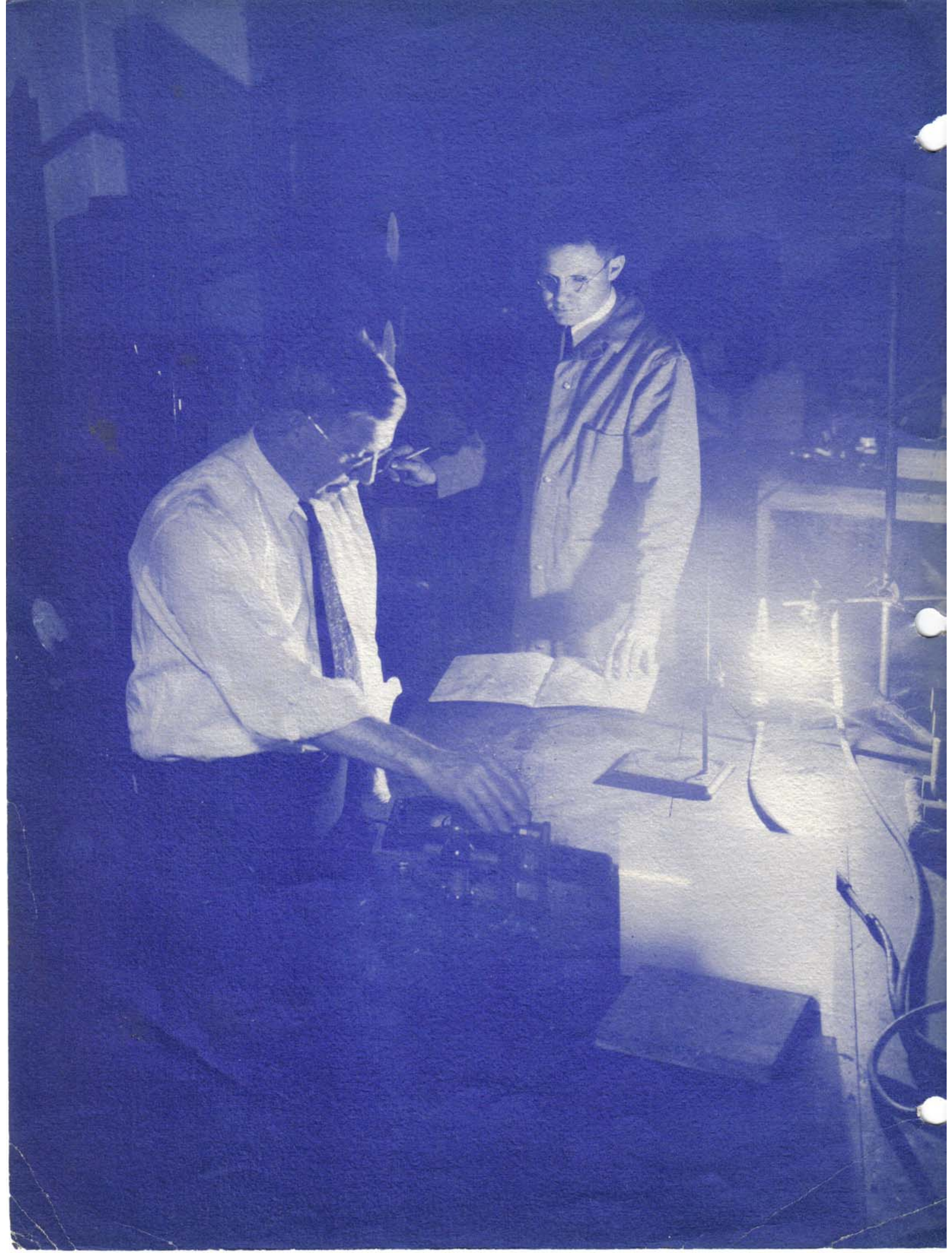
MERCURY VAPOR LAMPS

LAMPS • AUXILIARIES • APPLICATIONS

WESTINGHOUSE ELECTRIC CORPORATION
Lamp Division
BLOOMFIELD, NEW JERSEY



Westinghouse 1000 watt A-H-12 mercury lamps, mixed with 1500 watt incandescent lamps, provide 45 footcandles at the work level in a Pittsburgh manufacturing plant.

MERCURY VAPOR LAMPS FOR LIGHTING

Economical mercury vapor lighting has been in use for years, in industry particularly for "highbay" lighting and more recently in street lighting application. The fundamental advantages of lighting systems with Westinghouse Mercury Vapor lamps are long lamp life, high luminous efficiency and a very high light output per unit which reduces the number of luminaires to a minimum. There is also the characteristic bluish white color of the light, sometimes desirable in itself, and which produces an approximation of natural "daylight" when blended with incandescent light.

MERCURY VAPOR LAMPS FOR THE GENERATION OF ULTRAVIOLET

Important fields of application other than lighting have developed for these effective sources of radiant energy in the ultraviolet region of the spectrum. The best known is the large and growing sun lamp market where the efficient generation of erythemal ultraviolet rays is utilized. Photochemistry takes advantage of these economical high powered sources of ultraviolet radiation which is of such great value in blueprinting and in speeding up chlorination processes and similar chemical reactions.

ELECTRIC DISCHARGES THROUGH VAPORIZED MERCURY

When electric current is passed through vaporized mercury, the familiar blue-green-white light of the mercury arc is produced, together with a wealth of ultraviolet rays. At the turn of the century, Peter Cooper-Hewitt developed the first practical lamp utilizing a discharge through mercury vapor and together with George Westinghouse organized the Cooper-Hewitt Electric Co. of Hoboken, N. J. The product of that plant gave mercury lighting its start and their research and engineering work in medium and high pressure ranges laid the groundwork for the effective lamps available today. Thirty years later, Dr. Harvey Rentschler of the Westinghouse Research Laboratories, Bloomfield, N. J., perfected the now popular "Sterilamp" which generates bactericidal rays at high efficiency by a discharge through extremely low pressures of mercury vapor. Shortly thereafter Dr. J. W. Marden, also of Westinghouse, established the characteristic improved color, increased efficiency and high power per inch of arc stream obtained with discharge tubes at high vapor pressures. The most recent advance in this field was made by Mr. Luke Thorington of the same laboratories. His contribution is the Fluorescent Mercury lamp.

The mercury arc can be controlled and made to produce a variety of bands of radiation. At low vapor pressures the rays emitted consist almost entirely of the resonance line at 2537 Angstroms. This is the bactericidal ray found in the Westinghouse "Sterilamp" which operates with a low vapor pressure of only a few microns. Westinghouse fluorescent lamps also operate at this low vapor pressure and use this radiation to excite their phosphor coatings. At medium vapor pressures, the radiations of longer wave lengths are strengthened, the energy emitted per inch of arc stream rises and the increased energy in the visible lines results in high luminous efficiency. At higher vapor pressures, the color of the light becomes whiter and the intensity of radiations emitted per unit of arc length rises so that these sources become invaluable where optical light control is required as in new types of street lighting luminaires and in searchlights. By a suitable choice of vapor pressure, wattage and outer bulb material, these sources of radiant energy can be made to meet the requirements of a wide range of application.

H

TYPES OF WESTINGHOUSE MERCURY VAPOR LAMPS

The long useful life with high maintained output of radiation that characterizes Westinghouse Mercury Vapor—Type H—lamps is partly the result of good design and partly good execution in the fabricating plant. These, plus dependable performance with practical and efficient auxiliaries, are available in a complete line of Westinghouse lamps from 100 watts through 3000 watts for both visible and ultraviolet radiation.

