the circuit.

Constant current transformers may be temporarily short circuited without damage to the transformer or the load. However, they should not be operated at low loads as they develop heat.

Constant current transformers used on the Department's lines will regulate satisfactorily at loads as low as fifty percent of rating and in some cases lower. Over the range of load within which the secondary current remains constant, the primary current will also be constant since the transformer ratio is fixed. In adjusting itself for load changes, the regulator merely changes power factor. It is therefore desirable to select the smallest size of transformer that will carry the load in order to maintain the power factor high.

When carrying load the transformer secondary terminal voltage is regulated to be just sufficient to force the rated current through the impedance of the secondary circuit. If, however, the secondary circuit is open, the voltage will reach values about 35 percent above normal full load voltage.

The maximum load at 100 percent power factor which a constant current transformer will carry is slightly over its rating, the amount varying in different transformers. As the power factor is lowered, the capacity of the transformer is decreased greatly. This is the case when lamp transformers are in the circuit.

The ability of the transformer to carry load also varies with the primary voltage. Fully loaded transformers must be supplied with not less than rated voltage in order to keep secondary current up to normal.

Pole and subway transformers are automatic and require no attention when energized, the inherent reactance of the transformer preventing excessive current. Station transformer coils must be latched apart before energizing, but release themselves automatically.

Pole and subway transformers have no taps. Station transformers are provided with taps for efficient operation at 90 and 80 percent of full rated load. Connections are shown on Drawing D-402, which can be obtained from the Power Drafting Room.

CHARACTERISTICS OF

CONSTANT CURRENT TRANSFORMERS

4600 VOLT PRIMARY - 6.6 AMP SECONDARY

KW RATING	PRIMARY AMPS	SECONDARY VOLTS FULL LOAD	SECONDARY VOLTS OPEN CIRCUIT	POWER FACTORS FOR ALL SIZES
1	.31	152	220	Full load 75
2	.61	303	430	3/4 " 56
3	.93	454	660	1/2 " 38
5	1.53	757	1080	1/4 " 20
7.5	2.26	1137	1600	
10	2.95	1515	2090	
15	4.36	2272	3090	
20	5.80	3030	4115	
25	7.20	3787	5110	
30	8.65	4545	6130	

MISCELLANEOUS EQUIPMENT

There are a number of smaller pieces of equipment which have interesting features and should not be omitted in a street lighting discussion.

SOCKETS - Both multiple and series sockets are used in street lighting fixtures. For 200 watt lamps and smaller, medium multiple sockets are installed; for 300 watt lamps and larger, mogul multiple sockets are required. The multiple sockets are not different from the kinds generally used for any electrical installation. Some of the older 20 amp. luminaires use a multiple mogul socket.

The Department's standard series socket is made of wet process porcelain and is rated for 20 amperes. Many of the old 6.6 ampere porcelain and white composition sockets are still in service and care must be taken not to use them with 20 ampere lamps as they would not withstand the heat created by the larger lamps. The series socket contains a short circuiting device which is closed when the lamp is out and open when the lamp is in. When screwing in the lamp, it is essential that it be screwed in to the limit in order that the short circuiting device be opened. A disk film cut-out or fiber washer must be placed between the prongs of the socket or the lamp will be short circuited out. Both the mogul socket and the series socket are provided with a device for locking the lamp against loosening by vibration. A fiber washer must never be used with a 6.6 amp. lamp or an open circuit will result.

FILM CUT-OUTS - General Electric, Westinghouse and Joslyn cut-outs are used in the system. The General Electric consists of two aluminum disks one 3/4 in. diameter, the other smaller, insulated from each other by an oiled paper washer, the two disks contacting a piece of oxidized copper between them. The cut-out is assembled so as to form a weatherproof housing to protect the copper oxide surface. The Westinghouse cut-out consists of two 3/4 in. diameter aluminum disks separated by means of an asbestos washer. A hole in the center of the asbestos washer is filled with finely divided aluminum powder. The aluminum disks and the asbestos washer are cemented together.

Cut-outs are manufactured in various ratings but only one rating is used for the Los Angeles incandescent systems. This is the MEDIUM or 100-400 volt cut-out which is designed to break down and short-circuit the lamp when the voltage across the cut-out rises to some point above 100 volts and less than 400. General Electric cut-outs of this rating are identified by a black paper washer and Westinghouse by letter "B". Joslyn make only the MEDIUM size.

For circuits energized by small transformers, LOW VOLTAGE cut-outs must be used as the open circuit voltage is not high enough to break down the medium cut-out.

For sodium lights a special cut-out must be used. This is rated at 250 to 350 volts and is distinguished by a RED paper washer.

Where a series type socket is used in conjunction with either a series auto-transformer or an individual series insulating transformer, an insulating fiber washer is used in place of the disc cut-out. Voltage at the socket prongs in this type of installation is insufficient to insure complete breakdown of the cutout, often resulting in heat damage to the socket and receptacle.

RECEPTACLES - The device which holds the series socket is known as a series receptacle. The receptacle in its simplest form consists essentially of two self-closing spring contacts on an insulated mounting. The mounting may be designed for high voltage or for low voltage, the latter generally used in fixtures which are themselves insulated from ground.

