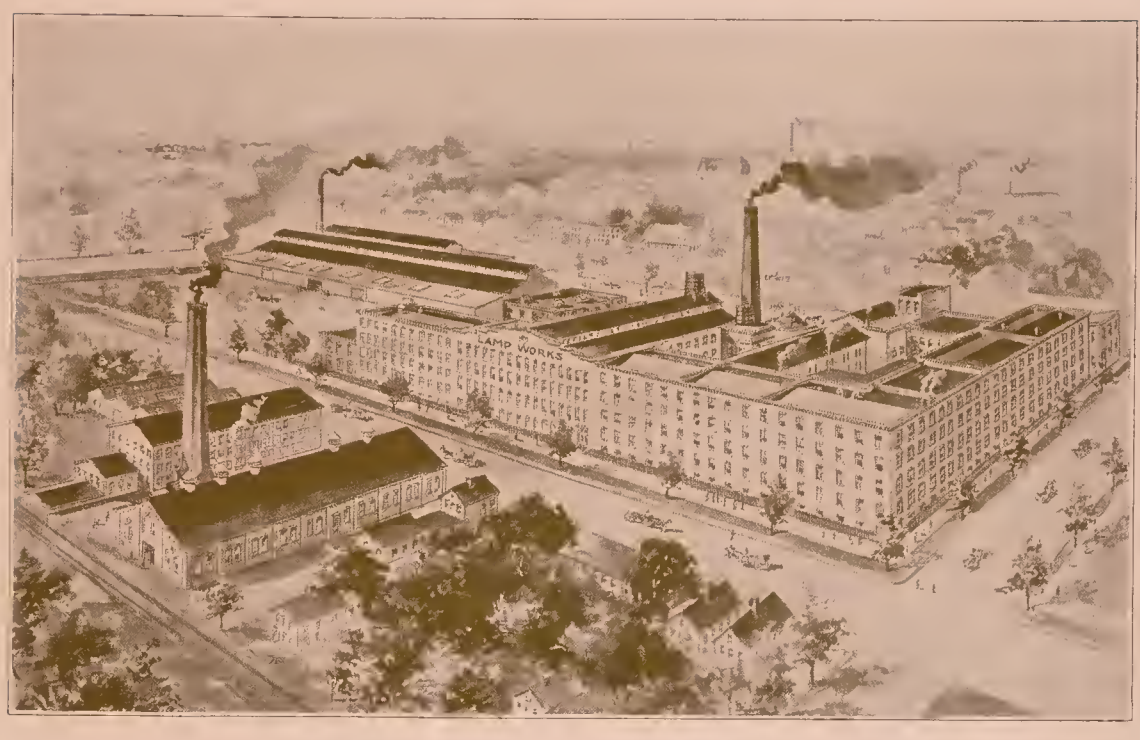
EDISON INCANDESCENT LAMPS

GENERAL ELECTRIC COMPANY

THE GENERAL ELECTRIC COMPANY'S INCANDESCENT LAMP FACTORY AT HARRISON, N. J.



CAPACITY PER DAY 35,000 INCANDESCENT LAMPS—ANNUAL PRODUCTION 6,500,000 LAMPS.

Edison

Incandescent Lamps

Complete Catalogue

of

Standard, Special and Miniature Lamps

Containing Much Information

of

Value to Lamp Users

General Electric Company

No. 1012

[1897.

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GENERAL ELECTRIC COMPANY

MAIN OFFICES, SCHENECTADY, N. Y.

MAIN LAMP SALES OFFICES, HARRISON, N. J.

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PREFACE.

IN PRESENTING THIS CATALOGUE WE HAVE ENDEAVORED TO FURNISH THE PURCHASER A GUIDE TO THE INTELLIGENT SELECTION OF THE LAMP BEST SUITED TO HIS PARTICULAR REQUIREMENTS. THE OPENING SECTION IS, THEREFORE, DEVOTED TO THE MANUFACTURE, SELECTION AND PROPER USE OF LAMPS, AND WE BELIEVE IT WILL REPAY A CAREFUL PERUSAL. DESCRIPTIONS AND FULL SIZE ILLUSTRATIONS OF THE VARIOUS TYPES OF OUR LAMPS, INCLUDING STANDARD, SPECIAL AND MINIATURE LAMPS, ARE GIVEN IN THE FOLLOWING PAGES, AND THE APPENDED GENERAL LAMP DATA SHOULD PROVE VALUABLE.

WE INVITE CORRESPONDENCE REGARDING SPECIAL LAMPS OF ANY TYPE, WHICH WE ARE PREPARED TO MANUFACTURE TO ORDER.

FOR THE CONVENIENCE OF OUR PATRONS, LARGE AND VARIED STOCKS OF LAMPS ARE CARRIED AT THE FOLLOWING POINTS:

LAMP FACTORY, HARRISON, N. J.

ATLANTA, GA. BOSTON, MASS.

CHICAGO, ILL. CINCINNATI, OHIO.

DENVER, COLO. SAN FRANCISCO, CAL.

SEPTEMBER 20, 1897.

The Manufacture of Lamps.

An incandescent lamp is to the casual observer an extremely simple device consisting of a carbon filament in a glass bulb. While it is simple in appearance the perfected incandescent lamp is nevertheless very complex in all its features. It is something more than a mechanical product, as its construction involves complex chemical, electrical and physical problems, making it a very highly organized article of manufacture. In probably no other manufacturing enterprise is success so dependent on experience combined with careful systematic testing and inspection, for in the manufacture of incandescent lamps, apparently insignificant changes in methods produce most important results, and the cause of defects is, therefore, difficult to locate and remedy.

It will no doubt be surprising to many to learn that every incandescent lamp manufactured by the General Electric Company requires fifty distinct constructive operations and forty separate tests and inspections to complete it for the market.

RESULTS OF SKILL AND EXPERIENCE

To produce an incandescent lamp and sell it at our present low price without omitting any detail of manufacture or test, is an achievement rendered possible only by our enormous output and many years of experience. The Edison lamp represents the most extended experience and the largest production and, therefore, stands superior to all others. So varied are the standards of candle-power that we have adopted a standard of our own which is higher than the standards of candle-power in use by other companies.

That the candle-power of other makes of lamps is below that of the Edison Lamp is a fact easily demonstrated. Not only are other companies' standards lower, but many companies deliberately or unknowingly over-rate their lamps—a practice never permitted with Edison Lamps.

The average eye can make only a very vague approximation to the true candle-power of a lamp, and exact results require the use of a photometer by a practical observer. The subject of candle-power is, therefore, very important to the customer, who seldom has apparatus to determine whether a lamp is of full rated candle-power. Over-rating of the candle-power, of course, involves over-rating of the efficiency. A true 16 candle-power lamp taking 50 watts has an efficiency of 3.1 watts per candle, but if it is really only a 13 candle-power lamp marked 16 candle-power, it will require 3.8 watts per candle.

Such facts emphasize the importance and value of dealing with the oldest and largest manufacturing company whose reliability as to standards and ratings is unquestionable.

While the low prices of the past two years have compelled many lamp manufacturers to save expense by abridging processes and neglecting vital points, we have been improving our methods and machinery, giving lamps more detailed attention than ever with the result of producing a better and more uniform lamp than was formerly sold at double the present price.

This is possible for us by reason of our immense production of over 6,000,000 lamps per year. This immense production also permits us to adopt improvements, conduct a laboratory and perform experimental and testing work, the expense of which while only a small fraction of a cent per lamp to us, is absolutely prohibitory to the average lamp company producing only a few thousand lamps per year. It is clearly evident that the lamp company able to most extensively conduct such work can give its customers a uniformity of product and improvement in quality unobtainable by other companies.

OUR NEW EXHAUSTION PROCESS

Among the many improvements in manufacture, our new exhaustion process may be mentioned as one of the most important in its effect on the quality of the product. From time to time during recent years mechanical vacuum pumps operated without mercury have been brought before the public, and while our engineers have fully appreciated the advantages of such pumps they have been prevented from adopting any of them owing to the size in which these pumps have been invariably made, the object of their inventors being to exhaust a very large number of lamps at the same time, which our engineers have always considered bad practice. Recently the Company succeeded in obtaining a small mechanical vacuum pump whose rate of exhaustion is such that it can be practically employed to exhaust only one lamp at a time. Experiments were begun with these pumps about a year and a half ago. These early experiments showed that lamps could be exhausted to a degree much nearer perfection than by any previous method employed, as on these pumps the lamps are exhausted one by one, each lamp being carefully watched from the start until it is laid aside thoroughly exhausted. By the employment in combination with these pumps of a chemical process exclusively used by us in the United States, the various phenomena of exhaustion are clearly marked so as to enable a very definite rule of operation to be worked out.

The natural residual gases of an incandescent lamp may be considered conducting gases, since they allow current to pass from one leg of the filament to the other. The residual gases are, therefore, not only very injurious to the filament, but their removal has previously involved long and tedious processes. The special feature of our new method of exhaustion, usually called the "chemical process," is the thorough removal of all the residual gases from a lamp by the introduction of a gas capable of combining with them. Previous to this introduction a blue glow fills the bulb when the filament shows bright incandescence. When the combination takes place between the residual gases and the new gas, the blue glow suddenly disappears and a lamp "sealed off" at this point has a vacuum of perfect insulating properties.

ADVANTAGES OF THE PROCESS

The advantages of the chemical process of exhaustion are:

First. The combination of the gases in the bulb is a phenomenon so marked as to furnish to the operator an absolute proof that the proper vacuum has been attained.

Second. Lamps are exhausted one at a time and the whole attention of the operator is concentrated on a single lamp, thus insuring a perfection of vacuum difficult to obtain when lamps are exhausted in groups.

Third. The operator may sit in a comfortable position and is, therefore, not unduly wearied and can do as accurate work late in the day as in the morning.

Fourth. The injurious effects of mercury upon the health of the operator are entirely avoided, enabling us to secure uninterrupted service from our operators and therefore the very highest skill which is dependent upon continued practice.

Our processes of manufacture are manifold, careful and exacting, embodying all the improvements and every detail that our judgment and extensive experience show are necessary to make a finished lamp of the finest appearance and highest quality—considerations always foremost with us. The results are as they should be, the Edison Lamp stands to-day absolutely unequalled, the Standard Incandescent Lamp of the world.

We were the first manufacturers of lamps and have always produced more than the combined output of all the other factories in America. We have by constant, careful, intelligent and thorough work, steadily increased the commercial possibilities of the incandescent lamp, building up the market for it and supplying for years a clientage of the largest lamp consumers in the world with the most perfect incandescent lamp on the market. The Edison Lamp of to-day is farther than ever in advance of other makes, and it has opportunities to improve at a far more rapid pace than is possible for any other lamp. The Edison Lamp with its eminent superiority is, therefore, rapidly leaving all competitors.

SUPERIORITY OF THE EDISON LAMP

Our present annual production of over six million lamps enables us more easily to produce a lamp which justifies the following statement made two years ago by the largest consumer of lamps in the world:

"Comparative tests of 'New Type Edison Lamps' with those of other makes, both European and American, demonstrate that in maintenance of candle-power, efficiency and average life, the 'New Type Edison Lamp' equals and surpasses them all."

THE SELECTION OF LAMPS.

In purchasing lamps the average customer considers only two points—the first cost of the lamp and the time it will last. Two other points are, however, even more important and should not be neglected. One is the efficiency of the lamp, or the number of lamps which can be supplied per horse-power. Lamps are classified according to voltage, candle-power, efficiency and type of cap or base. The term efficiency is used to denote the amount of power consumed by the lamp expressed in watts per candle, as for example, "3.5 watts efficiency" means that the lamp requires 3.5 watts for each candle-power of light given. High efficiency lamps that require small power per candle, are more susceptible to variations of pressure and have a shorter life than low efficiency lamps that consume relatively more power per candle.

CLASSIFICATION OF LAMPS

The Edison lamp is furnished in three different efficiencies:

3.1 watts per candle or 12–16 candle-power lamps to the mechanical horse-power.

3.5 watts per candle or 10–16 candle-power lamps to the mechanical horse-power.

4 watts per candle or 8–16 candle-power lamps to the mechanical horse-power.

The other important point to be considered is the period of *useful life*, beyond which it is economy to install a new lamp even though the old one be still unbroken. Mere life is not the principal feature of a lamp nor the most desirable. The fact that one lamp outlasts another, no more indicates superiority than does the length of a plot of ground determine its area. A lamp may be made to give any length of life desired and yet consume so much current as to make it cost more to burn than a lamp giving half the life but consuming less power. A lamp may also have long life and yet give so low an average of candle-power as to make it a very undesirable and worthless lamp.

The features of first importance in an incandescent lamp, are, therefore, *efficiency* (energy consumed for light given) and *maintenance of candle-power.* The point to be observed in purchasing lamps is therefore to select the lamp in which the average candle-power, energy consumed and length of life are combined to produce the best and most economical results,—that is, to give the greatest amount of light for least cost.

AHEAD OF ALL COMPETITORS

It is a fact demonstrated by impartial tests of scientific institutions and by the practical experience of the largest electric light companies, that the NEW TYPE EDISON LAMP excels all others in the most efficient combination of these desirable qualities.

The following facts determine the conditions to which each type of lamp is best adapted.

Lamps of an efficiency of 3.1 watts per candle, will give satisfaction only where the regulation of voltage at the station is the best, or, in other words, where the voltage at all times is practically constant. Such regulation can be secured only by constant and intelligent attention and the use of reliable indicators or volt-meters.

Lamps of an efficiency of 3.5 watts per candle should be used where the regulation is only fair, that is, where the maximum variation does not exceed 4%.

Lamps of an efficiency of 4 watts per candle should be ordered in every case where the plant is supposed to be self-regulating, receives little or no attention, and has no reliable pressure indicator or volt-meter in constant use.

Where the regulation of voltage is first-class, it is, of course, possible to obtain almost unlimited average life from any make of incandescent lamp of low efficiency. Using lamps of such prolonged life is, however, a decided mistake and is uneconomical in every way, as is shown in the following section and in the Appendix.

We invite correspondence regarding the particular conditions under which plants are operated, and will be pleased to advise as to what efficiency of lamp will best suit the requirements. Whatever efficiency of lamp is selected no one thing will so greatly increase the efficiency of the plant as the effort to maintain constant voltage at the lamps.