3000 W
A-H9

3000 W
C-H9

100 W
A-H4

250 W
A-H5
C-H5

400 W
D-H1
E-H1

1000 W
A-H12
B-H12

400 W
A-H1
B-H1
F-H1

275 W
RS SUNLAMP

100 W
B-H4

100 W
C-H4
E-H4

°TYPE
*WATTS (LAMP ONLY)
OUTER BULB
OUTER BULB GLASS
OUTER BULB FINISH
ARC TUBE MATERIAL
ARC LENGTH (INCHES) (APPROX.)
**BASE
RATED INITIAL LUMENS
RATED AVERAGE LIFE: AT 5 HOURS PER START AT 10 HOURS PER START
MAXIMUM OVERALL LENGTH (INCHES)
LIGHT CENTER LENGTH (IN.) (APPROX.)
BURNING POSITION
ELECTRODE TYPE
VAPOR PRESSURE (ATMOSPHERES)
OPEN CIRCUIT VOLTS
OPERATING VOLTS (APPROX.)
STARTING CURRENT (AMPS.) (APPROX.)
OPERATING CURRENT (AMPS.) (APPROX.
STARTING TIME (MINUTES)
RESTRIKING TIME (MINUTES)
GENERAL LIGHTING
FLOODLIGHTING
STREET LIGHTING
BLACK LIGHT
PHOTOCHEMICAL
BLUEPRINT AND PHOTOGRAPHY
SUN LAMP SERVICE
SEARCHLIGHT AND PROJECTION

TABLE I

TECHNICAL DATA FOR REPRESENTATIVE MERCURY VAPOR LAMPS

A-H4	B-H4	C-H4 (Sp) E-H4 (Fl)	A-H5	C-H5	RS	A-H1 B-H1	D-H1	E-H1	F-H1	A-H12	B-H12	A-H9	C-H9
100	100	100	250	250	275	400	400	400	400	1000	1000	3000	3000
T-10	T-16	PAR-38	T-14	T-14	R-40	T-16	T-20	T-20	T-16	T-28	T-28	T-9½	T-8
7720	5872	7720	7740	1720	7760	7720	7740	1720	7720	1720	7740	1720	7911
Clear	Nat. Red Purple	Alum. Reflect.	Clear	Clear	I.F. Alum. Ref.	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Quartz	Quartz	Quartz	Quartz	Quartz	7911	1720	Quartz	Quartz	1720	Quartz	Quartz	***1720	***7911
1	1	1	1⅝	1⅝	1⅝	6	2⅜	2¾	6	5	5	48	48¾
Admed. Sc.	Admed. Sc.	Admed. Sc. Skt.	Mogul Sc.	Mogul Sc.	Med. Sc.	Mogul Sc.	Mogul Sc.	Mogul Sc.	Mogul Sc. Mech.	Mogul Sc. Mech.	Mogul Sc. Mech.	Spade Term.	Spade Term.
3300	—	—	11,250	11,250	—	16,000	21,000	21,000	16,000	60,000	60,000	120,000	120,000
					****								
1000	1000	1000	1000	4000	1000	4000	†1000	4000	4000	3000	2000	5000	2000
1000	1000	1000	1000	4000	1000	6000	†1000	4000	6000	3000	2000	*6000	2000
5⅝	5½	5⁷⁄₁₆	8	8	6⅞	13	11	11	13	14	14	54⅞	56
3⁷⁄₁₆	3⁷⁄₁₆	—	5	5	—	7¾	7	7	7¾	9	9	—	—
Any	Any	Any	Any	Any	Any	††	Any	Any	††	Any	Any	Any	Any
Thorium	Thorium	Thorium	Thorium	Thorium	Thorium	Oxide	Thorium	Thorium	Oxide	Thorium	Thorium	Oxide	Thorium
8	8	8	4.5	4.5	1.1	1.2	2.5	2.5	1.2	1.5	1.5	0.4	0.35
250	250	250	250	250	—	220	†††220	†††220	220	†††220	†††220	850	850
					††††								
	130	130	135	135	110-125	135	135	135	135	135	135	535	535
1.3	1.3	1.3	2.9	2.9	3.2	4.7	4.7	4.7	4.7	12	12	9.3	9.3
0.9	0.9	0.9	2.1	2.1	2.4	3.2	3.2	3.2	3.2	8.2	8.2	6.1	6.1
3	3	3	4	4	2	7	4	4	7	4	4	7	7
3	3	4	4	4	3	7	4	4	7	6	6	8	8
RECOMMENDED APPLICATIONS													
X	—	—	—	X	—	X	—	X	—	X	—	X	—
—	—	X	—	X	—	X	—	X	—	X	—	—	—
—	—	—	—	X	—	X	—	X	X	X	—	—	—
X	X	X	X	—	—	—	X	—	—	—	X	—	X
X	—	X	X	—	—	—	X	—	—	—	X	—	X
X	—	—	X	—	—	—	X	—	—	—	X	—	X
—	—	—	—	—	X	—	—	—	—	—	—	—	—
X	—	—	—	X	—	—	—	X	—	X	—	—	—

*—For total wattage add transformer watts which range from 8% to 25% of lamp watts depending chiefly upon the type of lamp and transformer used.

**—Abbreviations: Admed. Sc.—Admedium Screw; Skt.—Skirted; Mech.—Mechanical; Term.—Terminal.

***—The A-H9 and C-H9 are single bulb lamps. The outer bulb is the arc tube.

****—Average life of the RS sun lamp is rated at 1000 quarter hour applications in normal sun lamp use in the home, or 1000 hours at 5 or more hours per start.

†—The rated average life for the D-H1 is 3000 hours in the vertical position only.

††—The A-H1 and F-H1 are designed for base up burning, the B-H1 for base down burning. These types should be operated within 10° of vertical to prevent the arc from touching the arc tube.

†††—For normal indoor use. Higher open circuit voltages are desirable for dependable starting at lower temperatures.

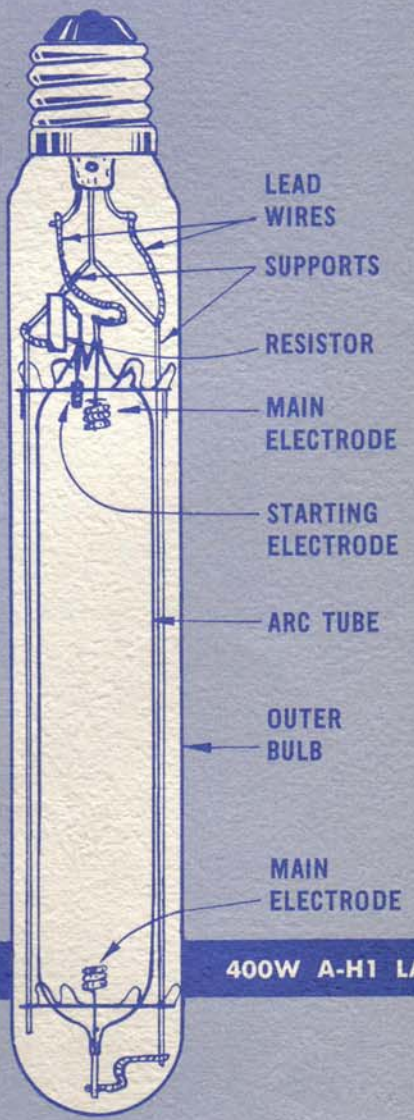
††††—For 50-60 cycle A-C operation only. Operates directly from regular lighting circuit, no transformer required.

°—Partial list; other types of mercury vapor lamps are also available.

*—The A-H9 carries the additional average life rating of 10,000 hours at 144 hours per start (6 days continuous burning).

DESIGNATIONS

The identifying designations of mercury vapor lamps are quite different from those of incandescent and fluorescent lamps. All designations contain the letter "H" (for Hg., mercury), and all types of the same wattage, which will operate on the same transformer, are given the same H numeral designation. All "H-1" lamps, for example, are 400 watt lamps requiring what is called an "H-1" transformer, all "H-4" lamps are 100 watt lamps operating on "H-4" transformers, etc. The numerals are not in order of wattage, but were merely assigned to the various lamp types in the order of their development. Specific types of lamps of a given wattage are identified by the letter preceding the "H" numeral designations: A-H1, B-H1, etc. The letter designations are also assigned arbitrarily in a chronological sequence and have no intrinsic meaning.