POTHEADS - Two makes of potheads are in general use - the R & L and the D & W. These are pulled to disconnect individual lamps from the circuit in case of posts damaged or knocked down by accident.

The R & L pothead consists of a metal case enclosing a porcelain housing containing the circuit-closing device. The cap is of bakelite and embodies a bakelite separator. When the cap is fitted on the pothead, care should be taken to see that the separator enters between the contacts or no current will flow in the lamp circuit.

In the D & W pothead which is an all porcelain housing, the main contacts are separated when contacted by the blades of the cap. The blades are held apart by a small porcelain cylinder, easily dislodged by handling which would cause the lamp to be shunted out. Care should be exercised to see that the cylinder is in place before attaching the cap to the housing.

SECONDARY DISCONNECTING PLUG CUT-OUTS - In the secondary disconnect boxes at feed points for electrolier circuits energized from pole type transformers are mounted porcelain disconnecting blocks. These are series cut-out blocks adapted for use as high voltage plug disconnects. One cut-out is used for each secondary lead. The transformer lead enters one of the side holes at the top and the line lead enters the hole at the bottom on the same corresponding side. Secondary disconnecting potheads are used in vault installations. Disconnects on series circuits should not be opened under load, except in following case.

In circuits served by transformers of 10 kw or less capacity, or where an electrolier circuit having a load of 10 kw or less is energized from a utilitarian circuit, a single disconnecting porcelain cut-out may be used for both electrolier leads. This may be pulled under load, as the utilitarian transformer or circuit leads will be shunted thereby avoiding an open circuit.

NUMBERING STREET LIGHTING EQUIPMENT

To every utilitarian light is assigned a number. For those which are on circuits from distribution stations, the number is composed of three parts separated with dashes. The first part is the distribution station number, the second the circuit number and the third, the three digits of the lamp number. Thus 14-2-003. When a B-way refractor is used, the letter B is added to the number on the lamp number tag and if deflectors are used the letter D is added.

Utilitarian light numbers on circuits controlled by field switches are composed of first, the letter X, then the field switch number, and then the three digits of the lamp number. If more than one utilitarian circuit is controlled by the switch, the switch number on the additional circuits is followed by a letter A, B, C, etc. and a dash to distinguish the circuits. Thus X262A-008.

Field switches are numbered in an arbitrary series regardless of location, the numbers always preceded by the letter X.

Type S.L. transformers serving electroliers are numbered first with the master street light circuit number followed by the letters SL and an arbitrary number assigned to the transformer.

Potheads terminating the underground section of a circuit energized from a distributing station regulator are numbered with first the number of the station and, next, the number representing the particular circuit. Thus 14-2. This number appears on a masonite plate on the pothead crossarm.

Street light vault switches are also numbered. Thus 17-2-SVI indicates that the switch is on Feeder No. 2 from Station 17. SV indicates that the switch is for a street light vault and the final figure 1 is the serial number for each vault switch on the feeder.

A bulletin issued by the Operating Division covers the numbering scheme of all distribution lines and equipment including street lights.

MAPS

Maps showing the location and connections of every street light in the city are prepared and issued by the Street Light Engineer's office. These maps are designed to be of use to the engineer, the construction foreman, the patrolman and the troubleman.

All maps are of uniform size 11 in. x 14 in. to fit the patrolman's loose leaf binder. The scale of the maps is 600 ft. to the inch. An instruction sheet is furnished with the maps showing symbols and the rules for making the maps.

The utilitarian maps are drawn according to individual circuit and are filed according to station and circuit number. Some circuits require several sheets and each of these is marked with the sheet number and the number of sheets comprising the circuit.

The electrolier maps represent uniform sections of the city, each covering approximately one by one and one-half miles. The sheets are arbitrarily numbered and a key map is furnished to locate the sections. Attached to each electrolier section map is a circuit map which shows the diagram of the wiring of each circuit within the section. With each set of maps is furnished a list of control station numbers in consecutive order, showing the control station location, the system or systems controlled and the map number.

The street light maps give a great deal of information when one learns to read them. Besides the location of the posts, conduit, transformers and field switches, the maps show the schedule on which the transformers and the circuits operate, the size of transformer, the number of the field switch and other data.

Maps are revised whenever a major change occurs, Minor changes such as relocation of a short length of line or addition of one or two lights is not considered of sufficient importance to re-issue a large number of new prints. Maps are checked in the field by the Street Light Superintendent's crews or, in the outlying districts by the trouble crews, and corrected when changes or errors are found.

FORMS AND RECORDS

A number of forms used exclusively for street lighting routine are shown here to indicate th kind of information recorded and the methods of keeping and transmitting such information.

The form "Electrolier Street Lighting Service Data" accompanies the authorization to the field and is intended to give the foreman information useful in putting a new system into service.

After the new electrolier system has been put in service the foreman fills out and returns to the Street Lighting Engineer's office, the mimeograph form "Electrolier Lighting System." Inasmuch as billing instructions are made up from data on this report, it is important that it be accurate.

In the Street Light Engineer's office is kept a card file showing the number and location of every utilitarian street light in the city, together with the lamp size and style of fixture. There is also a file arranged by street name showing for each cross street intersection, the number of the street light installed. This is a quick cross reference as all other records are filed by street light number.