THE PROPER USE OF LAMPS.

A lamp to give satisfaction must not only be properly made, but it must also be properly used. A lamp of the highest quality may be so misused as to give only a small fraction of its rated light capacity. Proper use, producing a maximum of light at a minimum expense, requires:

That the lamps be burned at marked voltage.

That the voltage be kept constant.

That lamps be replaced whenever they get dim.

The last requirement is not considered economical by many users who prize lamps that have long life and insist on using them as long as they will burn. Let us see by an example if extremely long life is desirable.

As the cost of current varies greatly, we will assume an average cost of one-half cent per lamp hour. If a rated 16 candle-power lamp, burned for 1000 hours, be burned an additional 1000 hours, it takes practically the same current during the last period, but gives an average light of only about 8 candles. The cost of current for the 2000 hours is $10.00. A new lamp costs 20 to 25 cents, and had three lamps, with a life of about 700 hours each, been used during the entire period, the average light would have been fully doubled, at an added expense of not more than 50 cents or 5% of cost of current. In other words, by adding 5% to operating expense (representing the cost of the two renewal lamps) the customer would add 100% to the light given. One new lamp gives a light equal to two old ones at half the cost of current. If the old lamps gave light enough, the new lamps would halve the number of lamps in use and produce the same light with half the current.

THE ECONOMY OF FREQUENT RENEWALS

It is important to note that the above example is based on results obtained with the highest grade of lamps. With an inferior quality of lamp the argument against extremely long life would be still stronger and the necessity of frequent renewals of lamps much greater.

Thus, from any point of view, it is false economy to select lamps with a sole regard for long life. Lamps should be renewed when dim, for in no other way can light be produced economically.

The points to be remembered are as follows:

Do not run pressure above the voltage of the lamps. Increased pressure means extra power, and, although old lamps may thus give more light for awhile, every new lamp that does not break from the excessive pressure, will deteriorate very rapidly and give greatly diminished light.

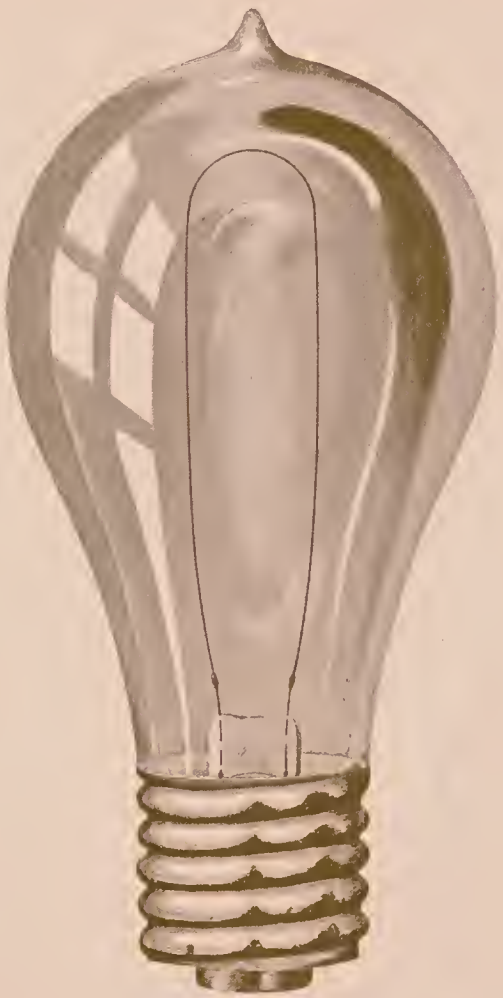
Do not treat incandescent lamps like lamp chimneys and use them until they break. They should be renewed whenever they get dim.

The section on Life and Candle-power in the Appendix of this pamphlet gives a complete discussion of this subject.

Standard
50 Volt
Incandescent
Lamps

8 and 10 Candle-power 50 Volt Lamps.

For service requiring only a moderate quantity of light, we furnish our 8 and 10 candle-power lamps. Owing to the extreme fineness of the filaments, these lamps are more sensitive to variation in voltage than standard 16 candle-power lamps of the same efficiency. For this reason to secure uniform average life, lamps of low candle-power should be ordered with lower efficiency than the standard 16 candle-power lamps to operate under the same conditions. The filaments being comparatively short and stiff are best adapted to the loop form.



DESCRIPTION.

Bulb—Moulded, Pear-shaped, Size as in illustration. Filament—Loop.

Voltages—45 to 90.

Efficiency, 8 candle-power lamp—3.1, 3.5 and 4 watts per candle.

Efficiency, 10 candle-power lamp—3.1, 3.5 and 4 watts per candle.

The 10 candle-power 4 watt lamp is furnished in the same size bulb as the standard 16 candle-power 50 volt lamp.

Fitted with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.

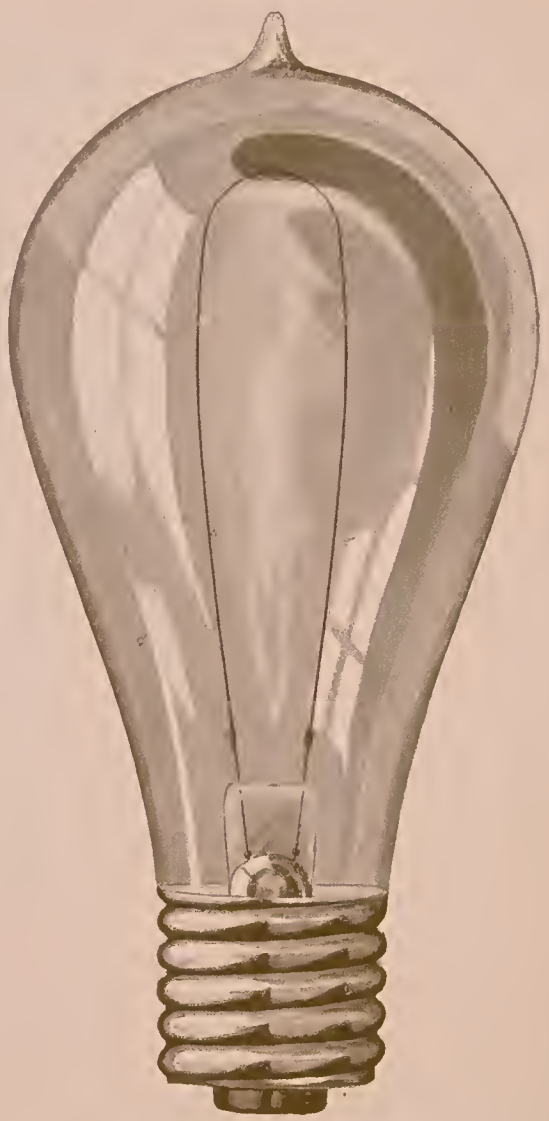
Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.

16 Candle-power 50 Volt Lamp.

Low voltage lamps by reason of their heavier filament give much better results than can be obtained with high voltage lamps. This superiority, however, tends to a fault, since low voltage lamps are frequently retained too long in service. Their life outlasts their usefulness. In no efficient lighting service can it possibly pay to allow such lamps to have an average life longer than 1000 hours. Frequent renewals, keeping the average life down to this figure or below it will be found to give the best results.

UNIFORM LIGHT AND LIFE

The tendency of modern practice is to change from low pressure to 100 volts and over. Improvements in high voltage lamps have brought them so near to the naturally better quality of low voltage lamps that the objections to their use no longer exist. The economy in copper on secondaries, and most important of all, the better regulation possible on 100 volt circuits have induced a change to higher voltages on the part of many large companies.



The standard low voltage lamp has an efficiency of 3.5 watts per candle, which is preferable on account of the difficulties of good regulation on low voltage secondaries. We nevertheless have a large clientage of customers who use with the greatest satisfaction our low voltage 3.1 watt lamp. For such stations as give special attention to their secondary regulation, the saving in power obtained with our 3.1 watt lamps will recommend them for service.

The bulbs are moulded of uniform size. We use the loop form of filament because it is the best permissible with a filament necessarily too short and stiff for the oval form.

DESCRIPTION.

Bulb—Moulded, Pear-shaped, Size as in illustration. Filament—Loop.

Voltages—45 to 90.

Efficiency, 16 candle-power lamp—3.1, 3.5 and 4 watts per candle.

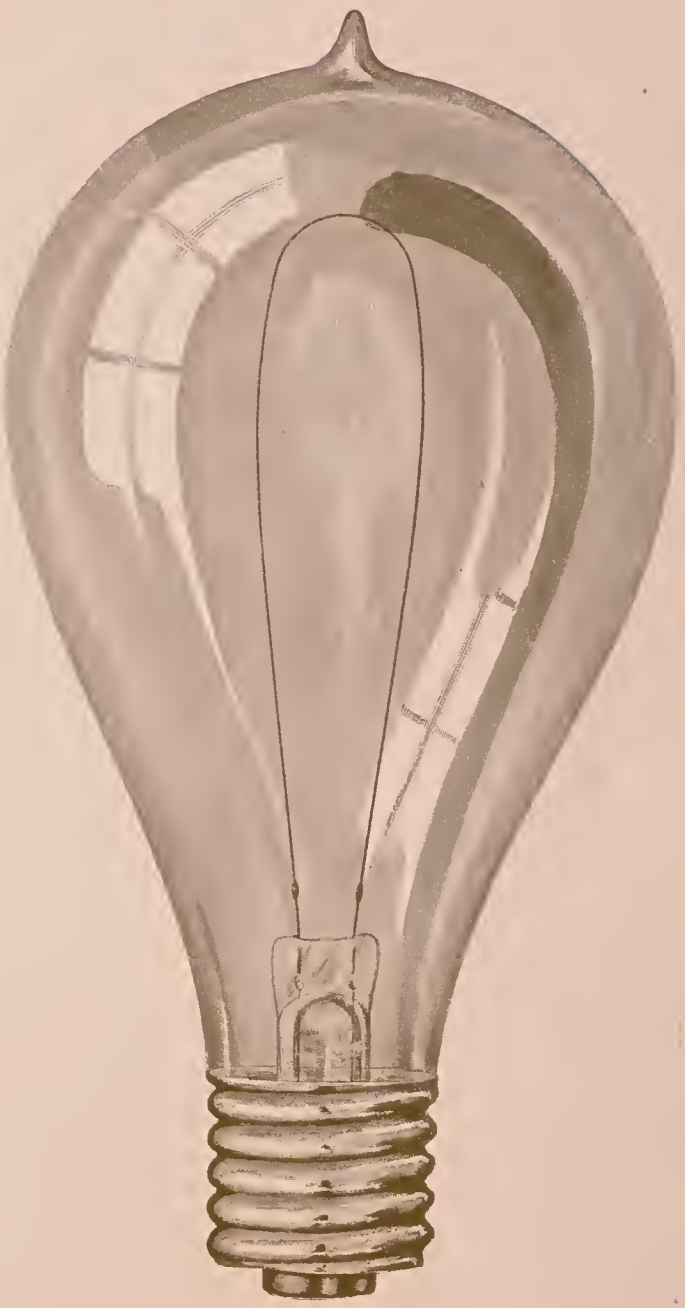
Efficiency, 20 candle-power lamp—3.1, 3.5 and 4 watts per candle.

Efficiency, 24 candle-power lamp—3.1, 3.5 and 4 watts per candle.

Fitted with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.

Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.

32 Candle-power 50 Volt Lamp.



We have adopted the loop filament for all our low voltage lamps in preference to the spiral, which we have tried and discarded. The proper size of filament, to give the best results in maintained candle-power and freedom from blackening requires a length too short to wind in a well formed spiral. The spiral filament owing to the weight of the coil at the end tends to droop more than the loop. Altogether our extensive experience with low voltage lamps shows that the loop form of filament makes a better lamp.

DESCRIPTION.

Bulb—Moulded, Size as in illustration.

Filament—Loop.

Voltages—45 to 90.

Efficiency—3.1, 3.5 and 4 watts per candle.

Fitted with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.

Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.

50 Candle-power 50 Volt Lamp.

A proper proportion should always be preserved between the size of bulb and the candle-power of an incandescent lamp. Too large a bulb is unnecessarily heavy, occupies much space and is bulky in appearance, while too small a bulb causes undue heating and blackening.

The illustration of our standard 50 candle-power low voltage lamp clearly shows the harmony of proportion in candle-power and size of bulb. The Edison lamp, as is well known by all users, also maintains a full ratio of light given to power consumed, to a greater degree than any other lamp. Our 50 candle-power lamps can be depended upon for accurate and perfect construction.

DESCRIPTION.

Bulb—Moulded, Pear-shaped, Size as in illustration.

Filament—Loop.

Voltages—45 to 90.

Efficiency—3.1, 3.5 and 4 watts per candle.

Fitted with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.

Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.

100 AND 150 CANDLE-POWER 50 VOLT LAMPS.

The mechanical structure of the heavy filaments in high candle-power lamps requires special attention. We have found that the greatest strength and rigidity are secured by the use of the double loop as shown in the illustration on the following page. These loops are connected in multiple and burn as two separate carbons. The chances of failure are thus reduced one-half, for should one filament break the other remains and the lamp will burn at half candle-power. As great dependence is placed on every high candle-power lamp, reliability is of marked importance. The value of our careful and exact processes is strongly realized in this type of lamp.

EXCELLENCE OF CONSTRUCTION

Special attention is called to the heavy currents carried by these high candle-power lamps and the consequent importance of having a large and certain area of contact between base of lamp and socket. For these lamps 6 to 9 amperes at 50 volts are required and on this account they should be ordered with bases to fit Keyless Socket for High Candle-power Lamps. (Cat. No. 8319). These sockets are specially designed to carry large currents, and smaller standard sockets in general use are not reliable for this purpose. These high candle-power lamps are preferably used in keyless sockets, but in any case the current should be turned off and on at the switch and not at the socket.

DESCRIPTION.

Bulb—Moulded, Pear-shaped, Size as in illustration.

Filament—Double loop—the two loops in multiple.