400W A-H1 LAMP

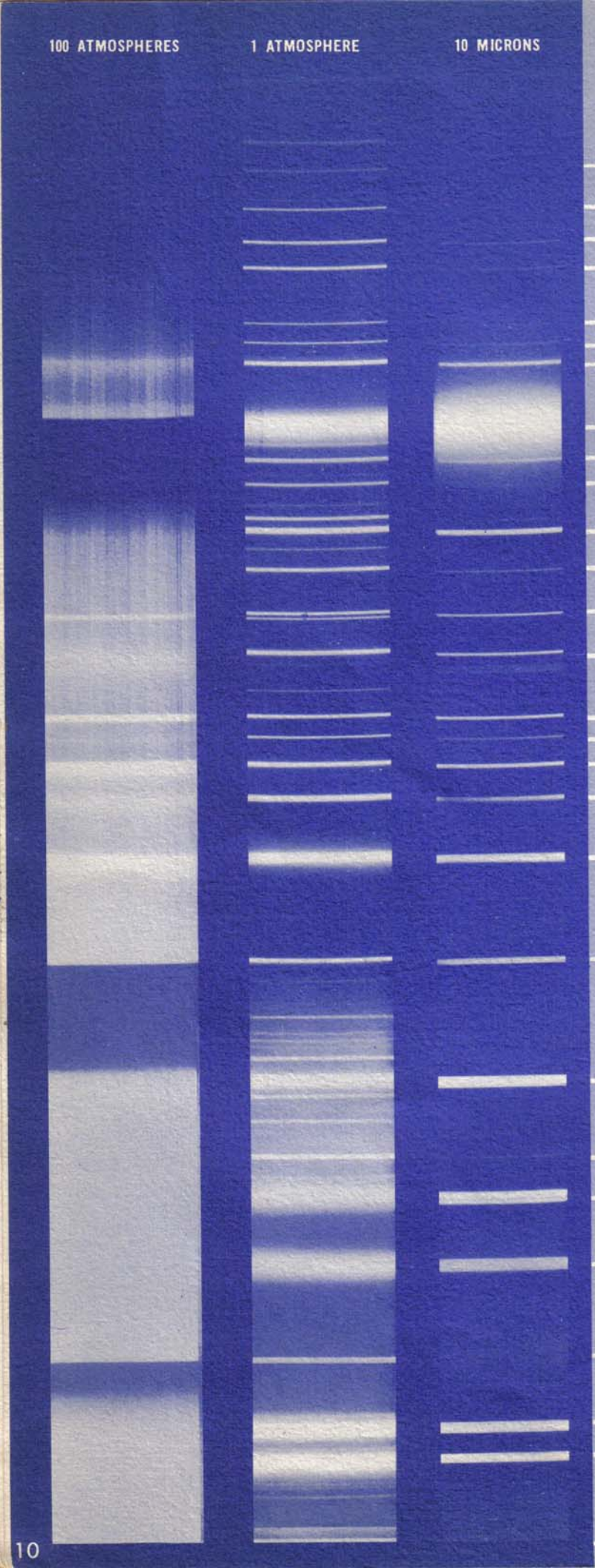
LAMP

CONSTRUCTION

The three basic elements of any electric discharge lamp are the gas, the electrodes and the bulb. In mercury vapor lamps the "gas" is vaporized mercury. Since mercury at room temperature is a liquid, seen as small drops on the inside wall of an unlighted lamp, a small amount of more readily ionized argon gas is introduced into mercury vapor lamps to facilitate starting. The original arc is struck through the ionization of this argon gas. Once the arc strikes, its heat begins to vaporize the mercury, which then gradually becomes a conductor.

The electrodes used in mercury lamps are either of the activated type, with barium oxide as the electron emissive material coated on a coil of tungsten wire, or of the thorium (non-activated) metal type. The electrodes also act as terminals for the arc.

Most mercury lamps are constructed with two bulbs, an inner bulb which contains the arc, and an outer bulb which shields the arc tube from changes in temperature and in some cases acts as a filter to remove certain wave lengths of the arc radiation. The arc tube is made of quartz in some lamps and of hard glass in others. The outer bulb is hard glass, the exact type depending upon the application for which the lamp is designed, and the portion of the arc spectrum which it is desired to transmit. The space between the two bulbs is evacuated in quartz lamps and filled with inert gas where the inner bulb is glass.



RADIATION

The mercury arc produces a line spectrum having strong lines in the ultraviolet and visible regions, and some in the infrared. Mercury vapor lamps vary greatly in design according to the region of the spectrum that it is desired to use. Lamps used primarily for lighting purposes are designed to produce as much energy as possible in the four important lines and in their side bands within the visible spectrum: 4047A, Violet; 4358A, Blue; 5461A, Yellow-Green; and 5770-90A, Orange-Yellow. Erythemal (sunburn) and vitamin D production or antirachitic effects are induced by shorter wave ultraviolet radiations centering around the 2967 Angstrom line and those immediately on either side of it. The bactericidal region of the ultraviolet spectrum is of still shorter wave lengths. The 2537 Angstrom line is the effective wave length produced by a group of special mercury vapor lamps designed for bactericidal use.

Photospectrograms of low, medium and high pressure mercury discharges in quartz

CHARACTERISTICS

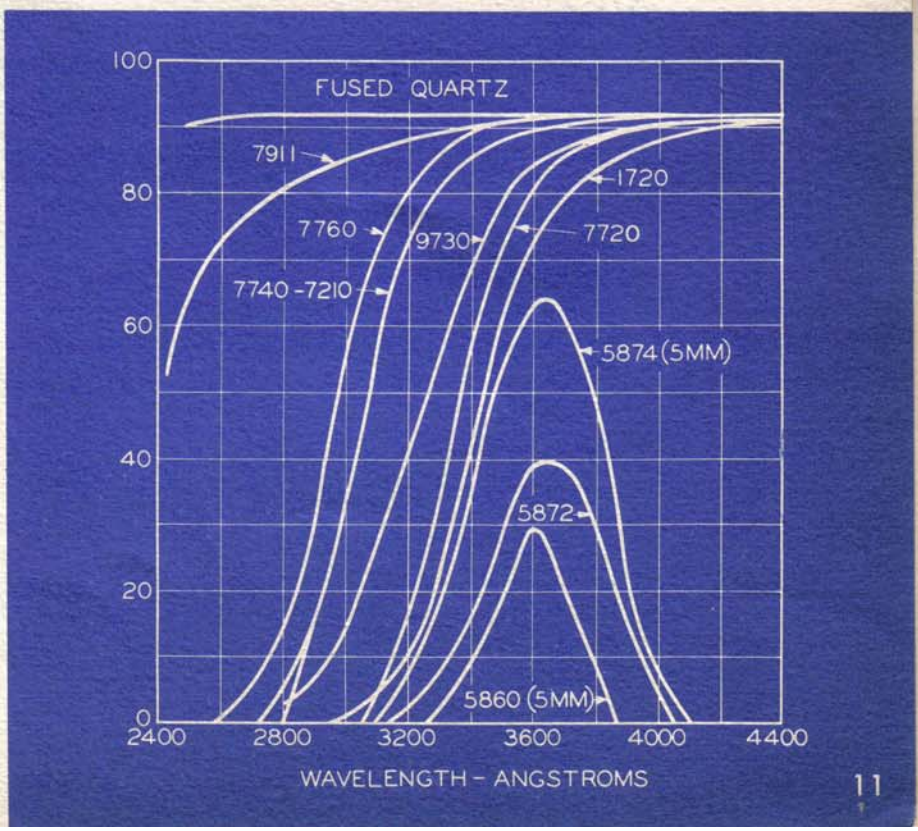
Control of the radiation generated by the mercury arc so as to produce energy in these various regions is accomplished by the choice of bulb glasses to act as filters, and by regulation of the vapor pressure at which the arc operates. The relative intensities of the various mercury lines change considerably with changes in vapor pressure, the general effect of increasing pressure being to shift the radiation toward the longer wave lengths as shown in the spectra so that relatively more energy is generated in the visible and relatively less in the short wave ultraviolet regions.

At high pressures there is a tendency for the lines to widen, and the gaps between them to be filled in, until at 100 atmospheres the lines appear against a background of radiation that is almost continuous throughout the spectrum. Bactericidal lamps operate at exceedingly low vapor pressures (about 10 microns) where the efficiency of production of the 2537 Angstrom line is very high. Most other types of mercury lamps are operated at medium pressures (one to ten atmospheres) where much less 2537 Angstrom energy but much more long wave ultraviolet and visible are produced.