A special job order for utilitarian street light installations, changes and removals is issued by the Street Light Engineer's office. This job order is a distinctive color (canary yellow) and carries instructions that a report must be written on the reverse side and one copy returned to the Engineer's office.

To each time switch sent to the field is attached a green "Time Switch Tag" which carries on the upper portion, the switch description with its record and serial numbers and on the reverse side, the shop inspector's O.K. At the time of installation in line, the installer notes the time switch station number and the date, removes the tag and returns it to Street Light Superintendent's office for his records. If the switch replaces an existing switch, the lower portion is also filled out with information regarding the switch removed. The installer also attaches to the switch removed another tag, upper portion only, on which he writes the switch description and station from which removed, and on the reverse side the reason for removal and the date.

Each sodium vapor lamp leaving the warehouse is accompanied by a "Sodium Vapor Lamp Tag" which, after installation of the lamp, must be filled out with the information required and returned to the Street Light Superintendent's office together with the lamp removed (if a replacement).

MIDDLETOWN AVE - "A" ST TO "B" ST
ELECTROLIER LIGHTING SYSTEM

SERVICE NO. 268745 DATE IN SERVICE 1-26-36 TSS FILE NO. #980 MAP NO. 510

POSTS 26 - Marbelite #1995 - 2 Arm LAMPS 52 - 4000 lumen 15 Amp GLOBES 52 - G.E. #124

TS STA.NO.	REC. NO.	SERIAL NO.	AMP.	VOLT	MAKE	TYPE	SCHE-DULE	TRANS. STA. NO.	RECORD NO.	SIZE	TYPE	PRIM	LAMPS NO.	LAMPS SIZE	LAMPS AMP.
980	906	96941	10	110	States	SZF	AN	55-1-004	14835	5	RO	4600	18	4000	15
	291	---	25	4600	BPL	RC B	MN	55-1-003	12796	10	RO	4600	34	4000	15

LOCATION TSS#980 - 453 "A" ST (Middletown Ave.) LOCATION, TRANS. Vault - same.

-45a-

REMARKS:

STREETS IN SYSTEM: (Show kinds of glassware each street)

POSTS & UNDERGROUND OWNED
& MAINTAINED BY: Street Light Dept.

CORRECTED:

DEPARTMENT OF WATER & POWER
OF THE CITY OF LOS ANGELES

ELECTROLIER STREET LIGHTING SERVICE DATA

Date 1-2-48

Accompanying OVERHEAD Auth. No. 51-67155
UNDERGROUND No.
STREET LIGHT J.O. No. 87134

See also OVERHEAD Auth. No. --
UNDERGOUND

Utilitarian lights displaced on Auth. No. --

System Name ROBERTSON BLVD -GREGORY WAY TO WHITWORTH DR LTG. DIST. Patrol Map No. 181

New system

Standards: 2 -Pressed steel, single arm
13 - " " , double arm

Lamps: 2 - 10000/20 IL
26 - 4000/15

CIRCUIT DATA

Circuit	LAMPS Schedule	Number	Size	Glassware	TRANSFORMERS Size	Sta. No.	Record No.	Control Sta. No.
POLE NO. 47875-G - WHITWORTH DRIVE -EAST OF ROBERTSON BLVD								
					Install			
#1	A.N.	6	4000/15c	GE 124	3 kw	43-12-85	12277	TS 56
		2	10000/20IL	GE 232				
#2	1:00 AM	20	4000/15c	GE 124	7½ kw	43-12-86	1726	

CONTROL: 10 Amp. 110 Volt States control time switch
Type RC Form B line switch

NOTE: The two 10000/20 IL lamps are located on the N.E. and S.E. Corners of Olympic Blvd. and Robertson Blvd.

This system must not be put in regular service until inspected and approved by Street Lighting Engineer of the Department of Public Works.

Copies to
Superintendent District No. 2
Street Light Superintendent
~~Underground Superintendent~~
Street Lighting Engineering Section
Bureau of Street Lighting

Contractor Bureau of Street Lighting

Expected date service required. March 1, 1948

Prepared by D. E. Cook

FORM 2160 CODE 115988
BUREAU OF POWER & LIGHT
CITY OF LOS ANGELES

Job Order A
STREET LIGHT

No. 900

AUTH. _____

E.O. _____ DATE _____ 19 _____

LOCATION _____

_____

LAMP STATION NO. _____

POLE NO. _____

IMPORTANT—IMMEDIATELY AFTER THIS STREET LIGHT IS CONNECTED IN OR DISCONNECTED FROM SERVICE, THE DATE MUST BE REPORTED ON THE REVERSE SIDE OF THIS FORM AND THE "B" COPY FORWARDED TO STREET LIGHT ENGINEER, 207 SO. BROADWAY. THIS INFORMATION IS FOR BILLING PURPOSES AND MUST NOT BE DELAYED.