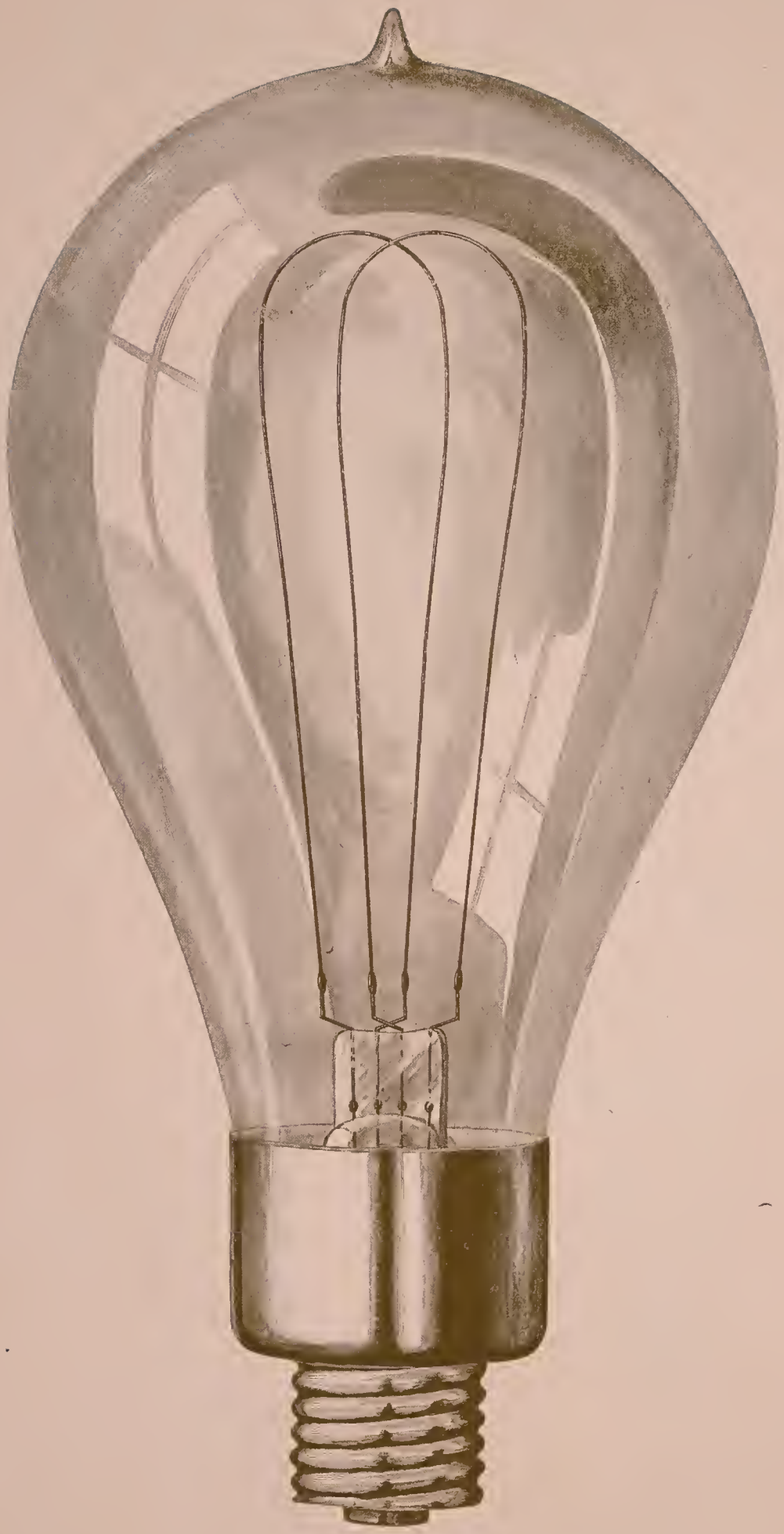
Voltages—45 to 90.

Efficiency, 100 candle-power lamp—3.1 and 3.5 watts per candle.

Efficiency, 150 candle-power lamp—3.1 watts per candle.

Based with High Candle-power Base to fit Socket, Cat. No. 8319 or with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.

Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.



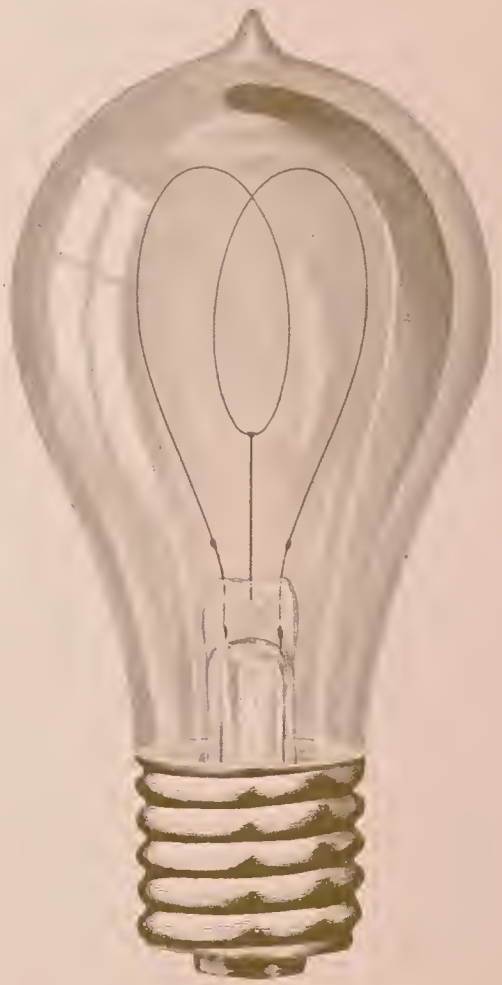
STANDARD
100 VOLT
INCANDESCENT
LAMPS

8 AND 10 CANDLE-POWER 100 VOLT LAMPS.

For service requiring lower candle-power lamps than the standard 16 candle-power, we offer our 8 and 10 candle-power lamps. The production of the commercial lamp of high efficiency and low candle-power is attended with even graver difficulties than are involved in the production of the standard 16 candle-power lamp. The extreme fineness of the filaments of 8 and 10 candle-power lamps renders them very sensitive to variations of voltage so that the life obtained will, in general, average below that obtained from the standard lamp. Wherever the type of lamp admits of a comparatively thick filament, stability is increased. Lamps of 50 volts and lamps of higher candle-power will thus always give better results than lamps that do not permit the use of a thick filament.

COMPARATIVE AVERAGE LIFE

As will be seen in the illustration, the filament is oval in form, anchored at the stem and possesses all the mechanical advantages enumerated in our description of the standard 16 candle-power lamp. The filament is secure against vibration, does not sag, and gives greater total illumination than any other type of filament. Although made in efficiencies of 3.1 watts per candle, the use of lamps of efficiencies higher than 8 candle-power 4 watts, or 10 candle-power 3.5 watts are not recommended, except in cases where the regulation is perfect.



DESCRIPTION.

Bulb—Moulded, Pear-shaped, Size as in illustration.

Filament—Oval, Anchored.

Voltages—90 to 125.

Efficiency, 8 candle-power lamp—3.1, 3.5 and 4 watts per candle.

Efficiency, 10 candle-power lamp—3.1, 3.5 and 4 watts per candle.

The 10 candle-power, 4 watt lamp has same size bulb as the standard 16 candle-power lamp.

Fitted with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.

Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.

16 Candle-power 100 Volt Lamp.

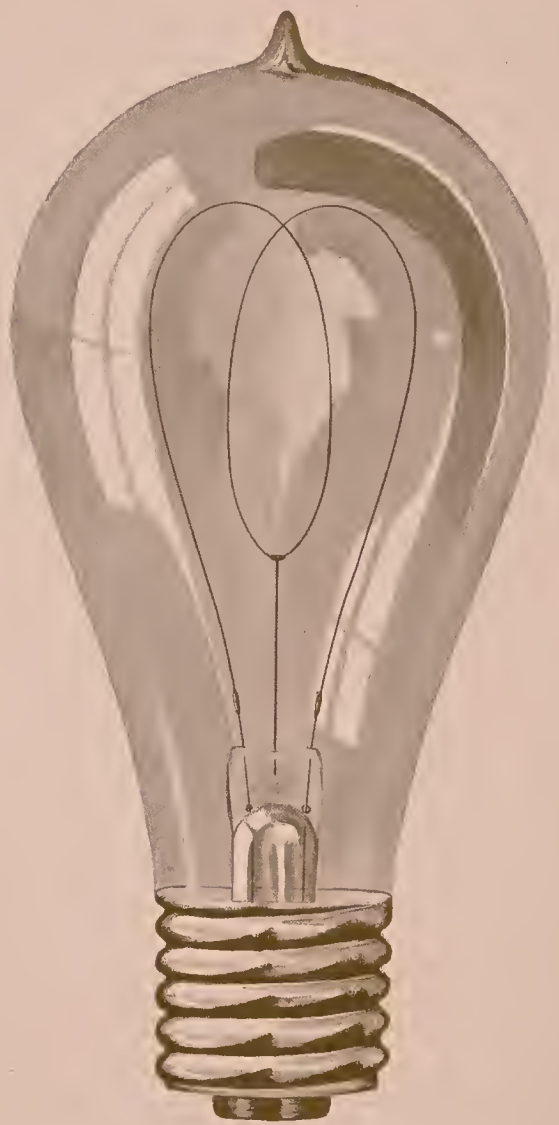
The 16 candle-power high voltage lamp is always the standard of comparison which distinguishes the perfected result of skill and experience applied in the finest equipped factory, from that of less favored competitors. The difficulties met in making a perfect 50 volt lamp are multiplied when the 110 volt lamp is attempted. The increased voltage acting upon a finer filament results in rapid deterioration and loss of candle-power, unless its construction has been given careful attention by experienced workmen. The average manufacturer is, therefore, unable to produce a high voltage lamp of higher efficiency than 3.5 to 5 watts per candle. The successful production by us of a commercial 3 watt, high voltage lamp, has been largely instrumental in bringing incandescent lighting to its present advanced stage.

THE STANDARD OF THE WORLD

The Standard New Type Edison Lamp here illustrated is to-day the most extensively used lamp in the world and upon it has been concentrated the greatest amount of skill, time and attention.

All its numerous good points cannot be shown in an illustration. Clean white light, uniform and highly sustained brilliancy, and good average life, are among the most notable superior qualities which can be appreciated only by using the lamp. The carbon filament is anchored securely in position, and thus prevented from vibrating or touching the glass. The filament is shaped to fit the bulb so as to form a bright sphere instead of two lines of light. The bulbs are uniform in size and shape, conducing not only to neat appearance, but to ease in installing and freedom from misfits in shades and holders.

By our new process of chemically exhausting lamps, the thorough removal of gases in and about the filament and connections reduces the possibility of blackening and adds to the life and maintained brilliancy of the lamps. More important still, each lamp is separately exhausted, and uniformity of product is, therefore, absolutely assured.



DESCRIPTION.

Bulb—Moulded, Size as in illustration. Filament—Oval, Anchored. Voltages—90 to 125.

Efficiency, 16, 20 and 24 candle-power lamps—3.1, 3.5 and 4 watts per candle.

Fitted with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.

Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.

32 Candle-power 100 Volt Lamp.

The beauty of form and brilliancy of the oval filament are strikingly illustrated in our higher candle-power lamps. The oval filament produces a sphere of light exactly filling the bulb and its many advantages enumerated in the description of the 16 candle-power lamp are here accentuated. Our new chemical exhaustion process is of special advantage in the production of 32 candle-power lamps. It overcomes many of the special difficulties in the exhaustion of high candle-power lamps—blackening is reduced, maintenance of candle-power is increased and the quality of the average lamp is materially improved.

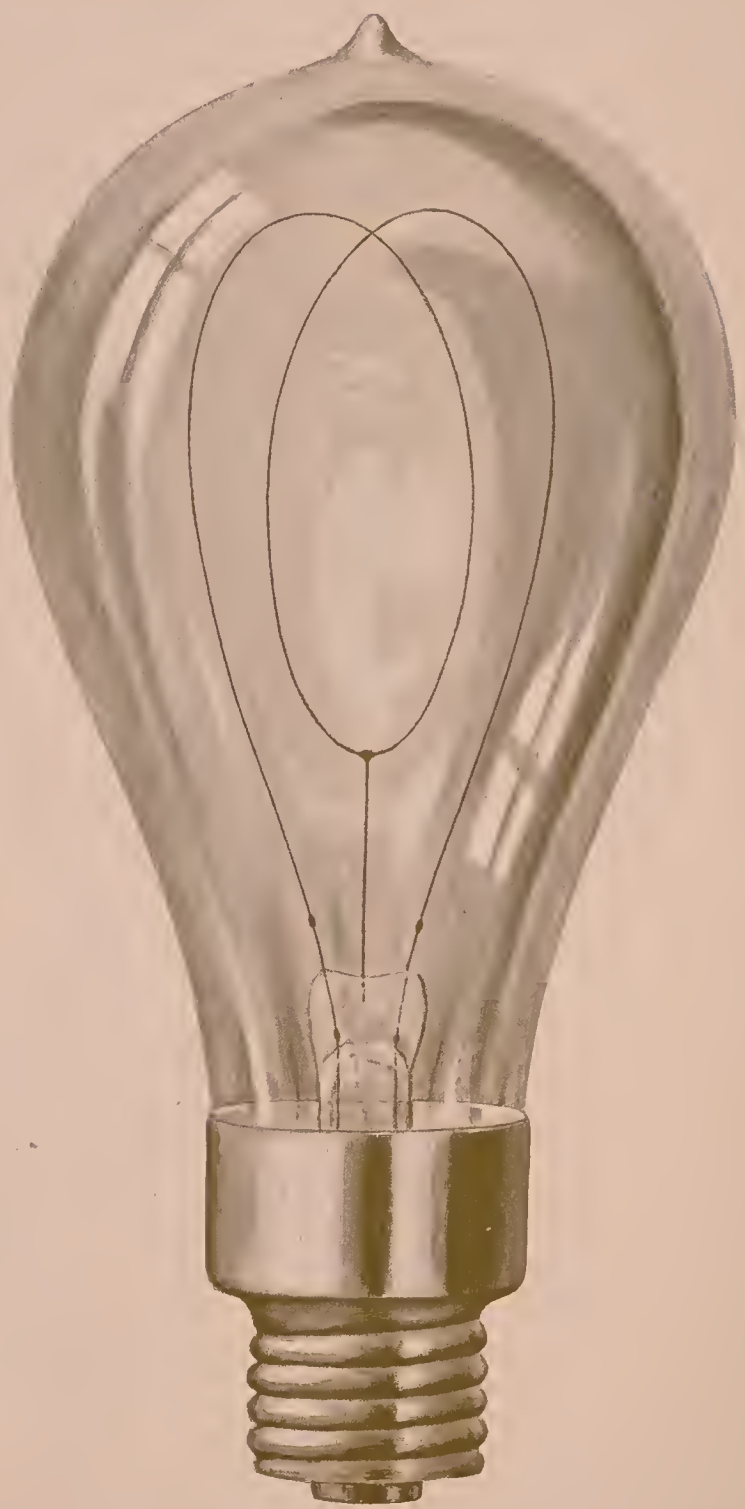
DESCRIPTION.