Reference to the accompanying spectral transmission curves of commonly used bulb and arc tube glasses will show how the purpose for which the lamp is designed determines the choice of glass for each of the lamps listed in the table of technical data.

Quartz and No. 7911 glass (vycor) have the highest transmission in the ultraviolet and remain high even at lamp operating temperatures. Where an outer bulb is used, a type of glass is selected that will screen out the bactericidal and erythemal ultraviolet, unless they are specifically wanted. Lamps designed for general lighting purposes have outer bulbs of No. 1720 or No. 7720 glass, which transmit very little energy below 3400 Angstroms. Lamps to be used as sources of erythemal or long wave ultraviolet energy generally have No. 7740 or No. 7760 bulbs which transmit further down into the ultraviolet, but still cut out the extremely short wave lengths that might be harmful to the eyes. Where quartz or No. 7911 glass is used without an outer bulb, the eyes must be protected from the rays.

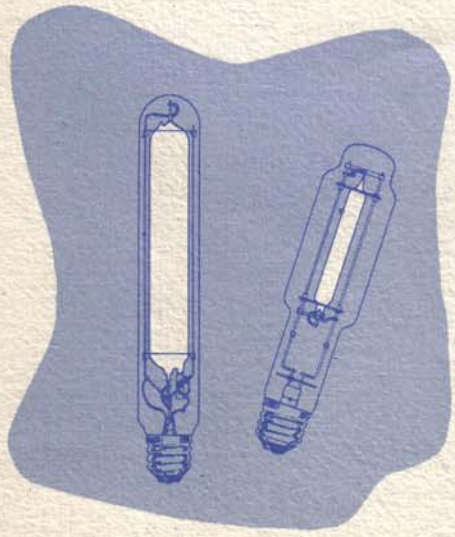
Transmission curves for various types of glass in the ultraviolet and visible spectrum at room temperature (20° C). At higher temperatures, the general effect is to shift the curves somewhat toward the longer wave lengths. The values given are for a thickness of 1 mm. except as indicated for the two typical "Black Light" filter glasses shown.

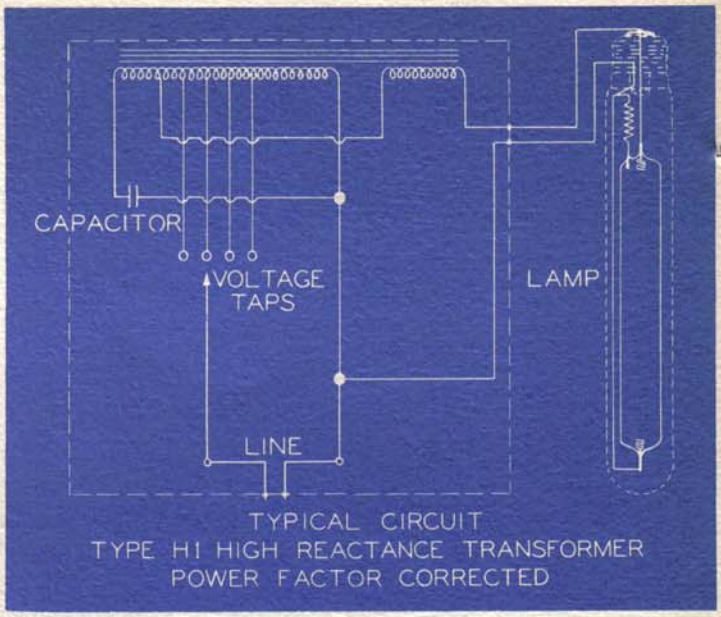


ARC TUBE MATERIAL

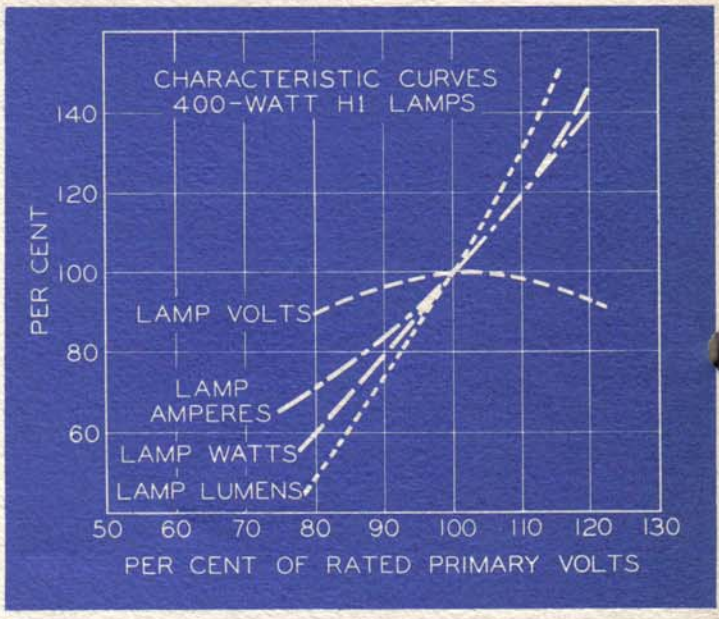
The older type of mercury lamps contain arc tubes made principally of glass, while the newer lamps have arc tubes made of quartz and vycor (No. 7911). The latter materials are able to withstand high temperatures better and so permit brighter, more concentrated sources of light, higher output, higher efficiency, and a slightly better color quality because of the higher pressure at which the arc can operate. All-glass lamps cost less per lamp, but where the same footcandle level is considered and free spacing is permissible, the quartz arc lamps generally furnish more economical lighting.

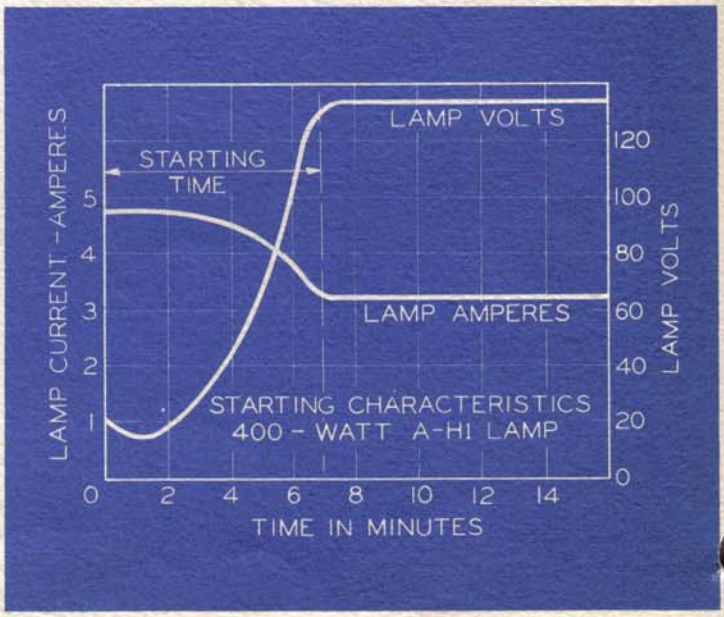
Double bulb lamps with glass arc tubes should be burned in a vertical or nearly vertical position, except where other means are provided to keep the arc from bowing and touching the wall of the tube and so overheating the arc tube glass. Lamps with quartz or vycor arc tubes are designed to give satisfactory performance in any burning position.





TYPICAL CIRCUIT
TYPE H1 HIGH REACTANCE TRANSFORMER
POWER FACTOR CORRECTED





AUXILIARY EQUIPMENT

Electric discharge sources have negative resistance characteristics which cause the current to rise indefinitely and, therefore, some form of current limiting device, usually a high reactance transformer, must be provided. A typical circuit is shown on the opposite page in the upper chart. Current limiting transformers have been designed for each type of mercury lamp to furnish proper lamp voltage and current ballasting through the inductance of the windings. Since a high reactance transformer has a low power factor, a condenser is generally built into the auxiliary. This raises the power factor to 90% or better, whereas uncorrected transformers have power factors of 50% to 60%. Two-lamp transformers only slightly larger than the single lamp type operate one lamp on a leading current and the other on a lagging current, producing an overall power factor of about 90%. Transformer wattage loss per lamp is in general less with the two-lamp transformer and stroboscopic effect is greatly reduced.