BY _____

DATE IN SERVICE _____

DATE OUT OF SERVICE _____

BY _____

FORM 2180 CODE 115989
BUREAU OF POWER & LIGHT
CITY OF LOS ANGELES

Job Order A
STREET LIGHT

No. 900

AUTH. _____

E.O. _____ DATE _____ 19 ____

LOCATION _____

_____

LAMP STATION NO. _____

POLE NO. _____

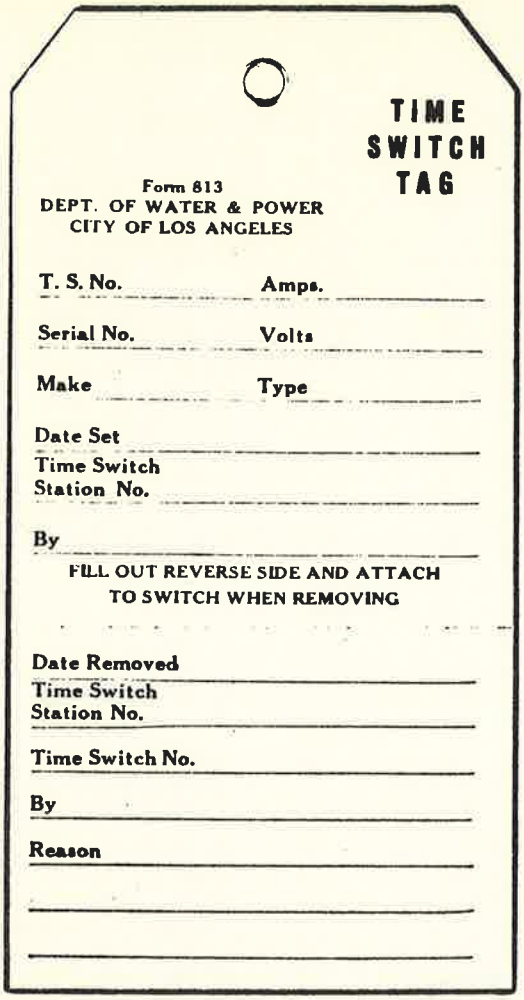
IMPORTANT—IMMEDIATELY AFTER THIS STREET LIGHT IS CONNECTED IN OR DISCONNECTED FROM SERVICE, THE DATE MUST BE REPORTED ON THE REVERSE SIDE OF THIS FORM AND THE "B" COPY FORWARDED TO STREET LIGHT ENGINEER, 207 SO. BROADWAY. THIS INFORMATION IS FOR BILLING PURPOSES AND MUST NOT BE DELAYED.