Bulb—Moulded, Pear-shaped, Size as in illustration. Filament—Oval, Anchored. Voltages—90 to 125. Efficiency—3.1, 3.5 and 4 watts per candle.

Fitted with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.

Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.

50 Candle-power 100 Volt Lamp.



An anchor is of special value in retaining in form and position the heavy filament required in a 50 candle-power lamp. The compact shape of the oval avoids the necessity of using a large and bulky bulb.

Our new exhaustion process produces 50 candle-power lamps in which blackening is reduced, maintenance of candle-power increased and weak spots in filaments avoided. The construction of our 50 candle-power lamp is accurate and thorough — features that are especially desirable where reliance is placed on single lamps in service.

DESCRIPTION.

Bulb—Moulded, Pear-shaped, Size as in illustration.

Filament—Oval, Anchored.

Voltages—90 to 125.

Efficiency—3.1, 3.5 and 4 watts per candle.

Fitted with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.

Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.

100 AND 150 CANDLE-POWER 100 VOLT LAMPS.

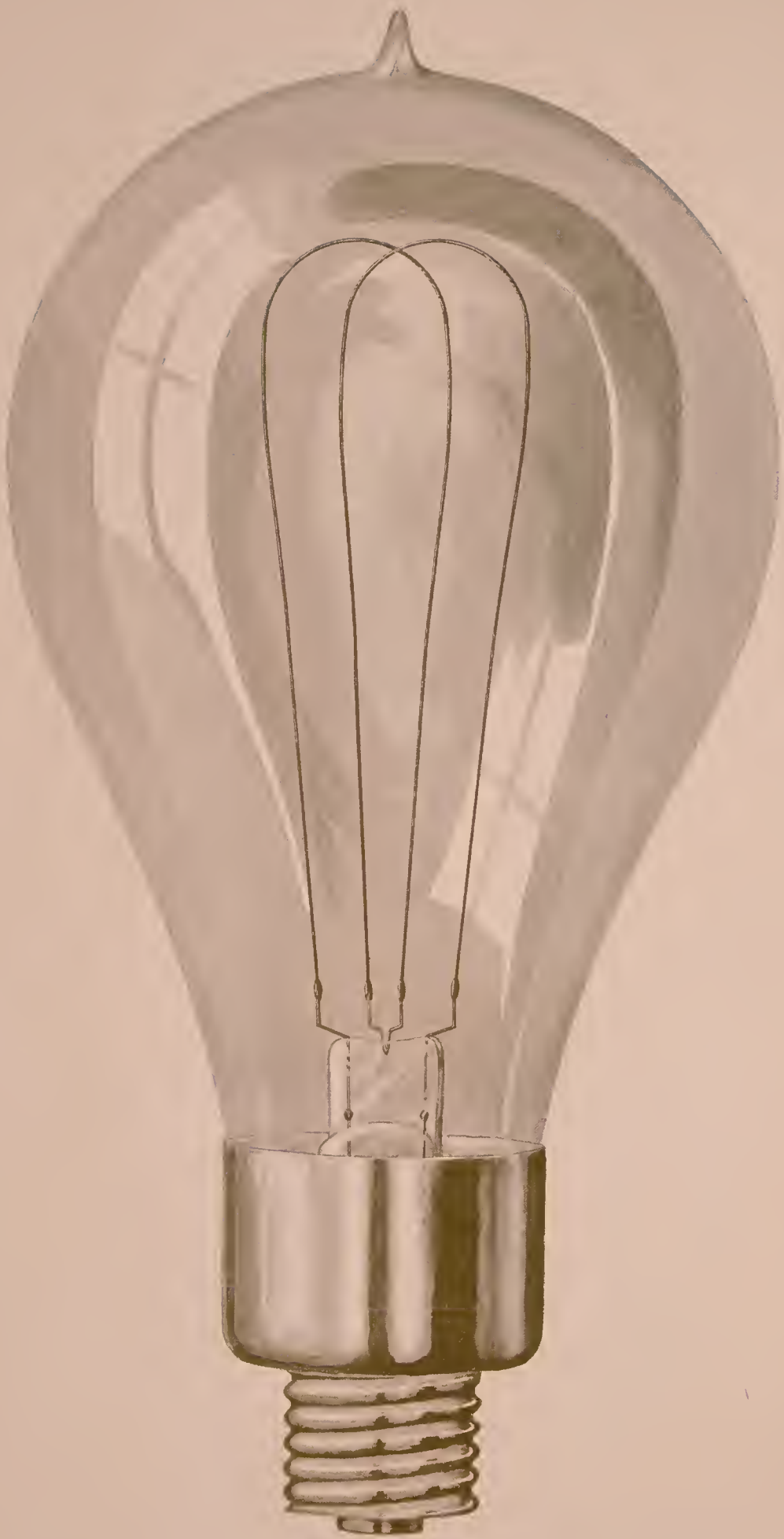
Reliability is a feature of prime importance in high candle-power lamps. When dependence is placed on a single lamp its failure from any cause is more serious than the failure of one of many lamps of lower candle-power. Our exact processes and individual treatment secure perfection in every lamp. The 100 and 150 candle-power lamp is shown in the illustration on the following page. For mechanical reasons we have found the double loop the most desirable form of filament for these lamps. The two loops being arranged in series, each loop is only half the length necessary with one continuous filament, and has many times the strength and rigidity. These lamps should be ordered with base to fit Keyless Socket for High Candle-power Lamps. (Cat. No. 8319). This socket is specially designed to carry large currents, and smaller standard sockets in general use are not reliable for this purpose. It is recommended that high candle-power lamps be used in keyless sockets, or in any case, that the current be turned off and on at the switch.

DESIRABLE FORM OF FILAMENT

DESCRIPTION.

Bulb—Moulded, Pear-shaped, Size as in illustration.
Filament—Double loop—the two loops in series.
Voltages—90 to 125.
Efficiency, 100 candle-power lamp—3.1 and 3.5 watts per candle.
Efficiency, 150 candle-power lamp—3.1 watts per candle.
Based with High Candle-power Base to fit Socket, Cat. No. 8319, or with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.

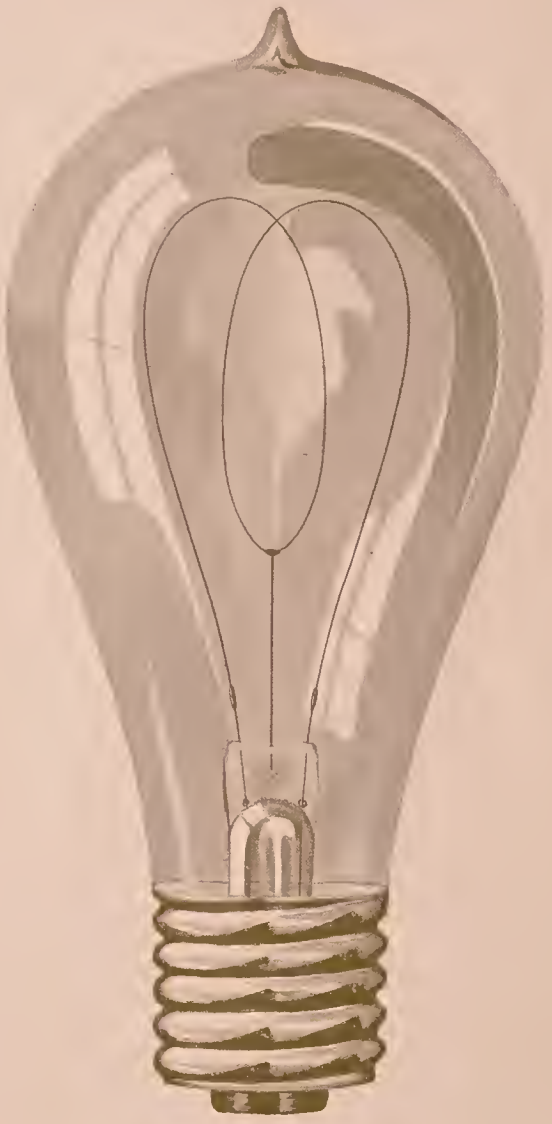
Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.



The Street Railway Lamp.

It is essential in a street railway lamp that the filament be anchored. An unanchored filament, to withstand the shock and vibration of street car service, has to be so short and stiff that the light is limited to a very small area. The efficiency and maintained brilliancy of the lamp is thus reduced, as well as the general illumination of the car. The position of the anchor is also an important consideration. Anchoring the lower end of the filament to the inside of the bulb is objectionable, as it holds the filament too rigidly and the effect of a shock or jar is to break either the filament or the anchor. Excessive rigidity cannot be overcome by resting the filament loosely in the anchor, since vibration of the filament against the anchor will cause it to wear away. With the anchor firmly connected to the stem or inside part of the lamp, as in the Edison oval filament, shown in the accompanying illustration, the ideal arrangement is secured. The filament is held so as to check vibration rather than to entirely prevent it. Freedom of vibration within proper limits is, therefore, allowed and the filament is not strained or weakened. With the anchor in the position shown, the whole filament vibrates together and there is practically no danger of the branches interlocking and short circuiting, as would be the case if one branch of the spiral were anchored rigidly to the side of the lamp, and the other branch free to vibrate and strike it.

IDEAL ARRANGEMENT OF THE FILAMENT



Another necessary consideration in the case of Railway Lamps is that they should have uniform current capacity since they are operated in series. Our Railway Lamps are made in three different classes, viz.: for 500 volt circuits, for 550 volt circuits and for 600 volt circuits. In each class, lamps are selected of a given amperage. In the 500 volt range, the current is .65 ampere. Thus carefully tested for candle-power and current these lamps are suited exactly to the requirements of street railway service and give uniform light and life. They have an efficiency of 4 watts per candle, at full 16 candle-power. Street Railway Lamps of 32 candle-power or other candle-powers are furnished to order.

DESCRIPTION.

Bulb—Moulded, Pear-shaped, Size as in illustration. Filament—Oval, Anchored.

Efficiency—4 watts per candle. Furnished for operating five in series on circuits of a total of 500 volts, 550 volts or 600 volts.

Fitted with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.

Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.

Special Incandescent Lamps

200 to 250 Volt Lamps.

We furnished lamps for 200 and 250 volt circuits on special order for several years before the general public knew that such a lamp was practicable.

Their successful use is now extended.

A perfect vacuum is of the greatest importance with these high voltage lamps, for unless all the residual gases are thoroughly removed from the bulb the lamps are liable to explode at the high voltage. If an explosion, blowing the lamp into fragments and causing serious short-circuits, does not occur in a badly exhausted lamp, the inside connections may melt. Our new process of exhaustion is, therefore, of special value in the production of these lamps. By this method, individual exhaustion insures a perfect vacuum in every lamp and reduces the danger of explosion or failure to a minimum.

VALUE OF OUR EXHAUSTION PROCESS

Owing to the increased strain to which the carbons or filaments are subjected by the high voltage, these lamps are uncommercial except in the lower efficiencies. The efficiency of our regular product is 4 watts per candle, and in its average life and maintenance of candle-power, corresponds to our standard 100 to 125 volt 3.1 watt lamp.

The illustration shows our latest type of 200 to 250 volt lamp. The length of filament necessary in this type of lamp is most advantageously arranged in a DOUBLE oval which is firmly held in position by TWO anchors. Such an arrangement is much neater than the method of anchoring to the inside of the bulb, and it avoids shadows. An anchor from the lower end of the filament to the inside of the bulb is useless, as the anchor breaks off with a slight shock and the weight of it destroys the filament. The Edison filament is so anchored as to allow some vibration and thus relieve the strain on the filament, but the vibrations are checked so as not to exceed proper limits. These lamps are made in 16 and 32 candle-power.

DESCRIPTION.