All transformers must of course be designed for the specific voltage and frequency of the supply with which they are to be used. The middle chart on the opposite page shows the relationship of voltage, current, power and light output for 400 watt H-1 lamps. Other mercury lamps have similar characteristics. For normal lumen output, wattage consumption, dependable starting and good lamp life, mercury lamps should be operated within proper voltage limits, and the primary of each transformer is provided with suitable taps for line voltages within its general range. For best results, the line voltage should be held to $\pm 5\%$ of the tap setting. Special transformers are available to provide constant wattage operation under conditions of varying input voltage.

Most equipment is designed for a frequency of 60 cycles. Operation of the lamps on lower frequencies down to 40 cycles is possible, although the transformers are larger and stroboscopic effect is greater. Since the arc is actually extinguished each time the current reverses, at frequencies below 40 cycles the mercury vapor may have time between cycles to deionize and the electrodes to cool sufficiently to prevent restriking of the arc. The RS sun lamp is restricted to 50–60 cycle operation.

OPERATING CHARACTERISTICS

Starting and Restarting—The two-electrode types of mercury vapor lamps, the A-H9 and the C-H9 require a starting voltage of 850 volts to ionize the argon fill gas and permit the arc to strike. In the more common three-electrode type of lamp an auxiliary starting electrode placed close to the main electrode nearest the base makes it possible to start the lamp on 250 volts or less. Here an electrical field is first set up between the starting electrode and the adjacent main electrode, causing an emission of electrons which develops a local glow and ionizes the starting gas. The arc then starts between the main electrodes, and the mercury gradually becomes vaporized and carries an increasing portion of the current. During this process the arc stream changes from the diffuse bluish glow of the argon discharge to the bluish-white of the mercury arc, increasing greatly in brilliance and becoming concentrated in the center of the tube.

At the instant the arc strikes the current is high and the voltage is low. Normal operating values are reached after a warm-up period of several minutes, during which the current drops and the voltage rises until the arc attains a point of stabilization in vapor pressure. This is shown in the lower chart, opposite.

An interruption in the power supply, or a sudden voltage drop of more than 15%, will extinguish the arc. Before the lamp will relight, it must cool sufficiently to reduce the vapor pressure to a point where the arc will restrike at the voltage available. Starting time (minutes to full light output at ordinary room temperatures with no enclosing fixture) and restriking time (cooling time until the lamp will restart) are given for the various types

of lamps in Table I. A combination of mercury and incandescent lamps is often used where these starting and restarting characteristics would prove to be inconvenient, as in places where the lighting is turned on and off frequently, or where the power supply is undependable.

Lamp Life and Lumen Maintenance

The lumen output of a new mercury vapor lamp is abnormally high. During the first 100 hours of burning, this drops about 5 to 10%. The deterioration during the remaining life of the lamp is less rapid and follows approximately the curves shown for the 400 watt A-H1 and for the 400 watt E-H1. The published "initial lumens" for Westinghouse mercury vapor lamps is the value obtained after the first 100 hours of burning.

The gradual deterioration that occurs after the 100 hour point is chiefly due to a gradual blackening of the inside of the arc tube throughout its life. Note that the curves illustrate the mean or average lamp. Individual lamps will vary somewhat both in the drop in lumens during life and at failure and in the time required for the lamp to pass through its life cycle.

The higher initial efficiency and higher intrinsic brilliance obtained with the quartz type of lamp is the result of the smaller size arc which is run at a higher loading in terms of wattage per square inch of arc tube. As a result of this smaller size arc chamber the arc tubes of quartz type lamps darken a little more rapidly than the larger glass tubes.

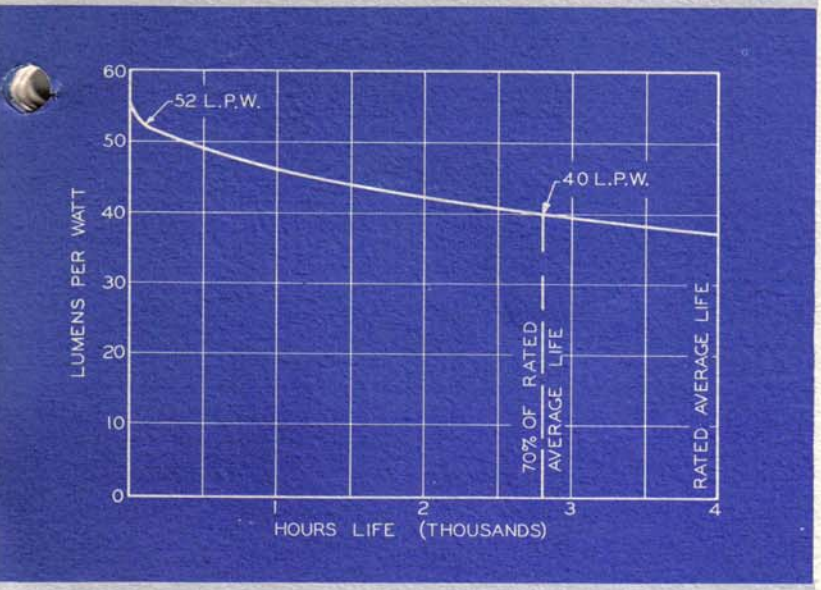
Long useful life is a primary characteristic of all Westinghouse general service mercury vapor lamps. With the oxide type of electrode used in glass arc tube lamps, both life and lumen maintenance are affected by the number of times the lamp is started. Each time the arc is struck some of the emission material is spluttered away and deposited on the inner surface of the arc tube, and this process results eventually in exhaustion of the emission material and blackening of the inner bulb. The thorium (non-activated) electrodes used in quartz arc tube lamps and high intensity photochemical lamps are so little affected by lamp starting that the same average rated life and lumen maintenance apply for burning cycles of either 5 or 10 hours per start.

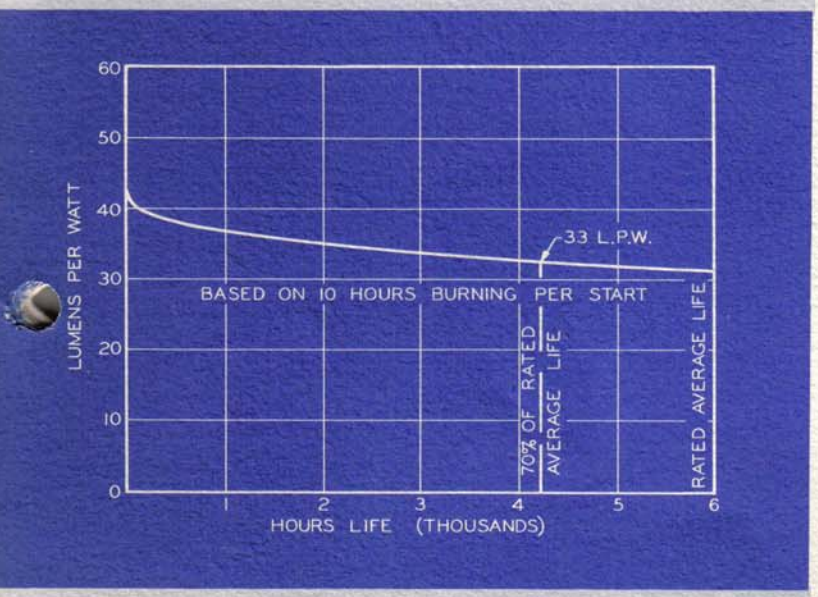
TABLE II

LUMEN MAINTENANCE VALUES FOR GENERAL AND STREET LIGHTING MERCURY VAPOR LAMPS

LAMP TYPE	LUMENS PER WATT		
	INITIAL	70% LIFE 5 Hrs/Start	70% LIFE 10 Hrs/Start
C-H5	45	35	35
A-H1	40	35	33
B-H1	40	35	33
E-H1	52	40	40
F-H1	40	35	33
A-H9	40	34	32
A-H12	60	46	46

LUMEN MAINTENANCE CURVE FOR 400 WATT E-H1 QUARTZ LAMP





LUMEN MAINTENANCE CURVE FOR 400 WATT A-H1, B-H1 & F-H1 GLASS LAMPS

Rated initial lumens per watt applies at the end of 100 hours of operation.