BY _____

DATE IN SERVICE _____

DATE OUT OF SERVICE _____

BY _____



TIME SWITCH TAG

Form 813
DEPT. OF WATER & POWER
CITY OF LOS ANGELES

T. S. No. _____ Amps. _____

Serial No. _____ Volts _____

Make _____ Type _____

Date Set _____

Time Switch Station No. _____

By _____

FILL OUT REVERSE SIDE AND ATTACH TO SWITCH WHEN REMOVING

Date Removed _____

Time Switch Station No. _____

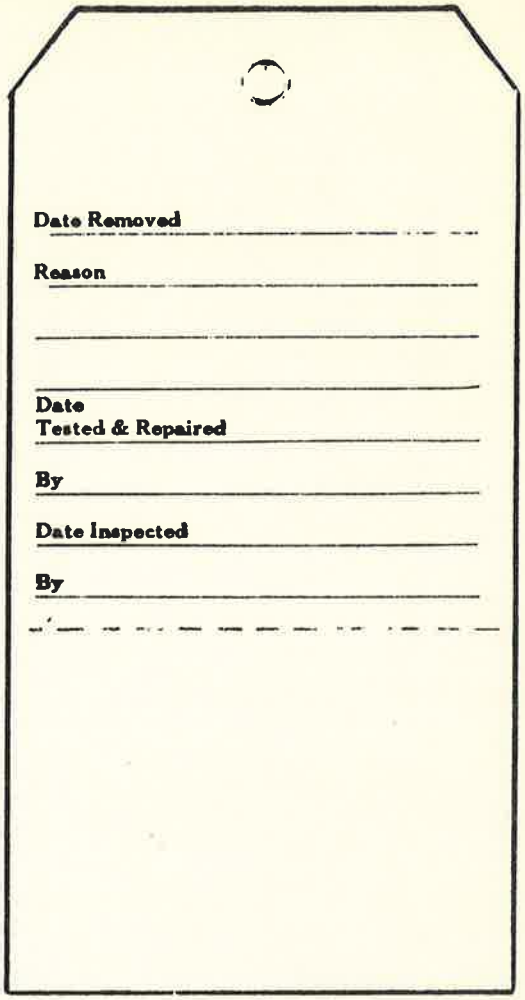
Time Switch No. _____

By _____

Reason _____

_____

_____



Date Removed _____

Reason _____

_____

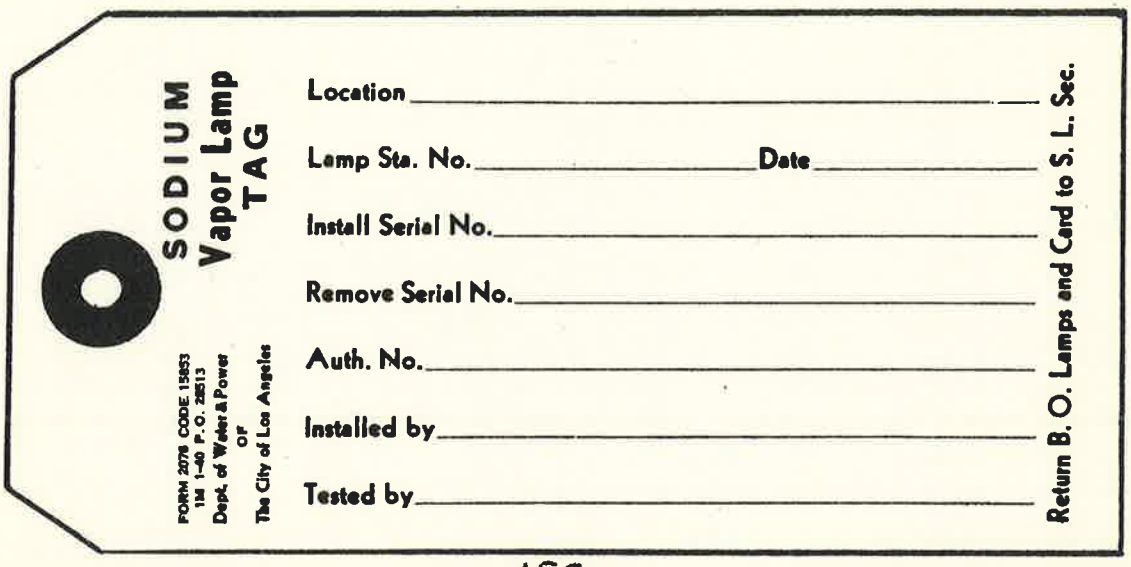
_____

Date Tested & Repaired _____

By _____

Date Inspected _____

By _____



SODIUM Vapor Lamp TAG

FORM 2078 CODE 15853
1M 1-40 P.O. 28513
Dept. of Water & Power
OF
The City of Los Angeles

Location _____

Lamp Sta. No. _____ Date _____

Install Serial No. _____

Remove Serial No. _____

Auth. No. _____

Installed by _____

Tested by _____

Return B. O. Lamps and Card to S. L. Sec.

The Street Light Superintendent maintains the following records in his office:

A file by street names for electrolier street lighting maintenance, showing the name of the system, kind of glassware and size of lamp.

A list of time switch control numbers showing location, name of system, transformer station and record numbers, and number and size of lamps on each transformer.

A list of time switches by record numbers for keeping the life history of each switch.

A list of synchronous motor time switches showing locations, circuit number and transformer station numbers from which energized. This is a ready reference in case of circuit interruptions as synchronous time switches must be re-set after an interruption of an appreciable amount of time.

SERVICE

Continuity of service is the ideal toward which every up-to-date electric utility directs its greatest effort. This rule applies to street lighting as well as other types of service. Failure of lighting on the streets may not only cause adverse criticism of the Department's service but under modern traffic conditions may occasion serious accidents.

The following remarks are offered in the interest of good service:

Street lighting circuits - both utilitarian and electrolier - should not be switched off during lighting period except in case of emergency and then for the shortest possible time.

Time switches should be maintained to follow the schedule as closely as the limitations of the present day apparatus will permit. Under-schedule causes dissatisfaction and inconvenience; over-schedule wastes energy and lamp life and occasions criticism.

When it is desired to energize a circuit for testing or inspection during daytime, it is usually necessary to trip the time switch manually. With the variety of time switches in use in the system, tripping is accomplished by a number of different arrangements some of which are so involved with the other functions of the switch that if wrongly handled, the switch will fail to follow its schedule, complaints will be occasioned and the services of a troubleman will be required to restore service. Those whose duties make it necessary to switch circuits on and off at odd times should become familiar with all methods of tripping before tampering with the switches. In case information or instructions are needed, the Street Light Superintendent's office should be called.

Where 1:00 a.m. and all night circuits are controlled by two time switches at the same location, it is customary to connect the all night switch as the master switch to control the "on" operation of both circuits simultaneously as shown on Diagram 3, Page 0-858 of Electrical Standards. After manually tripping switches in this arrangement, care should be exercised to leave the timing mechanism properly set for correct sequence of operation - the master switch on standard all night "on" and "off" schedule and the 1:00 a.m. switch "on" at noon and "off" at 1:00 a.m.

Carrier current controllers are provided with buttons mounted externally to the case for manual operation.

In operating, the buttons must not be held longer than necessary to trip the solenoid switch as there is danger of blowing the fustat or damaging the solenoid winding. In cases of repeated operation of the buttons, the Street Light Superintendent's office should be called to check the controller.

Synchronous motor timed controllers, which are similar to electric clocks, altho self-starting, must be re-set to correct time after an interruption lasting any appreciable time. It is the rule that whenever a distribution transformer is disconnected from line, altho it be but a few moments, the interruption be reported to trouble dispatcher. If the lost time is not compensated, switching of street lights may be delayed.

ELECTROLIER SYSTEMS OUT OF SERVICE

In assessment districts which have demanded lower cost of electrolier lighting, portions of the lighting systems have been taken out of service. This has been done in several ways. In some cases the 1:00 a.m. lights have been discontinued. In others only the street side lights of two unit posts are lighted. On some residential systems if the entire system is not abandoned, only the most essential lights remain lighted. On some systems the size of the lamp has been reduced.

Where lights are out of service, the street light patrol maps have been marked so that the patrolman can readily locate them.