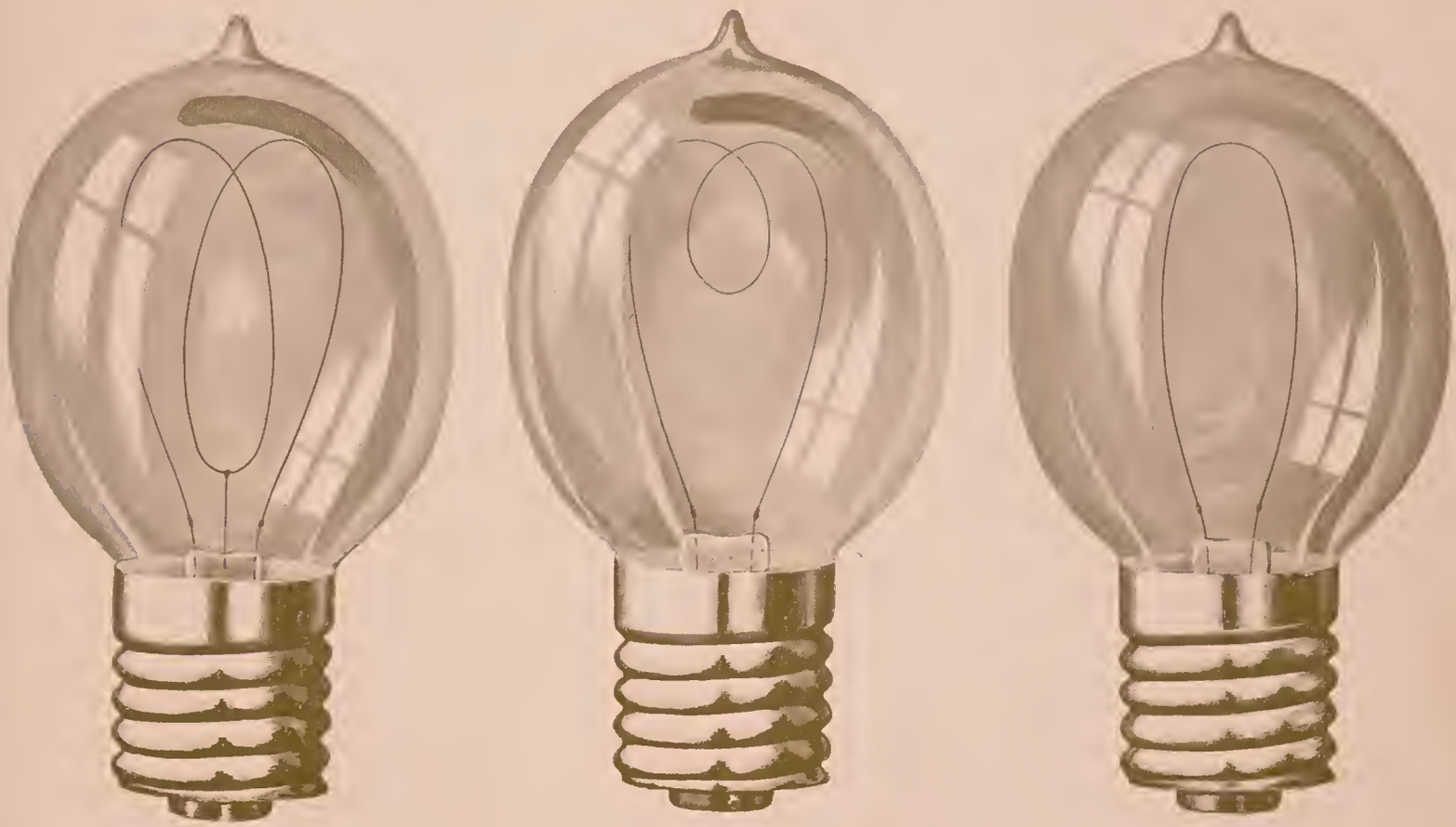
Bulb—Moulded, Pear-shaped, Size as in illustration. Filament—Double oval, Double anchored. Voltages—200 to 250. Efficiency—4 watts per candle.

Fitted with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.

Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.

Round Bulb Lamps.

For window or other decorations and for all installations where a short bulb is desirable, we offer our Round Bulb Lamps. The bulbs are $2\frac{1}{8}$" in diameter and make a very neat compact type of lamp. The oval form of anchored filament provides the best arrangement for the long filament of high voltage lamps in small round bulbs. In low voltage lamps the shorter and stiffer filament is well adapted to the spiral and loop forms. The round bulb lamps are frequently used in street railway service, in headlights and elsewhere. They can be obtained specially selected for amperes when desired for railway service.



DESCRIPTION.

Bulb—Moulded, Spherical, $2\frac{1}{8}$" in diameter.

Filament, 100 volts and over—Oval, Anchored.

Filament, 50 to 60 volts—Spiral in 16 candle-power lamps, Loop in 8 and 10 candle-power lamps.

Voltages—45 to 125.

Efficiency, 8 candle-power lamps—3.1, 3.5, and 4 watts per candle.

Efficiency, 10 candle-power lamps—3.1, 3.5, and 4 watts per candle.

Efficiency, 16 candle-power lamps—3.1, 3.5, and 4 watts per candle.

Fitted with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.

Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.

Tubular Lamps.

Tubular or "Bunghole" Lamps are useful in confined or narrow places. They were originally made for examining the interior of casks and barrels, the lamps being inserted through the bunghole. These lamps are also frequently used on candelabra and resemble lighted candles. With the tubular form of bulb, the loop filament anchored at the lower end to prevent sagging, is most suitable.

DESCRIPTION.

Bulb—Moulded, Size as in illustrations. Filament—Loop, Anchored. Voltages—45 to 125.
Efficiency, 8 candle-power lamps—3.5 and 4 watts per candle.
Efficiency, 10 candle-power lamps—3.1, 3.5 and 4 watts per candle.
Efficiency, 16 candle-power lamps—3.1, 3.5 and 4 watts per candle.
Fitted with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.
Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.

STEREOPTICON LAMPS.

To meet a large and constantly increasing demand, we supply a specially designed lamp for stereopticons. A compact filament is here essential so that the light shall be radiated as nearly as possible from one point. As these lamps are required only in the higher candle-powers, the filament is necessarily heavy and must not be too closely bent. The convoluted spiral shown in the illustration meets these conditions most satisfactorily.

The illustration shows the 100 and 150 candle-power stereopticon lamp. We make the 50 candle-power size in a smaller bulb $3\frac{1}{8}''$ in diameter. We also manufacture lower and higher candle-powers to special order.

DESCRIPTION.

Bulb — Moulded, Round — For 100 to 150 candle-power, Size as in illustration; for 50 candle-power, Size $3\frac{1}{8}''$ in diameter. Filament — Convoluted spiral. Voltages—45 to 125.

Efficiency, 50, 100 and 150 candle-power lamps—4 watts per candle.

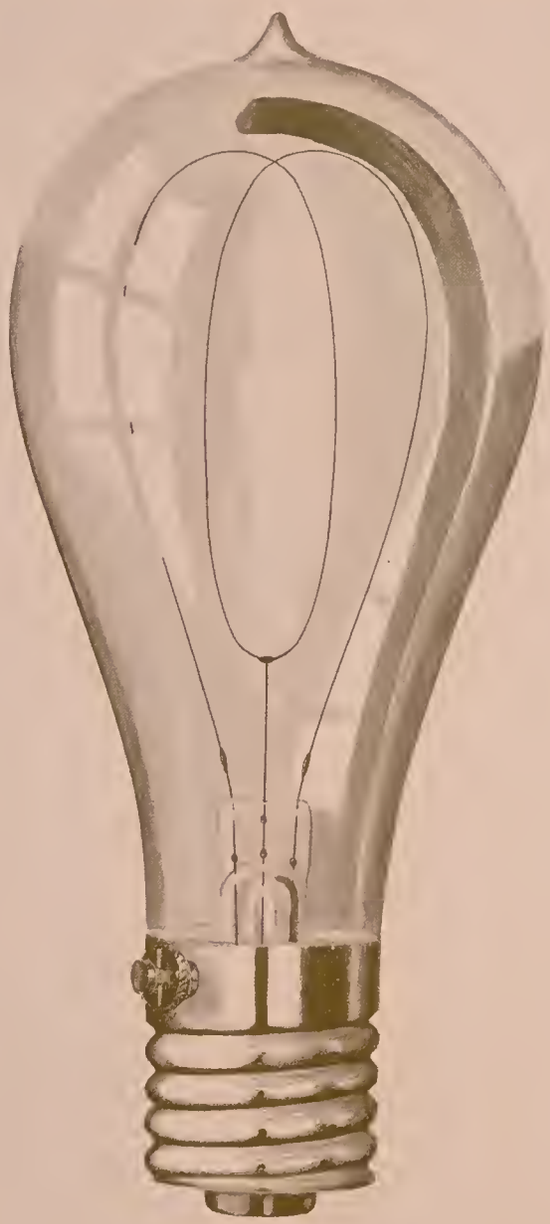
Fitted with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.

Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.

The Edison Night Lamp.

An objection to the Incandescent Light has always been that it could not be turned down or dimmed. This objection has been overcome in the Edison Night Lamp. A simple movement of the milled screw provided on this lamp changes the candle-power from sixteen to one. The device is economical as well as simple since the current consumed is reduced with the candle-power to a negligible amount. This lamp can be furnished without the screw, if a permanent low candle-power lamp is desired. The bulbs are always frosted.

The Night Lamp is particularly adapted for use in hospitals, nurseries, bed-chambers, halls and closets.

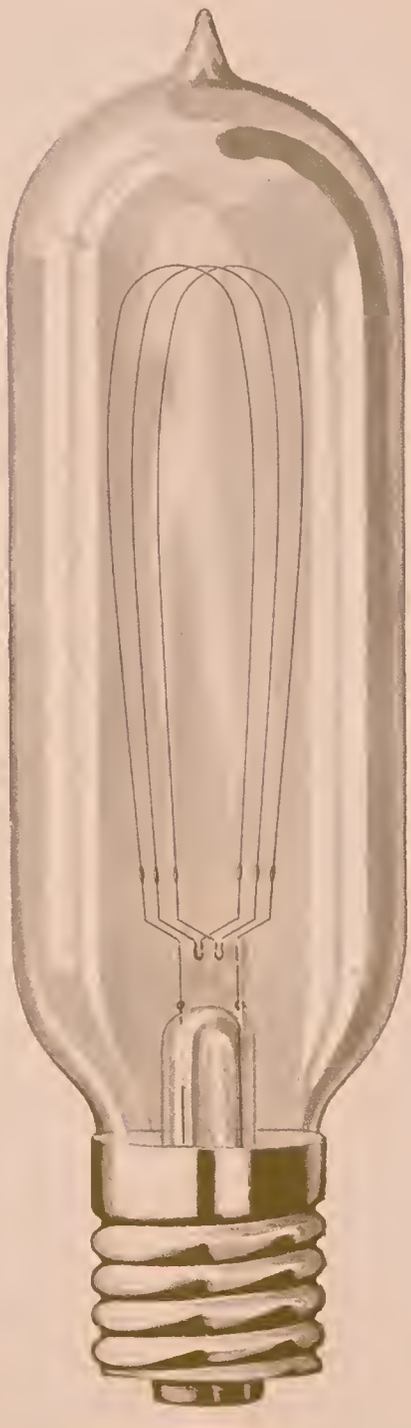


DESCRIPTION.

Bulb—Moulded, Pear-shaped, Size as in illustration.
Filament—Oval, Anchored. Voltages—45 to 125.
Fitted with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.
Bulbs in all cases furnished frosted.

Resistance Lamp.

Banks of lamps for resistance are in quite general use and are very satisfactory for moderate currents. We have for years had a large demand for specially made resistance lamps, of the type shown in the illustration. Resistance lamps are furnished in tubular bulbs, in order that they can be packed closely and thus minimize space. The filaments are loops connected in series to give required resistance. Lamps of this type can be furnished of any desired resistance up to 1000 ohms cold, and for currents up to five amperes. In ordering state resistance and the current in amperes at which this resistance is desired.



DESCRIPTION.

Bulb—Moulded, Tubular, Size as in illustration.

Filament—Loop. Resistance—As stated above.

Fitted with Standard Edison Screw Base or any of the following bases: Westinghouse, Thomson-Houston, United States, Brush-Swan, Hawkeye, Mather, Perkins or Schaeffer.

Bulbs can be furnished frosted, or of almost any desired color, either artificially dipped or in natural glass.

ORDERS FOR AND CORRESPONDENCE CONCERNING MINIATURE LAMPS AND APPLIANCES, AND ANY SPECIAL LAMPS NOT DESCRIBED IN THIS CATALOGUE, SHOULD BE ADDRESSED TO

EDISON DECORATIVE AND MINIATURE LAMP DEPT.,

GENERAL ELECTRIC COMPANY,

HARRISON, N. J.

Miniature Lamps and Appliances

Candelabra and Decorative Lamps.

The practical application of Candelabra Lamps in decorative interior lighting has become so general and so well understood that any special remarks in the sense of exploitation are unnecessary at this date.

The Series Candelabra Lamps which were introduced by us a few years ago have constantly grown in public favor, and are now in extensive use, chiefly for decorative lighting in residences, hotels and other places to which they are eminently suitable. The favorable reception that this form of lighting has met, has led to a demand for lamps of the same general styles and sizes capable of being used in multiple, instead of in series, on circuits of from 100 to 120 volts.

Anticipating such a demand, we produced several styles of multiple burning Candelabra Lamps, which are shown in the following pages. We have found them to be a product that has met with instant favor and, in consequence of their many points of excellence, the demand for them has rapidly grown.

The Special Series Lamps have also retained their great popularity for all kinds of temporary and permanent decorative and electric sign work. In this branch we have also added a multiple burning lamp to meet a demand for such a type of lamp, to be used more especially in electric sign work. This lamp has filled many requirements for that special use that could not be met by the series lamps. All of these lamps, however, series and multiple, have their proper sphere of utility, according to the circumstances under which they are to be used.

It is proper to call special attention also to our Sockets and Receptacles. Many improvements have been made in them, not only with regard to their usefulness and to the convenience of handling, but with a view to their appearance and increased safety from a fire underwriter's standpoint. It will be found from a careful examination of the sockets and receptacles listed in the following pages, that we have so devised them as to provide for all contingencies that could be reasonably anticipated.

Regarding Series Lamps.

The lamps shown on pages 44, 46 and 47, are made especially for series burning on electric lighting circuits.

Particular attention is called to the following general remarks on these lamps.

If these remarks are carefully read before ordering or using any of these series lamps, purchasers will save themselves and us considerable trouble, expense and delay.

The most important point in burning lamps in series is that the amperes of each of the lamps in any one series should be the same within three one-hundredths of an ampere.

The voltage of the lamps may vary, but the sum of the voltages in any series must equal the voltage of the circuits within three volts.

In selecting lamps for any one series, use only lamps of approximately the same amperes, and see that the sum of their voltages equals the voltage of the circuit.

In replacing a lamp which has burned out in any series, use only a lamp of the same voltage and amperes as the one broken.

In ordering series lamps to replace those burned out, give both voltage and amperes of those in use, also, voltage of circuit.

Series Candelabra Lamps.

Series candelabra lamps are made in five different styles, A, B, C, D and E, and are furnished, when specified, to be used two, three or four in series on electric lighting circuits of 100 to 120 volts, and two in series or in multiple on circuits of 50 to 60 volts.

Style A is always a 10 candle-power lamp.

Styles B, C, D and E differ from each other only in the shape of the bulbs, but they all differ from the style A lamp in that the candle-power of each varies according to the number of lamps used in series. On 100 to 120 volt circuits, two lamps in series give 8 candle-power each—three in series, 5 candle-power each—four in series, 4 candle-power each. If burned in multiple on circuits of 50 to 60 volts, each lamp will give about 8 candle-power.