Ambient Temperature

The light output of the double bulb type of mercury lamp is little affected by ambient temperature. Experience has shown that these lamps maintain satisfactory lumen output with temperatures down to —20° F. The single bulb A-H9 and C-H9 lamps, on the other hand, are rather critically affected by low temperatures, particularly if the surrounding air is moving, and they are not considered suitable for use below 32° F. without special protection.

Ambient temperature affects the striking voltage of all discharge lamps to some extent, and higher starting voltages than those listed in the table for indoor use are recommended for street and floodlighting installations in cold climates, particularly where quartz arc tube lamps are used.

Lamp Temperature

Because mercury vapor lamps are long lived, operating temperatures are particularly important. The effect of heat is partly a function of time, and the longer the life of the lamp the greater the possibility of damage from high temperatures. Excessive bulb and base temperatures may cause lamp failure or unsatisfactory performance due to softening of the glass, damage to the quartz arc tube by moisture driven out of outer bulb, softening of the solder, failure of the basing cement, or corrosion of the base, socket or lead-in wires. The use of any reflecting equipment that might concentrate heat and light rays on either the inner arc tube or the outer bulb should be avoided.

The temperatures listed in the following table do not represent maximum safe operating temperatures in actual service. They are the temperatures which should not be exceeded in a laboratory test, with a new luminaire and a new lamp, operating at rated watts, and an ambient temperature of 25° C. Allowance is made for higher temperatures in service due to bulb blackening, overvoltage operation, high ambient temperatures, etc. If a lamp in a given luminaire does not exceed the rated base and bulb temperatures under laboratory conditions the fixture should be safe in service under all ordinary circumstances.

TABLE III

LUMINAIRE TEST TEMPERATURE LIMITS FOR MERCURY LAMPS

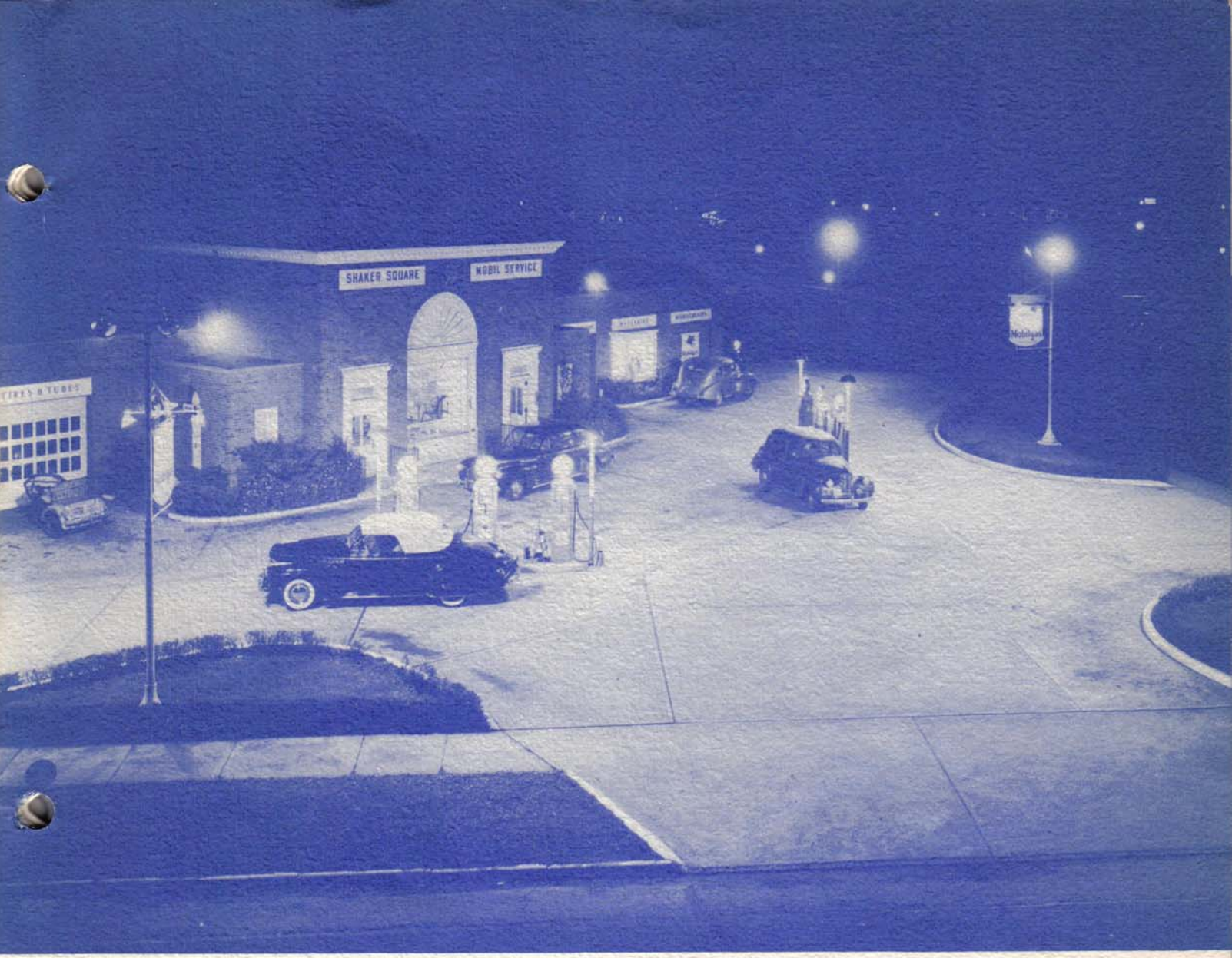
(Measured at 25° C Ambient)

LAMP	OUTER BULB	*BASE
100 Watt A-H4	400° C	170° C
B-H4	400° C	170° C
C-H4, E-H4	400° C	170° C
250 Watt A-H5	400° C	210° C
C-H5	475° C	210° C
275 Watt RS	250° C	170° C
400 Watt A-H1, B-H1	400° C	170° C
D-H1	400° C	210° C
E-H1	475° C	210° C
F-H1	425° C	200° C
1000 Watt A-H12	475° C	210° C
B-H12	400° C	210° C
3000 Watt A-H9	375° C minimum to 550° C maximum throughout length of arc tube	
C-H9	375° C minimum to 650° C maximum throughout length of arc tube	

A 10° C higher test temperature is considered acceptable in street lighting and outdoor floodlighting fixtures because the ambient temperatures during operation are generally lower than in other types of service.

APPLICATION

INFORMATION



Attractive nighttime appearance of gasoline station provided by 400 watt A-H1 or E-H1 lamps in floodlight units. Warm color of light from incandescent lamps is used to light the pump island.

The line spectrum of mercury lamps is a very efficient source of light, but its deficiency in the red and preponderance of blue and yellow-green results in marked distortion of object colors and makes its use undesirable where the appearance of colors is important. Color correction satisfactory for many purposes and resulting in a sort of "synthetic daylight" may be obtained by adding tungsten filament lamps in the same fixture or alternate fixtures, to supply the red lacking in the mercury spectrum. The incandescent lamps also furnish light while the mercury lamps are heating up. The minimum amount of incandescent light necessary to provide noticeable color improvement, particularly in the appearance of the human skin, is about 15% of the total light, on the basis of lumens. Beyond a ratio of approximately 60% incandescent lumens to 40% mercury lumens the additional improvement obtained by adding more incandescent lamps is slight, and the overall efficiency of the lighting system is seriously reduced. On the other hand, the distinctive color of mercury light may sometimes be an advantage, as in certain street lighting applications, or in floodlighting designed to attract attention to roadside stands, service stations, or displays. Where the floodlighted area includes green grass or foliage or is treated with paint having a high reflectivity for one or more of the strong visible mercury lines, the effect is particularly striking. Mercury lamps with properly selected filters are also highly suitable for the production of violets, blues, yellows and yellow-greens for floodlighting purposes.