In residential districts it is customary to remove the lamps and glassware and cap the post. On boulevards the district is usually willing to pay for the maintenance (cleaning and replacement) of the glassware on the dead units. The actual expense is billed to the district monthly.

When an entire circuit goes out of service, the transformer is disconnected from both the line and the load. This is done by pulling cut-outs if possible, although in some cases it is necessary to cut the leads on pole type transformers or to disconnect the terminals inside the tanks on subway transformers.

PUTTING NEW ELECTROLIER SYSTEMS IN SERVICE

Electrolier systems are constructed by contract under specifications and inspection of the Bureau of Street Lighting of the Board of Public Works.

Inasmuch as the Department of Water and Power assumes the maintenance and operation of the systems, it is essential that the new installation be tested and inspected by its own organization to protect against later development of faults of design or construction which would increase the cost of service above normal.

Random posts are selected and inspected for the following points:

Lamps - Correct rating and correct filament mounting as to base up or base down position.

Refractors - Type and position as to "house side" and "street side" of asymmetric refractors.

Sockets - Position as to correct light center in refractor, globe or lantern. Mechanical construction of mounting.

Lamp Transformers - Rating. Integrity of soldered joints.

Potheads - Rigidity of mounting. Convenience of removing caps. Excess of compound interfering with contacts or removal of caps.

Glassware - Uniformity of color and density. Possibility of leakage when pinnacles are used.

Posts - Quality of painting.

General - Various details of hardware, fittings, wiring and fastenings.

Tests are made as follows:

1. Each circuit lighted separately.

2. All circuits lighted together.

3. With one secondary leg of the transformer disconnected from line and connected to ground, transformer is energized for two minutes. The test is then repeated for the other leg. This test will break down any weak spots in the insulation avoiding possibilities of failure in regular operation.

4. Transformer adjusted for current regulation.

As each circuit is lighted, a count is made of the number of lamps lighted and checked with the data sheet furnished from the Engineering Office. Discrepancies are corrected in the field or noted on the sheet. The proper position of all-night and 1:00 a.m. lamps on the posts are also checked. An accurate check of the number of lamps is important as billing is based on this count.

STANDARD TESTS ON UTILITARIAN CIRCUITS AT DISTRIBUTING STATION

These tests are made daily between 12:00 and 12:30 p.m. and again between 4:00 and 4:30 p.m.

No. 1. Foreign current - A test is made between each terminal of each street light circuit and ground through the primary side of a potential transformer. A lamp on the secondary side glows or lights if foreign current is present. The approximate voltage is determined by successively testing with different ratios on the transformer or with different numbers of lamps in a series bank until a combination is reached on which the lamps burn bright. The voltage of the foreign current which produces bright lamps is marked on the taps.

No. 2. Low voltage ground - This test is for low resistance grounds on the circuits and is made by applying 240 volts between each terminal and ground through two lamps in series. The lamps light if the circuit is grounded.

No. 3. Low voltage open circuit - This is a continuity test. Ungrounded 240 volts through two lamps in series is applied to the street light circuit terminals. If the circuit is closed, the lamps burn; if open, they remain dark.

The following special tests are made only on orders from the load dispatcher.

No. 4. Locating open circuit - The station operator grounds one side of the street light circuit and supplies 240 volts between the other side of the circuit and ground through two lamps in series. The troubleman in the field then tests at successive points in the circuit by connecting his test set (which is merely a coil and plunger indicator) between line and ground. The open lies between two test points at one of which the test set indicates voltage and at the other none. The clearing of the trouble is indicated in the station by the steady burning of the lamps. Instead of using his test set, the troubleman often makes a contact between the line wire and ground noting whether or not a spark is struck.

No. 5. Locating a ground - The station operator applies 240 volts between one line terminal and ground through two lamps in series. The troubleman in the field then opens the circuit at successive points connecting in his test set in series. The ground lies between two test points at one of which the set indicates current, the other where it does not. The clearing of the ground is indicated at the station by the lamps going out and remaining dark.

No. 6. Locating foreign current - The station operator grounds one side of the street light circuit through the connections described in Test No. 1. The troubleman in the field opens the circuit at successive points and connects his test set in series being careful to insulate himself against the high voltage. The cross with the foreign circuit lies between two test points, at one of which the test set indicates current and at the other does not. Removal of the foreign current is indicated at the station when the lights go out and remain dark.

No. 7. High voltage ground test - This test is for high resistance grounds or for cases of short arcing distance to ground. The station operator fuses the low side of a step-up transformer. One leg of the high side is grounded and the other is connected to one terminal of the street light circuit. The transformer is energized. The fuse blows if the circuit is grounded and remains intact if clear.

No. 8. High voltage open circuit test - This test is for checking the low voltage open circuit test. The high voltage will often break across gaps and indicate a closed circuit although the circuit will not actually close until the line is energized for lighting. This is due to the fact that many lamps burn out at the moment the circuit is switched off as then no voltage is available to break down the film cut-outs. The station operator proceeds as in Test No. 7 except that the two transformer legs are connected to the street light circuit terminals. The fuse blows if the circuit is closed and remains unblown if the circuit is open.

The method of performing the above tests is detailed on Drawings D-739 and D-740 which can be obtained from Power Drafting Room.