STYLE A STYLE B STYLE C STYLE D STYLE E

All colored candelabra lamps will be made of natural glass, except amber-colored, which will be dipped.

Unless otherwise ordered the Style D lamp is frosted, as a better effect is thereby obtained. It is not made in colors.

Amperes and volts are etched on each lamp.

Note directions for ordering, page 43.

The above lamps will fit Candelabra Sockets and Receptacles Nos. 1, 2, 3, 6 and 7, page 48.

Multiple Candelabra and Sign Lamps.

Multiple candelabra lamps, Styles A, B and D have been especially designed for burning in multiple on circuits of 100 to 120 volts. In ordering these lamps the voltage of the circuit should be specified and the lamps be designated as *Multiple* Candelabra Lamps, Styles A, B or D to distinguish them from the Series Candelabra Lamps of the same styles.

The multiple sign lamp, Style F, was especially designed to fill a demand for small lamps to burn in multiple in illuminated signs having letters from ten inches to two feet in height. It has attained a great popularity for use in this connection, as well as in many other lines on account of its size, beauty, candle-power and economy in the use of current. It is an 8 candle-

STYLE A STYLE B STYLE D STYLE F

power lamp, is furnished for use in multiple on circuits of 100 to 120 volts, and takes a current of about .28 ampere. In ordering these lamps, the voltage of the circuit should be specified.

All colored multiple candelabra and sign lamps will be made of natural glass, except amber-colored, which will be dipped.

Unless otherwise ordered the Style D lamp is frosted, as a better effect is thereby obtained. It is not made in colors.

Note directions for ordering, page 43.

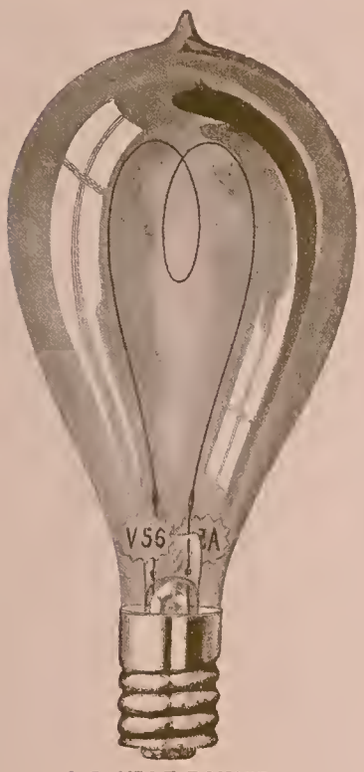
The above lamps will fit Candelabra Sockets and Receptacles Nos. 1, 2, 3, 6 and 7, page 48.

Special Series Lamps.

The following lamps are called "Special Series" Lamps to distinguish them from Candelabra and Battery Lamps. We furnish these in four different candle-powers for burning in series on electric lighting circuits of 100 to 120 volts, or on circuits of 50 to 60 volts.

The 8 candle-power lamp is used for decorative purposes where large units of light, but few in number, are desired. In illuminations covering a large area this lamp can be used advantageously. It is also used in multiple for illuminated signs on 50 to 60 volt circuits.

The 5 candle-power lamp is also used for decorative purposes where large units of light, but few in number, are desired, and it can be used advantageously in illuminations covering a large area. It is used quite extensively in decorative sign work where the effect to be obtained is not based upon the employment of large units of light but upon the special design or the number of lamps used.

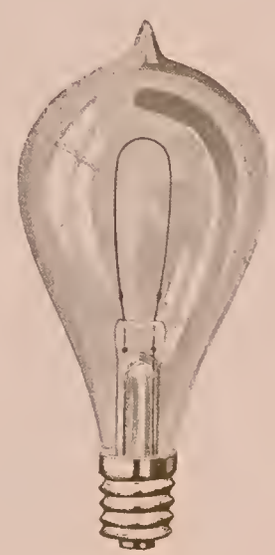


8 CANDLE-POWER.

2 in Series on 100-120 Volts
In Multiple on 50- 60 Volts
Current required for each
series will average
about .50 amp.

5 CANDLE-POWER.

4 in Series on 100-120 Volts.
2 in Series on 50-60 Volts
Current required for each
series will average
about .55 amp.



3 CANDLE-POWER.

8 in Series on 100-120 Volts.
4 in Series on 50-60 Volts
Current required for each
series will average
about 1 amp.

1 CANDLE-POWER.

8 in series on 100-120 Volts.
4 in Series on 50-60 Volts
Current required for each
series will average
about .33 amp.

The 3 candle-power lamp is used for decorative purposes in cases where plenty of current is obtainable. We do not recommend its use where lamps are to be placed close together, as in sign work and many cases of floral decorations, because it becomes quite hot in continual use.

The 1 candle-power lamp is that which we most strongly recommend for sign and decorative work where lamps are to be placed close together. It gives a good light, generates very little heat, and each series requires only about one-third of an ampere of current. It is therefore, the best small lamp for series work, whether for interior signs, among flowers or otherwise.

Special Series Lamps.—Continued.

The theatrical lamp is made to give 1 candle-power, burning 16 in series on 100 to 120 volt circuits or 8 in series on 50 to 60 volt circuits. Each series takes about one-half ampere of current. It is extensively used for theatrical purposes, for decorating dancers and producing special effects. This lamp is carried in stock as an unbased (or wire) lamp, and will be so shipped unless otherwise ordered. If desired it will be furnished fitted with miniature screw base to fit No. 4 Receptacle or No. 5 Socket.

SPECIAL SERIES THEATRICAL LAMP

All colored series lamps will be made of natural glass, except amber-colored, which will be dipped.

Amperes and volts are etched on the 8 candle-power and 5 candle-power lamps.

Note directions for ordering, page 43.

The 8 candle-power and the 5 candle-power lamps will fit Candelabra Sockets and Receptacles Nos. 1, 2, 3, 6 and 7, page 48.

The 3 candle-power and the 1 candle-power lamps will fit Miniature Lamp Socket and Receptacle Nos. 4 and 5, page 48.

Receptacles and Sockets.

No. 1 is known as the Standard Round Candelabra Receptacle. It is made of non-combustible insulating material. This receptacle is especially designed for use on fixtures fitted with glass candles, the receptacle screwing into a central supporting tube, and the candles, when in place, completely covering both supporting tube and receptacle. It will receive lamps having candelabra screw base—pages 44 and 45, and the 8 and 5 candle-power lamps on page 46.

No. 2 is the Standard Flat Base Candelabra Receptacle. It is made of porcelain and will receive lamps shown on pages 44 and 45, and the 8 and 5 candle-power lamps on page 46.

NO. 1 RECEPTACLE.

NO. 2 RECEPTACLE.

NO. 3 SOCKET.

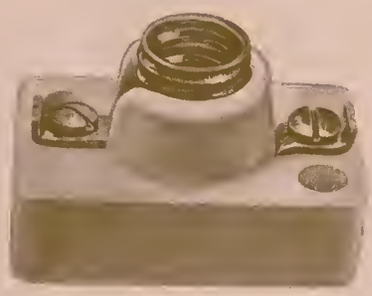
NO. 4 RECEPTACLE.

No. 3 is the Candelabra Socket. It is made of brass, with porcelain insulating parts, and will receive lamps shown on pages 44 and 45, and the 8 and 5 candle-power lamps on page 46.

No. 4 is the Standard Round Miniature Lamp Receptacle. It is made of porcelain and will receive the 3 and 1 candle-power lamps fitted with miniature screw base—pages 46 and 47.

No. 5 is the Standard Socket for use with Miniature Lamps. It is made of brass with porcelain insulating parts, and will receive the 3 and 1 candle-power lamps fitted with miniature screw base—pages 46 and 47.

NO. 5 SOCKET.



NO. 6 RECEPTACLE.

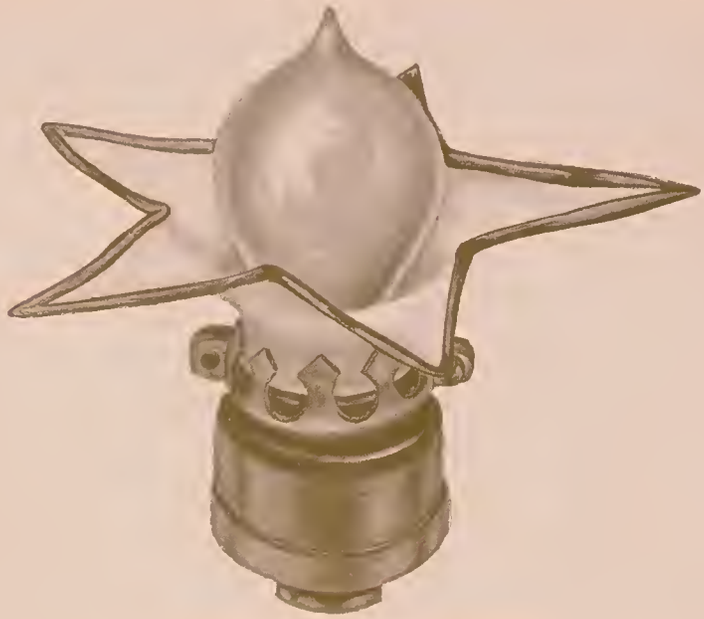
NO. 7 RECEPTACLE.

No. 6 is a Special Receptacle made by us for sign work. It has been designed for strength and compactness and is very extensively used for sign work of all kinds. It is made of porcelain and will receive lamps shown on pages 44 and 45, and the 8 and 5 candle-power lamps on page 46.

No. 7 is a Double-pole Fused Receptacle which has been designed to meet the requirements of certain climatic conditions demanding the use of fuses in connection with the receptacle itself. It is also particularly suitable for many classes of inside work necessitating the use of an ornamental receptacle. This receptacle is made of porcelain and has a removable cap or cover concealing both connections and fuses, yet permitting ready access thereto. It will receive lamps shown on pages 44 and 45, and the 8 and 5 candle-power lamps on page 46.

Shades for Miniature Lamps.

The star shade here illustrated is made especially for certain classes of decorative work, and presents a very handsome and striking effect when the lamps are lighted.



STAR SHADE WITH COLORED EDGING.

The shades for miniature lamps illustrated below are furnished in the following colors: Red, White, Blue and Green, with edgings of different colors.

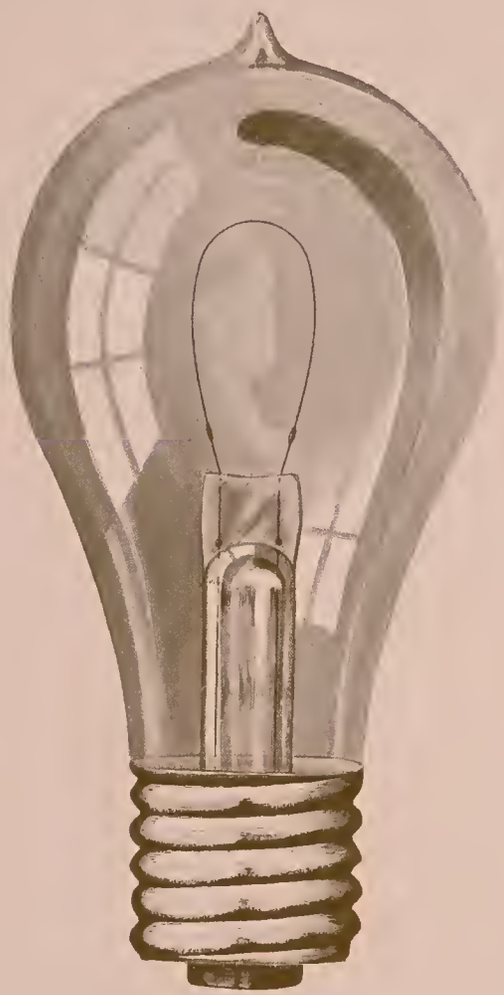
SHADES FOR MINIATURE LAMPS.

SHADE-HOLDER ATTACHMENT.

The type of Shade-holder Attachment shown in the illustration is furnished for use with Sockets Nos. 3 and 5. It is made of brass and may be readily attached. As these attachments are not interchangeable for Sockets Nos. 3 and 5, customers should be careful in ordering to state with which socket the attachment is intended to be used.

Battery Lamps.

The lamps shown on the following pages are made especially for use with batteries and are not adapted for series work. They should not under any circumstances be used for series lighting.



BATTERY LAMP.
FOR STANDARD SOCKET.

Battery lamps as shown in the above illustration are extensively used for railway-carriage lighting and for other purposes in connection with storage battery plants. They are made up in standard bulbs of about the size shown in the cut, and can be furnished to fit all standard sockets.

They are made of 8, 10, 16, 20 and 24 candle-power, and from 8 to 45 volts.

These lamps are furnished at an economy of from 2.5 to 4 watts per candle.

BATTERY LAMPS.—CONTINUED.

The battery lamps here illustrated are described in the accompanying table. WE MAKE NO LAMPS TAKING LESS THAN 3 VOLTS.

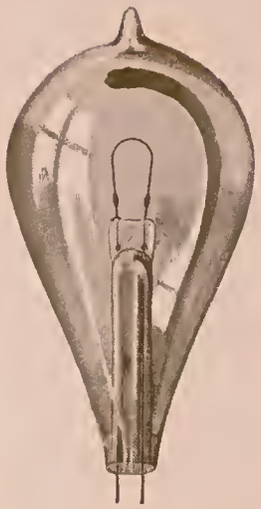
½ CANDLE.

1 CANDLE.

2 CANDLES.

3 CANDLES.

4 CANDLES.



6 CANDLES.

DENTAL, SIDE SEAL.

SPECIAL DENTAL, SIDE SEAL.

SPECIAL DENTAL, BOTTOM SEAL.

SURGICAL LAMP.

PEA LAMP.