A new Westinghouse *fluorescent* mercury vapor lamp now being developed will provide color correction at high efficiency. These lamps will be used for floodlighting and general lighting where accurate color discrimination is not required.

Brightness: All medium and high pressure mercury arcs are brilliant. The values given in Table IV below show average candles per square inch of projected arc area in several representative lamps. The effective width of the arc stream used in the computations includes practically all of the luminous energy radiated. The values are only approximate but they show the relative merits of the various lamps, particularly for applications where light control is important. Westinghouse short arc mercury lamps are being developed for use where greater brightness and more compact sources are desired.

TABLE IV

BRIGHTNESS OF MERCURY ARCS

LAMP	LUMENS	ARC LENGTH (INCHES)	EFFECTIVE ARC DIAMETER (IN.)	*AVERAGE CANDLES PER SQ. IN.
A-H4	3,000	1	3/32	3,200
C-H5	10,000	1-5/8	5/32	3,800
A-H1	16,000	6	7/16	600
F-H1	16,000	6	7/16	600
E-H1	21,000	2-3/4	15/64	3,250
A-H12	60,000	5	7/16	2,700
A-H9	120,000	48	7/16	500

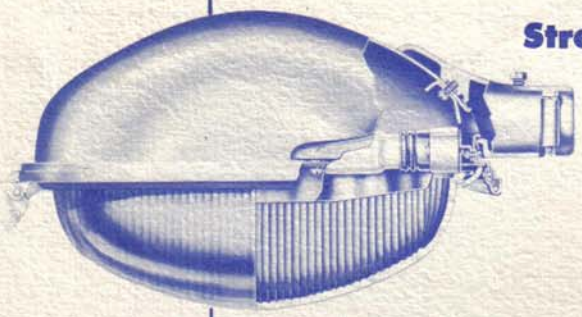
*—At 90° from axis of arc stream.

Stroboscopic Effect: The arc of a mercury vapor lamp operating on 60 cycle alternating current is completely extinguished 120 times a second. Thus there is a tendency for the eye to see in flashes, with the result that a rapidly moving object may appear to move in a series of jerks. Stroboscopic effect may be greatly reduced by operating pairs of lamps on lead-lag two-lamp transformers, or three lamps on the separate phases of a three phase supply. The use of incandescent lamps in combination with mercury lamps also lessens stroboscopic effect.

LAMP APPLICATION

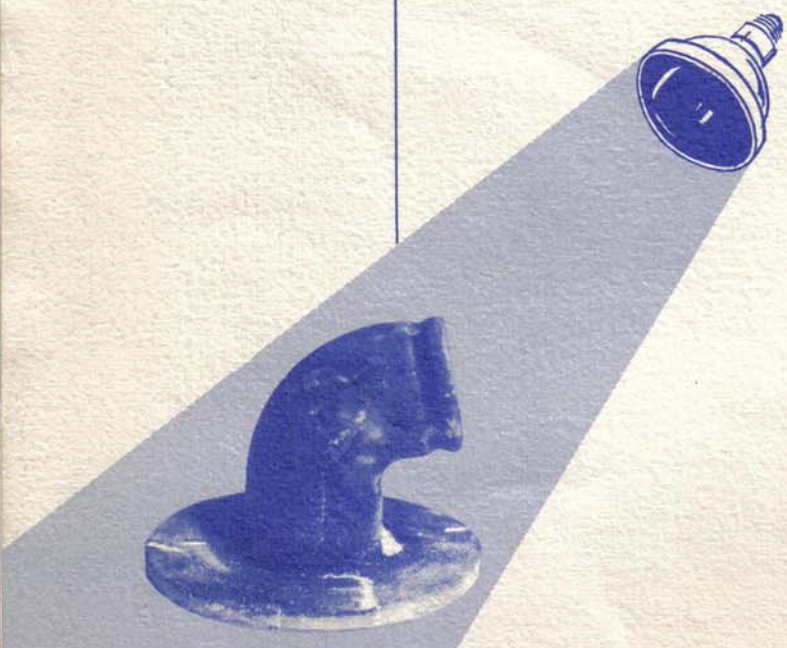
Highbay mounting of 3 Kw. A-H9 mercury lamps with minimum percent of incandescent lamp color correction illuminate Geneva, Utah, steel plant to 50 footcandles.

General Lighting: Mercury lamps are most commonly used for general lighting purposes in high bay installations covering large areas such as steel mills, airplane plants and foundries where color discrimination is not important. The distinctive mercury color is sometimes an advantage and the high output and long life of each individual lamp reduces maintenance costs to a minimum. Where rough work is done, as in steel mills, the lamps are used alone, but where a fairly high degree of color discrimination is required and to improve the appearance of people and things seen in the light, alternate fixtures with incandescent filament lamps are often used.



Quartz mercury vapor lamps in new optical system increases utilization of light in street and highway lighting.

Street Lighting: There is an increasing interest in the use of mercury vapor lamps for solving the difficult problems of street and highway lighting. One of the newest and most promising developments in street lighting equipment is an oval reflector with a companion refractor, designed around a horizontally mounted quartz mercury vapor lamp. Because of the relatively small size of the quartz mercury arc and the horizontal mounting in the fixture, a higher utilization of light on the street is possible than with previous vapor lamp-luminaire combinations.

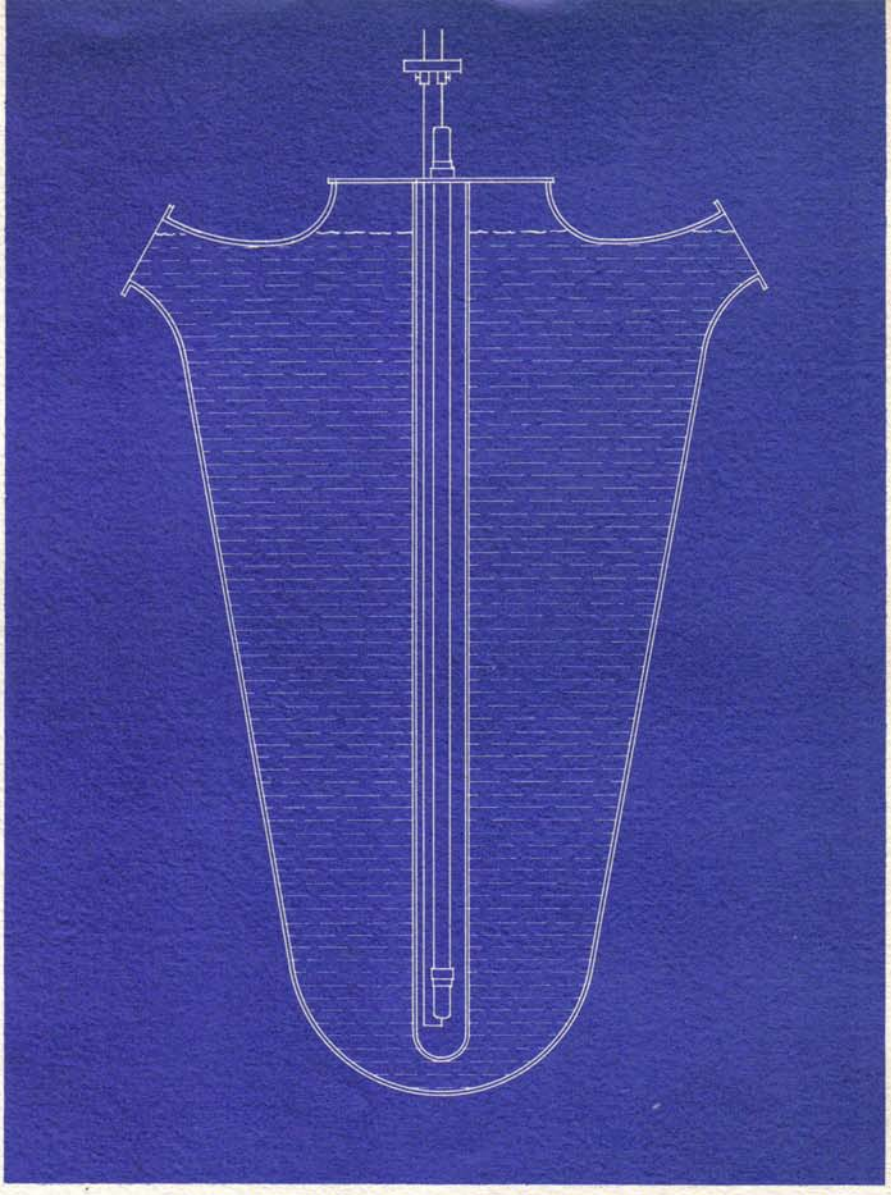


Crack in casting is revealed by black light—fluorescence in industrial inspection.