Another test which is made during street lighting hours in case of a swinging open is that of keeping the circuit energized for a full minute although the movable coil of the transformer may be jumping. This causes an arc across the open which is generally reported in by telephone by some chance observer.

- - - - - - -

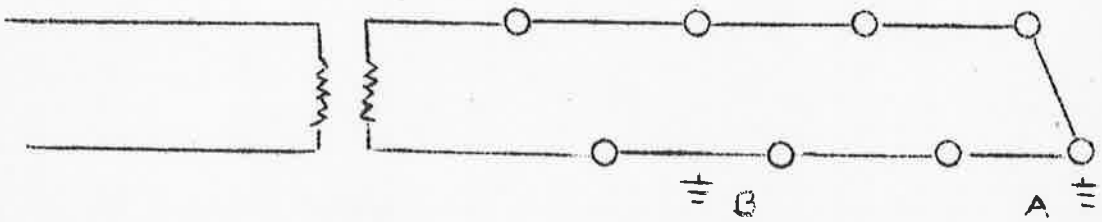
Where utilitarian circuits are fed from field transformers, the troubleman arranges his own tests. The transformer secondary leads are provided with disconnecting switches and a series receptacle is installed in one leg of series circuit into which either a portable ammeter or a "hot" leg from an available commercial secondary line can be plugged in and tests made similar to No. 2 and No. 3 above.

Utilitarian street light circuit troubles are mostly "opens" which usually occur either at the lamp terminals or within the lamp fixture. However, the above tests fully provide for any type of trouble which may develop.

REMOVABLE GROUNDS ON SERIES ELECTROLIER CIRCUITS

Since the early part of 1946, the Bureau of Street Lighting has been equipping some of the existing series electrolier circuits with removable grounds installed at or near the middle point of the circuit. The grounds are connected through disconnecting potheads for safety to the workmen when switching the grounds on or off. The locations of the removable grounds are shown on the patrol maps, the position of the symbol indicating whether the pothead is in a post base or in a junction box.

The removable grounds were established for the purpose of detecting accidental grounds when they occur on the circuits so that they can be immediately cleared. In the following diagram,



A is the removable ground and B is the accidental ground. When the ground at B develops, all lights between A and B will go out, indicating to the patrolman that the accidental ground will be found at B. He should note this point and then pull the pothead plug at A which will re-light the lamps in the section of the circuit between A and B. During the following day, the maintainer will clear the ground at B and replace the pothead plug restoring the circuit to normal.

PROTECTION

Constant current transformers like distribution transformers, are protected by fuses on the primary side. However, since the constant current transformer is not damaged by overloading, the fuses are only for the protection of the circuit against internal breakdown of the transformer. As there is a heavy current surge when constant current transformers are switched on, the fuse is approximately fifty per cent higher capacity than for distribution transformers of the same output rating. Fusing standards are given on Sheet 0-60 of Electrical Standards.

Vaults containing constant current transformers served from overhead lines are protected by automatic oil circuit breakers installed on the riser poles. Switch settings are based on the instructions given on Sheet 0-336-B of Electrical Standards, the ampere tripping values to be taken as two times the total rated kw capacity of the constant current transformers. S & C Positect type of fuse cut-outs as identified by yellow handle or by yellow "Scotch Lite" tape on cut-out may be substituted for automatic oil circuit breakers where the installed transformer capacity is less than 30 kw per phase.

Series insulating transformers except in the smallest sizes are protected from high voltage damage by a protector installed across the secondary leads. The protector operates by short-circuiting the transformer in case an open develops in the series circuit. The high voltage breaks down the film cut-out which must be replaced between the clips of the plug just the same as in the series socket. Special film cut-outs are stocked for SL transformers and are carried in three ratings which correspond with the transformer ratings. Thus a 3 kw cut-out is used on SL transformers of 3 kw and smaller, a 5 kw cut-out on 5 kw transformers and a 10 kw cut-out on transformers larger than 5 kw.

REGULATION

When series lamps are burned above rated current, the life is materially shortened. When burned below rated current, the efficiency of light output is lowered. Regulation of current is therefore of great importance in street lighting maintenance.

Modern constant current regulating transformers will maintain the current within one percent above or below 6.6 amperes over the range from full to zero load. However, on new transformers there is a tendency for the current to rise slightly over a period of a few weeks after installing due to the absorption of oil into the coils and further rechecks of regulation, at intervals of two to four weeks, must be made until the regulator is found to be operating in a satisfactory manner. Thereafter routine regulation checks are made in the field at intervals of about twelve months. The current is adjusted for some value between 6.57 and 6.62 amperes but as close to 6.60 as possible. Similarly, it has been found advisable to check the regulation of existing transformers after load changes.

The current as found and as left, reported to the nearest 1/100 of an ampere, is noted on a special Regulating Street Lighting Transformer Job Order, the "B" copy of which is transmitted to the Street Lighting Engineers where the data forms part of a useful history of each transformer.

Procedure of routine regulation check is as follows:

Before checking regulation, the circuit should be patrolled and out lamps replaced. This is particularly important when lamp transformers are in the circuit as the reactance of lamp transformer with open secondary tends to overload the regulating transformer and give a false regulation adjustment.