DESCRIPTION.	CANDLE-POWER.	ELECTRO-MOTIVE FORCE. VOLTS.	CURRENT REQUIRED, APPROX. AMPERES.
Standard Battery Lamp . . .	½ Candle	3 to 5	.80 to 1.35
Standard Battery Lamp . . .	1 Candle	4 to 6	.90 to 1.40
Standard Battery Lamp . . .	2 Candles	4 to 7	1.00 to 1.50
Standard Battery Lamp . . .	3 Candles	5 to 7	1.25 to 2.00
Standard Battery Lamp . . .	4 Candles	7 to 9	1.25 to 2.00
Standard Battery Lamp . . .	6 Candles	9 to 12	1.50 to 2.25
Dental Lamp, Side Seal . . .	½ Candle	3 to 5	.80 to 1.35
Special Dental, Side Seal . . .	½ Candle	3 to 5	.80 to 1.35
Special Dental, Bottom Seal . .	½ Candle	3 to 5	.80 to 1.35
Surgical Lamp	½ Candle	3 to 5	.80 to 1.35
Pea Lamp	½ Candle	3 to 5	.80 to 1.35

BATTERY LAMPS.—CONTINUED.

The telephone lamps here shown are specially made for use on telephone switchboards. They are designed to take a very small quantity of current. The volts and current required are as follows:

One-fourth candle-power, 10 volts, .14 ampere.

One-half candle-power, 20 volts, .14 ampere.

These lamps are *always* furnished with miniature screw base to fit No. 4 Receptacle or No. 5 Socket, unless otherwise ordered.

¼ C.P.
TELEPHONE LAMP.

½ C.P.
TELEPHONE LAMP.

¾ C.P.
BICYCLE LAMP.

1 CANDLE
MINER'S LAMP.

The bicycle lamp here shown is the form and type of lamp most generally used with storage or primary battery for bicycle headlights, etc. It is of high economy, giving about ¾ of a candle-power at 4 volts and .50 ampere. This lamp is always furnished with miniature screw base to fit our No. 4 Receptacle or No. 5 Socket, unless otherwise ordered.

The miners lamp is a flat lamp of one candle-power, arranged with loops at the top and bottom, in order that it can be hooked upon springs in the miner's lantern and so held steady. This lamp requires about 3.5 to 5.5 volts, and .90 to 1.40 amperes.

4 CANDLE
FLAT LAMP.

½ CANDLE
FLAT LAMP.

4 CANDLE
SPHERICAL LAMP.

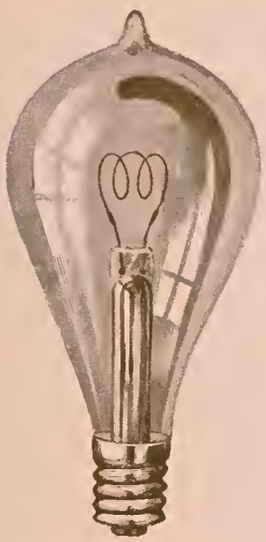
The electromotive force required for the flat lamps is 3 to 5 volts, and 7 to 9.5 volts. The current required is .80 to 1.35, and 1.25 to 2 amperes.

The electromotive force required for the spherical lamp is 7 to 9.5 volts. The current required is 1.25 to 2 amperes.

BATTERY LAMPS.—CONTINUED.

The kinetoscope lamp is that originally adopted for use in the Edison Kinetoscope, and it is still used therewith all over the world. As will be seen from the illustration, the filament is in spiral form, thus providing for concentration of the light in one spot. This lamp is always furnished with miniature screw base, to fit No. 4 Receptacle or No. 5 Socket, unless otherwise ordered.

The microscope lamps are for one-half candle-power. The electromotive force required is 3 to 5 volts and the current required is .80 to 1.35 amperes.

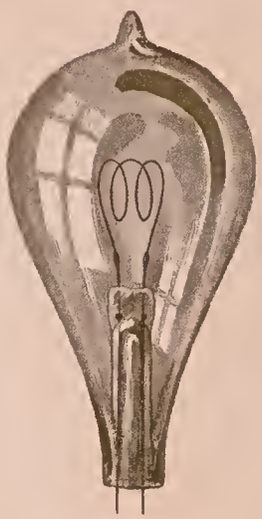


KINETOSCOPE LAMP
4 C.P. 8 VOLTS.

MICROSCOPE LAMP
LARGE.

MICROSCOPE LAMP
SIDE SEAL.

MICROSCOPE LAMP
SMALL.



20 CANDLE
SPIRAL LAMP.

The carbon of the 20 candle-power spiral lamp is made in spiral form, as shown in the illustration, and the lamp is therefore adapted for special purposes where a brilliant and concentrated light is desired. This lamp is furnished without base unless otherwise ordered.

Electromotive force required is from 30 to 38 volts, and current of from 1.75 to 2.50 amperes.

STICK-PIN LAMP.

WATCH-CHARM LAMP.

We have not heretofore listed the stick-pin and watch-charm lamps, having usually supplied them only on special order. The demand for these ornaments has of late become so general that we have decided to carry them in stock regularly. The lamps are similar in appearance to an ordinary incandescent lamp, but they are only dummies and cannot be lighted.

ORDERS FOR AND CORRESPONDENCE CONCERNING MINIATURE LAMPS AND APPLIANCES, AND ANY SPECIAL LAMPS NOT DESCRIBED IN THIS CATALOGUE, SHOULD BE ADDRESSED TO

EDISON DECORATIVE AND MINIATURE LAMP DEPT.,

GENERAL ELECTRIC COMPANY,

HARRISON, N. J.

Appendix of Information on Incandescent Lamps

Life and Candle-power of Lamps.

Since the prime function of an incandescent lamp is to give light, the best lamp is that which gives maximum light at minimum cost. This is an exceedingly simple axiom and yet few users of lamps follow it out in practice. Lamps are repeatedly selected for long life irrespective of good, uniform candle-power. Lamps are often continued in use long after their candle-power has seriously diminished.

An examination of the characteristics of an incandescent lamp will give a clear understanding of the principles applying to their selection and use. A theoretically perfect lamp would maintain its normal candle-power indefinitely, or until the lamp was broken. In practice the deterioration of the lamp filament causes a steady loss of candle-power.

The drop in candle-power is a characteristic of an incandescent lamp always to be borne in mind. The relative drop or loss of candle-power, other things being equal, determines the comparative value of different lamps. We may have a lamp that loses 50% in candle-power inside of 200 hours on a 3.1 watt efficiency basis. This type is almost invariably furnished by the inexperienced manufacturer, and there are many such lamps in the market. Considered from the standpoint of life only, such lamps are excellent, because their filaments deteriorate to such a degree that it is practically impossible to supply enough current to brighten them up to the breaking point, but no discerning station manager would want such dim lamps even with unlimited life. As in the selection of incandescent lamps so in their use—the exclusive consideration of life leads to poor results. Loss of candle-power in a lamp sooner or later makes it uneconomical to continue in use.

REGARDING LOSS IN CANDLE-POWER

There is no lamp yet made which is economical to burn over 1000 hours, and in the great majority of cases the limit is under 600 hours.

An incandescent lamp is nothing more than a transformer, receiving current and transforming it into light. After a certain time this transformer may lose 50% in efficiency, taking practically the same current, but giving only about one-half the light. A boiler or an engine suffering such loss in efficiency would be promptly repaired or replaced. The renewal of incandescent lamps is even more important. The old lamps jeopardize the customer's trade with their poor and expensive light. A customer cares little how efficiently a station is operated, but is much concerned about the quality of light furnished. At the present price of lamps, doubling the number of lamp renewals adds little to cost of operation, while it increases the lighting efficiency 40% to 50%. Some stations attempt to correct the dimness of old lamps by raising the voltage, but this is bad practice, for the increased pressure damages every new lamp placed in circuit. These principles are carefully observed by many of the large lighting companies, and a force of men is employed to weed out and replace all dim lamps. Some such means of keeping the average life below 600 hours should be adopted by every lighting company that has any regard for the economical production of light or the satisfaction of their customers.

A simple method is to fix the average life at 600 hours or less and then determine from the station record how many lamps should be renewed each month to keep the average life within this limit. The required number of lamps should be renewed each month.

If, for example, a station decides on an average life not to exceed 600 hours and the station records show that on the average 60,000 lamp hours of current are supplied monthly, then it would be necessary to renew $\frac{60,000}{600}$ or 100 lamps a month.

The Importance of Good Regulation.

PROPER SELECTION AND USE OF TRANSFORMERS.

Poor regulation of voltage probably results in more trouble with customers than any other fault in electric lighting service.

Some Central Station managers act on the theory that so long as the life of the lamp is satisfactory, an increase of voltage, either temporary or permanent, will increase the average light. The fact is that when lamps are burned above their normal rating the average candle-power of all the lamps on the circuit is decreased, and if the station is on a meter basis, it increases the amount of the customers' bills.

EVILS OF EXCESSIVE VOLTAGE

Excessive voltage is thus a double error—it decreases the total light of the lamps, and increases the power consumed. The loss of light displeases the customers and discredits the service. If light is sold by meter, the increased power consumption dissatisfies the customers; if light is sold by contract, the additional power is a dead loss to the station. If increased light is needed, 20 candle-power lamps should be installed instead of raising the pressure. Their first cost is the same as 16 candle-power lamps; they take but little more current than 16 candle-power lamps operated at high voltage and give greater average light.

Increased pressure also decreases the commercial life of the lamp, and this decrease is at a far more rapid rate than the increase of pressure as shown in the following table. This table shows the decrease in life of standard 3.1 watt lamps due to increase of normal voltage.

Per Cent. of Normal Voltage.	Life Factor.
100	1.000
101	.818
102	.681
103	.662
104	.452
105	.374
106	.310

From this table it is seen that 3% increase of voltage halves the life of a lamp, while 6% increase reduces the life by two-thirds.

Irregular pressure, therefore, necessarily results in the use of lamps in which the power consumption per candle is greater than a well regulated pressure would allow. The result is reduced capacity of station, and reduced station efficiency.

THE SAVING RESULTING FROM GOOD REGULATION

These remarks apply with special force to alternating current stations, since we have here two sources of possible irregularity in voltage—the generator and the transformer. Poor regulation is most apt to occur in the transformers and the utmost care should, therefore, be taken in their selection and use. The efficiency of the average lamp on alternating systems is nearly 4 watts per candle. With good regulation obtained by the intelligent use of modern transformers, the use of lamps of an efficiency of 3.1 watts per candle becomes practicable. It is thus possible to save 25% in power consumption at the lamps and increase the capacity of the station and transformers by the same amount.

In the past two years there has been a marked advance in the method of making transformer installations. The general adoption of higher voltage secondaries gives smaller loss in

wires and permits the use of larger transformer units, thus greatly improving the regulation. On this account 50 volt lamps are gradually going out of use. The replacement of a number of small transformers by one large unit, and of old, inefficient transformers by modern types, has also been of immense advantage to stations. A large number of stations, however, still retain these old transformers, and load their circuits with large numbers of small units. Such stations necessarily suffer from loss of power, bad regulation and a generally deteriorated lighting service. Simply as a return on the investment, it would pay all such stations to scrap their old transformers and replace them with large and modern units.

MODERN TRANSFORMER PRACTICE

Proper care in the selection of transformers considers the quality and the size. Quality is the essential consideration and should have preference to first cost. No make of transformer should be permitted on a station's circuit that does not maintain its voltage well within 3% from full load to no load. The simple rule regarding size is to use as large units as possible and thus reduce the number of units as far as the distribution of service permits. Every alternating station should aim to so improve regulation as to permit the satisfactory use of 3 watt lamps.

Good regulation is eminently important to preserve the average life and light of the lamps, to prevent the increase of power consumed by the lamps, and to permit the use of lamps of lower power consumption, so that both the efficiency and capacity of the station may be increased.

Constant voltage at the lamps can be maintained only by constant use of reliable, portable instruments. No switchboard instrument should be relied on, without frequent checking by some reliable standard. Owing to the varying drop at different loads, constant voltage at the station is not what is wanted. Pressure readings should be taken at customers' lamps at numerous points, the readings being made at times of maximum, average and minimum load. Not less than five to ten readings should be made at each point visited, the volt-meter being left in circuit for four or five minutes and readings taken every fifteen seconds. The average of all the readings gives the average voltage of the circuits. Lamps should be ordered for this voltage, or if desired, the voltage of the circuits can be reduced or increased to suit the lamps in use. The practical points are to determine the average voltage at frequent periods with a portable volt-meter at various points of the circuits, and then to arrange the voltage of the lamps and circuits so that they agree.

HOW TO MAINTAIN CONSTANT PRESSURE

Candle-hours—The Measure of Lamp Value.

The amount of light given by lamps of the same efficiency is the only proper measure of their value. The amount of light given, expressed in candle-hours, is the product of the average candle-power for a given period by the length of the period in hours.

Many of the best Central Station managers consider that a lamp has passed its *useful life* when it has lost 20% of its initial candle-power. In the case of a 16 candle-power lamp the limit would be 12.8 candle-power. The period of time a lamp burns until it loses 20% of its candle-power may therefore be accepted as its useful life. The product of this period in hours by the average candle-power gives the "candle-hours" of light for any given lamp.

The better a lamp maintains its candle-power under equal conditions of comparison the greater will be the period of "useful life" and therefore, the greater will be the "candle-hours." This measure is, therefore, the only proper one with which to compare lamps and determine their quality.

The practical method of comparison is as follows:—Lamps of similar candle-power and voltage are burned at the same initial efficiency of 3.1 watts per candle on circuits whose voltage is maintained exactly normal. At periods of 50, 75 or 100 hours the lamps are removed from the circuits and candle-power readings taken, the lamps being replaced in circuit at the end of each reading. Readings are thus continued until the candle-power drops to 80% of normal. The results obtained are then plotted in curves, and the areas under these curves give the "candle-hours" and the relative value of the different lamps.

Variation in Candle-power and Efficiency.

In the following table is shown the variation in candle-power and efficiency of standard 3.1 watt lamps, due to variation of normal voltage.

Per Cent. of Normal Voltage.	Per Cent. of Normal Candle-power.	Efficiency in Watts Per Candle.
90	53	4.68
91	57	4.46
92	61	4.26
93	65	4.1
94	69½	3.92
95	74	3.76
96	79	3.6
97	84	3.45
98	89	3.34
99	94½	3.22
100	100	3.1
101	106	2.99
102	112	2.9
103	118	2.8
104	124½	2.7
105	131½	2.62
106	138½	2.54

Example.—Lamps of 16 candle-power, 105 volts, and 3.1 watts, if burned at 98% of normal voltage, or 103 volts, will give 89% of 16 candle-power, or 14¼ candle-power and the efficiency will be 3.34 watts per candle.

Lamp Renewals.