Black Light: Black light is the name commonly given to the near ultraviolet portion of the spectrum. These radiations are absorbed and converted into visible radiations by fluorescent substances. For best results it is generally necessary to eliminate the visible radiations from the mercury arc which would otherwise mask the fluorescent effect. For this purpose, a red purple glass filter is used which transmits the ultraviolet and absorbs most of the visible rays. The C-H4 and E-H4 mercury lamps with inbuilt reflectors are particularly suitable for black light application with the addition of a simple snap-on filter of No. 5874 red purple heat resisting glass. The B-H4 lamp incorporates the filter as its outer bulb and is usually used with an external reflector of Alzak aluminum. Other mercury lamps that are applicable for black light service are generally mounted in a reflector in conjunction with a red purple glass filter plate placed across the reflector opening. The principal applications for black light are primarily for theatrical, decorative and amusement purposes. It is finding increasing use in the field of industrial inspection such as for the detection of cracks in castings with a fluorescent penetrating oil. In criminology work, document identification and similar fields, black light is often invaluable.

Floodlighting: Mercury vapor lamps have in the past been used but little in floodlighting, partly because they could not be tilted at will. Quartz type lamps listed on page 7 now not only make possible a universal burning position but often result in greater optical effectiveness because of the small size of the source and its high brightness. Quartz mercury lamps therefore promise to help widen the market for mercury lamps in the floodlighting field where their high output, blue-green-white color and other characteristics recommend them. The long-life A-H1 glass type lamp is frequently used for wide beam short throw floodlighting and is restricted to vertical burning, except as noted on page 12. In combination with incandescent lamps mercury lamps provide a close approximation of daylight which now becomes practical in all of the many applications of floodlight projectors.

Mercury floodlights fully reveal the bronze green beauty of the Statue of Liberty.



WESTINGHOUSE C-H9 IN PHOTOCHEMICAL REACTION KETTLE

Photochemistry

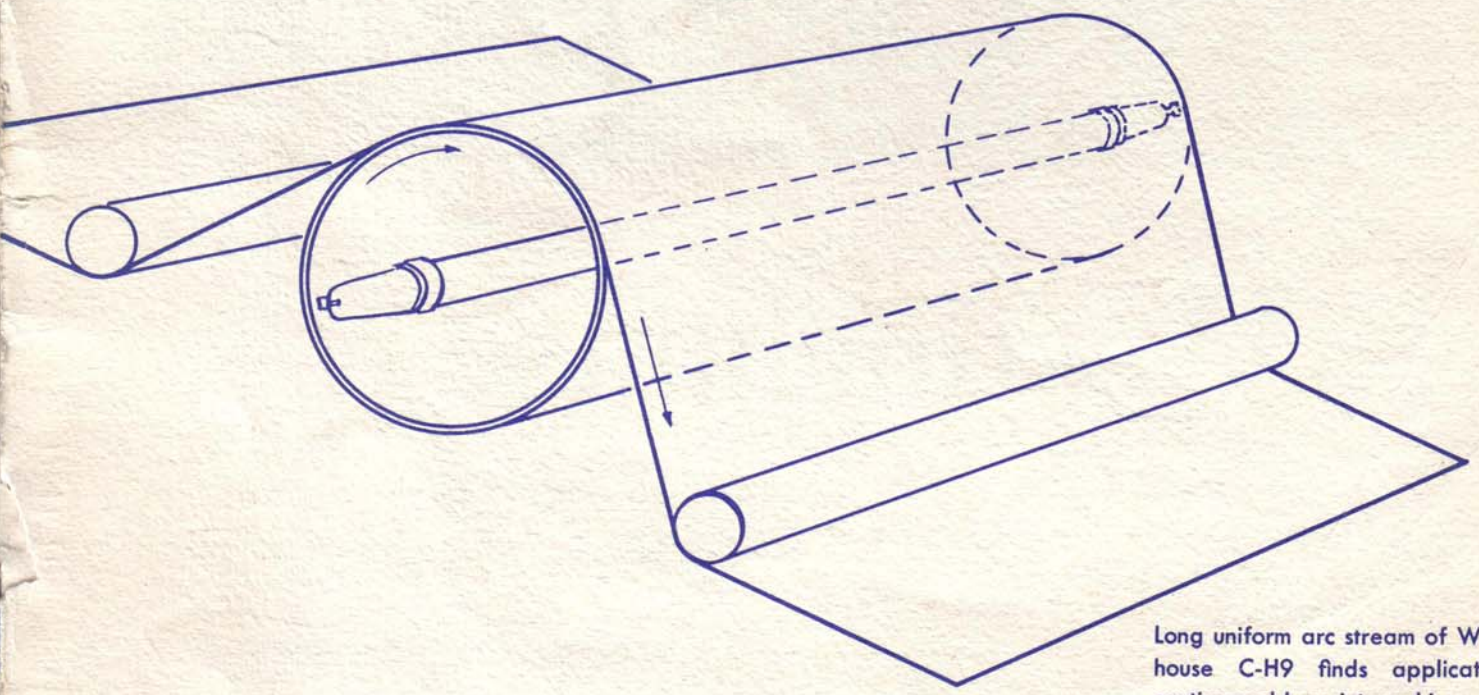
Mercury lamp radiations from 2800 Angstroms in the ultraviolet to 5000 Angstroms in the visible are being used increasingly in the field of photochemistry as a catalyst or chemical matchmaker to speed the completion of many chemical reactions. The chief application at present is the use of these lamps in chlorination processes.

Blueprinting,

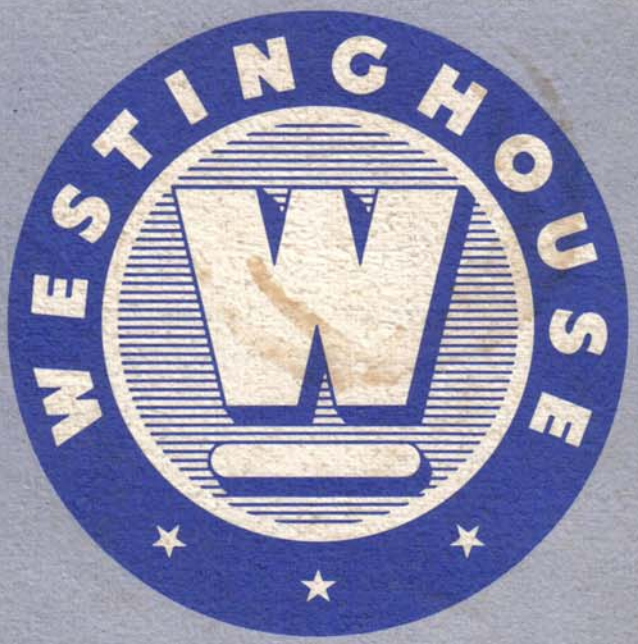
Photoprinting, and

Photolithography

Because of the high sensitivity of blueprint paper and film emulsions to the near ultraviolet and blue radiations of mercury lamps they are used extensively in photoprinting and blueprinting equipment. Photoenlarging, photoengraving, and motion picture printing find increasing use for mercury vapor lamps.



Long uniform arc stream of Westinghouse C-H9 finds application in continuous blueprint machines.



Westinghouse

ELECTRIC CORPORATION

Lamp Division

BLOOMFIELD, NEW JERSEY

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