With the circuit dead, a direct reading ammeter is connected in the circuit by plugging into a lamp socket receptacle or into a plug cut-out at the transformer vault. As the ammeter is at line potential, it must be insulated from ground and care must be taken not to touch it while the circuit is energized. Before taking a reading, the circuit should be energized for sufficient time to allow the current to become stable. If mercury lights are on the circuit, the time will be not less than 10 minutes.

Adjustments of the transformer mechanism are made with the transformer disconnected from the primary line. The adjustment is made by manipulating weights which balance the moving coil. To reduce the current, weights must be adjusted to hold the coils further apart and vice versa. This is accomplished in the three different makes of transformers by different methods. To reduce the current in the older General Electric, add weights; in the new General Electric, screw weight toward end of arm in the Westinghouse, slide weight toward end of arm and in the Moloney, screw the weights toward the center of the transformer.

It has been found that lead weights in transformers cause sludging of the oil. The older transformers were originally furnished with lead weights and where such are found at the time of checking regulation, they should be replaced with iron weights.

In some transformers the oil level is above the regulation adjusting mechanism and if the oil is too hot for the hands to be comfortably immersed, a portion of the oil may be removed. The oil however must be replaced or some added if necessary to bring the oil level to normal before checking regulation.

At the time of regulating the transformer, a check should be made for friction and aging. Friction may occur in the bearings or between the coils. It can be checked while the transformer is energized by slightly moving the movable coil with a light slender stick and watching to see if it returns to its original position and the current returns to its original value. Aging may be determined from the appearance of the inside and from the color and odor of the oil.

After adjustments have been completed and before replacing the cover on subway transformers, the gaskets should be examined for evidence of overcompression, presence of foreign material or defects in the gasket and replaced with new gaskets if necessary. After bolting down the cover, an air pressure of 3 pounds per square inch is applied to the tank for ten minutes to test for leaks. If the pressure is not maintained for the period, the leaks may be found by applying soapy water around the joints.

SAFETY IN STREET LIGHT MAINTENANCE

Multiple street lights require no further safety precautions than necessary on any low voltage system. However, some multiple systems are switched on the primary side of the transformers and the usual precautions for handling 4800 volts must be observed in handling the switch.

Series street light circuits involve voltages which in some cases reach values as high as 5000 volts and require extreme care in handling.

The following safety rules have been proved by many years use on the street lighting system:

All circuits at all times, day and night, shall be considered as energized except for clearances in accordance with provisions of Operating Order #1.

When handling disconnecting potheads or any parts which carry current rubber gloves and leather protectors must be used except for clearances in accordance with provisions of Operating Order #1.

The standard practice for switching street light transformers in the field is by means of a single pole primary oil switch in one phase of the primary.

With one or more transformers switched by a common switch leg, such arrangement leaves the other phase and the primary winding of the transformer "hot" even though the switch is open. To prevent feed back through primary winding of related transformers, the fuse cut-outs or similar protective device must be opened to clear switch and transformers.

When installing or removing lamps, rubber gloves must always be used whether the circuit be dead or alive. The glass may break and contact might be made with the circuit unless one's hands are protected.

Utilitarian circuits must be kept continuously closed at all times - day and night except under the following conditions:

1. Utilitarian circuits supplied from distribution stations may be opened after obtaining clearance from dispatcher who orders the circuit to be grounded on both legs at the station.
2. Utilitarian circuits supplied from pole transformers may be opened if troubleman opens transformer primaries or secondaries and protects with "Men at Work" sign.
3. A portion of a circuit may be opened at any time if shunted or by-passed with a jumper. However, the circuit must be considered as though energized and worked with rubber gloves.

When working on an electrolier circuit:

EITHER:

Block the time switch or remove control fuse and place "Men at Work" sign on switch,

OR

Ground the circuit on both sides of the point being worked on. This, however, should never be attempted on an open circuit without first de-energizing the circuit.

Secondary disconnecting potheads or disconnecting plugs at feed point must not be pulled while circuit is energized; the switch controlling the transformer primary first must be tripped open, except where a single plug cut-out is used as described on Page 42.

Series disconnecting potheads on individual lamps must be pulled slowly. In case of continued arcing due to failure of the short-circuiting contacts to close, the plug must be immediately restored.

Primary disconnecting cut-outs on 15 kw and larger constant current transformers must not be opened while energized as the arc will burn up the cut-out. The only safe method of opening the circuit is by means of shunting the cut-out with an oil switch. First close the oil switch, next open the disconnecting switch, then open the oil switch and finally remove the oil switch.

An exception to the preceding paragraph is the use of the new type S & C Positect cut-outs, as identified by yellow handle or by yellow "Scotch Lite" tape on cut-out. These cut-outs may be used to open single or combinations of constant current transformers totaling 30 kw or less without the use of an oil switch.

In some vaults the G & W oil fuse cut-outs on the transformer primaries may be some new and some old style. When handling plugs, care must be taken to return the proper plug to the cut-out to which it belongs. If wrongly matched, the position of the handle will give a false indication of the open and close positions of the contacts.

Reference is made to the following material for personnel required to open or work in manholes or vaults:

Underground Section Instruction Bulletin Nos. 1, 5, 6, 7, 12, 13, 14, 15 and 16.

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