The importance and necessity of proper lamp renewals applies forcibly to all stations, regardless of the cost of power and whether lamp renewals are charged for or furnished free. The policy of free lamp renewals at the present low price of lamps is, however, preferable for both station and customer. Free lamp renewals give a station that full and complete control of their lighting service so requisite to perfect results.

Since, however, a large number of companies charge for renewals, we offer some suggestions as to the best method of inducing customers to renew their old lamps, for it is evident that some inducement is necessary.

Offering new lamps in exchange for dim lamps at a reduction in price is one good method. A customer, for example, would save by paying say half price for the renewal of a dim lamp, instead of waiting and paying full price when the lamp burns out.

Another method is to offer lamps for renewals at less than cost, say 15 cents each, and reserve the right to say when lamps shall be renewed. Such a plan works well, as no customer can justly complain when the company renews lamps at less than cost.

As profit on the sale of lamps is certainly secondary in importance to the sale of current and the improvement in quality of light, either of the above plans should commend themselves to all Central Stations not furnishing free renewals.

Whatever method be adopted, the one chief principle of good economical lighting service should never be forgotten, viz.: that the average life of lamps should never exceed *600 hours*.

Points to be Remembered.

That a constant pressure at the lamps must be maintained.

That the lamps are not to be used to the point of breakage—they should be renewed when they become dim.

That satisfaction to customers, and the success of electric lighting is dependent upon good, full and clear light, which old, black and dim lamps cannot give.

That to furnish a good, full and clear light is as much a part of the Lighting Company's business as to supply current to light the lamps.

That a company should always endeavor to keep the average life of lamps within 600 hours.

That to renew dim lamps properly on the free renewal system, inspectors should examine the circuits regularly when the lamps are burning. If lamp renewals are charged to customers, induce them to exchange their dim lamps.

Faults in Incandescent Lamps.

RAPID LOSS OF CANDLE-POWER.

Rapid loss of candle-power is one defect in incandescent lamps, and we have shown that all lamps suffer a gradual loss of candle-power as they are used. A very rapid loss in candle-power is, however, a real fault, due to inexperienced manufacture, or use at excessive voltage. The remedy is to purchase only lamps of standard reputation produced by the experienced manufacturer and to maintain the pressure at normal on the lamps. The pressure should be carefully tested with accurate portable instruments at the lamp sockets, and if found high, the pressure should be regulated to accord with the voltage of lamps, or lamps supplied to accord with the pressure.

BLACKENING OF BULBS.

Another defect in incandescent lamps is the blackening of bulbs, although this is more often a supposed defect than a real one. A lamp may lose in candle-power and show but little blackening, and on the other hand, a lamp may get quite black and lose little in candle-power. Thus a 50 volt lamp which has a more stable filament than the 110 volt lamp often shows considerable blackening with little loss of candle-power.

Blackening in good lamps results from either high pressure or excessive life. This is a supposed fault. The best of lamps, if burned too long, will always show a certain amount of blackening. The remedies are, of course, regulation of pressure and frequent renewals.

The above are the most important defects to be found in incandescent lamps.

General Illumination.

The subject of illumination has been divided by Mr. E. L. Elliott, to whom we are indebted for many suggestions, into the following sub-divisions: Intensity or Brilliancy, Distribution, Diffusion and Quality.

INTENSITY OR BRILLIANCY.

The average brilliancy of illumination required will depend on the use to which the light is put. "A dim light that would be very satisfactory for a church would be wholly inadequate for a library and equally unsuitable for a ballroom."

The illumination given by one candle at a distance of one foot is called the "candle-foot" and is taken as a unit of intensity. In general, intensity of illumination should nowhere be less than one candle-foot, and the demand for light at the present time quite frequently raises the brilliancy to double this amount. As the intensity of light varies inversely with the square of the distance, a 16 candle-power lamp gives a candle-foot of light at a distance of four feet. A candle-foot of light is a good intensity for reading purposes.

Assuming the 16 candle-power lamp as the standard, it is generally found that two 16 candle-power lamps per 100 square feet of floor space give good illumination, three very bright, and four brilliant. These general figures will be modified by the height of ceiling, color of walls and ceiling and other local conditions. The lighting effect is reduced, of course, by an increased height of ceiling. A room with dark walls requires nearly three times as many lights for the same illumination as a room with walls painted white. With the amount of intense light available in arc and incandescent lighting, there is danger of exceeding "the limits of effective illumination and producing a glaring intensity," which should be avoided as carefully as too little intensity of illumination.

DISTRIBUTION OF LIGHT.

Distribution considers the arrangement of the various sources of light and the determination of their candle-power. The object should be to "secure a uniform brilliancy on a certain plane, or within a given space. A room uniformly lighted, even though comparatively dim, gives an effect of much better illumination than where there is great brilliancy at some points and comparative darkness at others. The darker parts, even though actually light enough, appear dark by contrast, while the lighter parts are dazzling. For this reason naked lights of any kind are to be avoided, since they must appear as dazzling points, in contrast with the general illumination."

The arrangement of the lamps is dependent very largely upon existing conditions. In factories and shops, lamps should be placed over each machine or bench so as to give the necessary light for each workman. In the lighting of halls, public buildings and large rooms, excellent effects are obtained by dividing the ceilings into squares and placing a lamp in the center of each square. The size of square depends on the height of ceiling and the intensity of illumination desired. Another excellent method consists in placing the lamps in a border along the walls near the ceiling.

For the illumination of show windows and display effects, care must be taken to illuminate by reflected light. The lamps should be so placed as to throw their rays upon the display without casting any direct rays on the observer.

The relative value of high candle-power lamps in case of an equivalent number of 16 candle-power lamps is worthy of notice. Large lamps can be efficiently used for lighting large

areas, but in general, a given area will be much less effectively lighted by high candle-power lamps than by an equivalent number of 16 candle-power lamps. For example, sixteen 64 candle-power lamps distributed over a large area will not give as good general illumination as sixty-four 16 candle-power lamps distributed over the same area. High candle-power lamps are chiefly useful when a brilliant light is needed at one point, or where space is limited and an increase in illuminating effect is desired.

DIFFUSION OF LIGHT.

"Diffusion refers to the number of rays that cross each point. The amount of diffusion is shown by the character of the shadow. Daylight on a cloudy day may be considered perfectly diffused; it produces no shadows whatever. The light from the electric arc is least diffused, since it emanates from a very small surface; the shadows cast by it have almost perfectly sharp outlines. It is largely due to its high state of diffusion that daylight, though vastly more intense than any artificial illumination, is the easiest of all lights on the eyes. It is a common and serious mistake, in case of weak or overstrained eyes to reduce the intensity of the light, instead of increasing the diffusion."

QUALITY OF LIGHT.

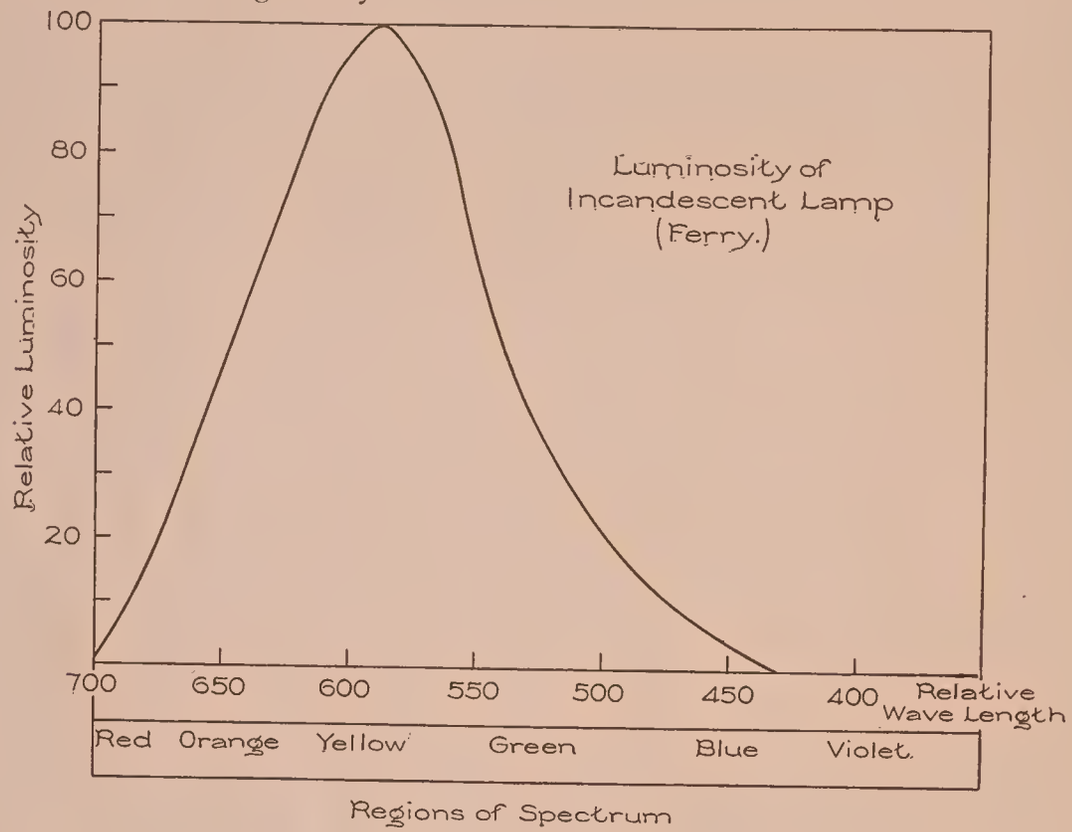
"Aside from difference in intensity, light produces many different effects upon the optic nerves and their centers in the brain. These different impressions we ascribe to difference in the quality of the light. Thus, 'hard light,' 'cold light,' 'mellow light,' 'ambient light,' etc., designate various qualities. Quality in light is exactly analogous to timbre or quality in sound, which is likewise independent of intensity. The most obvious differences in quality are plainly those called color. But color is by no means the element of quality. The proportion of invisible rays and the state of diffusion, are highly important factors, but on account of not being directly visible, they have been generally overlooked, and are but imperfectly understood."

Luminosity of Incandescent Lamps.

As showing the quality of the incandescent light, we present here a curve showing the relative luminosity of an incandescent lamp at different regions of the visible spectrum.

On this subject Mr. E. L. Nichols states the following:

"The most important wave lengths, so far as light-giving power is concerned, are those which form the yellow of the spectrum and the relative luminosity falls off rapidly both toward the red and the violet. The longer waves have, however, much more influence upon the candle-power than the more refrangible rays.



"Luminosity is the factor which we must take into account in seeking a complete expression for the efficiency of any source of illumination, and the method to be pursued in the determination of luminosity must depend upon the use to which the light is applied. If we estimate light by its power of bringing out the colors of natural objects, the value which we place upon the blue and violet rays must be very different from that which would be ascribed to them, if we consider merely their power of illumination as applied to black and white. In a picture gallery, for instance, or upon the stage, the value of an illuminant increases with the temperature of the incandescent material out of all proportion to the candle-power, whereas, candle-power affords an excellent measure of the light to be used in a reading room."

Relative Value of Arc and Incandescent Lighting.

The relative value of the arc and incandescent systems of lighting is frequently difficult to determine. Incandescent lamps have the advantage that they can be distributed so as to avoid the shadows necessarily cast by one single source of light. Arc lamps used indoors with ground or opal globes cutting off half the light, have an efficiency not greater than two or three times that

of an incandescent lamp. Nine 50 watt, 16 candle-power lamps consume the same power as one full 450 watt arc lamp. It has been found that unless an area is so large as to require 200 to 300 incandescent lights distributed over it, arc lamps requiring equal total power will not light the area with as uniform brilliancy.

The Correct Use of Light.

HOW TO AVOID HARMFUL EFFECTS ON THE EYES.

An objection frequently urged against the incandescent lamp is that it is harmful to the eyes and ruins the sight. This is true only in so far as the lamp may be improperly used. Any form of light as frequently misused would produce the same harmful results. Few people think of attempting to read by an unshaded oil lamp, and yet many will sit in the glare of a clear glass incandescent lamp. Incandescent lamps are more generally complained of because, unlike oil or gas, they can be used in any position. Bookkeepers and clerks are often seen with an incandescent lamp at the end of a drop hanging directly in front of their eyes—an impossible position of the light from gas or oil.

The first hygienic consideration in artificial lighting is to avoid the use of a single bright light in a poorly illuminated room. In working under such a light, the eye is adapted to the surrounding darkness and yet there is one spot in the middle of the eye that is kept constantly fixed on the very bright light. The brilliancy of the single light acting on the eye adjusted to darkness works harm. There should be a general illumination of the room in addition to any necessary local light. If sufficient general illumination is provided, the eye is adjusted to the light, and the local light can be safely used. The ideal arrangement provides general illumination so strong that a pencil placed on the page of a book casts two shadows of nearly equal intensity—one coming from the general light and the other from the local light.

Care should also be taken to prevent direct rays from striking the eye. The light that reaches the eye by day is always reflected. In reading or writing, to avoid shadows, the light should come over the left shoulder. Only the reflected rays can then reach the eye.

Another point to be avoided is the careless general use of clear glass, unshaded lamps. Frosted bulbs should be used in place of clear glass where soft light for reading is required. The intensity of light reflected from a small source is increased, and intense light injures the eye. With a clear glass globe the whole volume of light proceeds directly from the small surface of the lamp filament. With a frosted bulb the light is radiated from the whole surface of the bulb and while the total illuminating effect is practically undiminished, the light is softened by diffusion to the great comfort and relief of the eyes.

Finally, the use of old, dim and blackened lamps giving but a small fraction of their proper light is very often a source of trouble in not supplying a sufficient quantity of light. Users of lamps are not often aware of the loss in candle-power a lamp undergoes and so it happens that lamps are retained in use long after their efficient light giving power has vanished. Proper attention to lamp renewals on the part of Central Stations is necessary to correct this evil.

The correct use of light requires:

That there should be general illumination in addition to the light near at hand.

That only reflected light should reach the eye. The light should be so placed as to throw the direct rays on the book or work and not in the eye.

That the light should be placed so that shadows will not fall on the work in hand.

That shades and frosted bulbs should be used to soften the light.

That lamps be frequently renewed to keep the light up to full candle-power.

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