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Edited by
LEON · GASTER

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EDITORIAL.

A Year's Progress.

THE present number completes the first volume of *The Illuminating Engineer*, and the moment is perhaps opportune to express our appreciation of the great interest and sympathy with which our objects have invariably been received at the hands of authorities in different countries—a degree of appreciation that bears witness to the general recognition of the value of the work we are trying to carry out.

Although, at the beginning of our movement, there were a few instances in which our intentions were not fully realized or were misconstrued, the publication of our views during the time that has elapsed since then has done much to show that it was only on misapprehension that these objections were grounded, and we feel confident that our desire to see the subject of illumination brought before the combined notice, and made the subject of concerted action of the architectural, medical, and engineering professions is now generally approved. We are glad to be able to record indications that the desired *rapprochement* between these authorities is gradually coming about.

The attention drawn to the subject of illumination in the technical press, on which we commented some time ago, is still increasing. On this occasion we should like to acknowledge the courtesy of the many distinguished societies and technical journals who have accepted an exchange of publications; many of them now habitually deal with matters of illumination, though they would have considered it out of their province to do so a few years ago.

And in addition, we feel that special acknowledgment is due to the kindness and courtesy of the Council of the Illuminating Engineering Society of New York, in putting at our disposal the official records of their proceedings, thus enabling us to provide first-hand information on the subject of the progress of illuminating engineering in the United States.

The doings of the Illuminating Engineering Society in America deserve special attention at our hands in this country, for the conditions in both countries resemble each other sufficiently closely for us to draw useful conclusions from their experience.

In the present number we again devote special attention to the papers read at the Convention and the interesting discussion to which they gave rise.

One illustration of the readjustment of views mentioned above is presented by the gradual change of attitude towards one another that is slowly but surely coming about among those representing different systems of lighting.

It is true that the perpetual wrangle as to the relative cheapness of gas and electricity still proceeds in some quarters, each of the disputants professing to be staggered by the iniquity and misrepresentations of the other; but the ferocity with which these discussions were often formerly conducted, we are glad to note, has lessened of late years. To the impartial onlooker it seems self-evident that many supposed misrepresentations are really based on mutual misunderstanding, or on want of appreciation of general conditions, and over-accentuation of some detail. And any one who has been called upon to advise as to the selection of different methods of lighting, must realize that each case must be considered on its merits, and that he has to bear in mind very carefully the exact conditions under which the illuminant is to be used.

His decision must be based not merely upon the running cost of the two illuminants under consideration—gas and electricity, for example. He must also bear in mind the costs of maintenance and renewals, taking into account the local conditions. And at the same time he must not lose sight of the æsthetic and hygienic aspects of the question; good illumination, as we pointed out above, can only be obtained by the concerted action of the physiologist, the architect, and the engineer.

In reality there is room for the existence of alternative systems of illumination, and it is our desire to indicate the conditions for which each of these systems is best adapted in an impartial manner. In this connexion it must not be forgotten that the consumer is now showing a much more critical attitude than formerly, and his increased interest in matters of illumination is to be regarded as a hopeful sign for the future.

It is particularly gratifying to observe that some of our contemporaries rightly condemn not merely the circulation of statements which they regard as untrustworthy on the part of competitors, but also deprecate the issue of misleading general claims by those engaged in the branch of lighting with which they are mainly concerned.

We appreciate the spirit that prompts the contentions that: "It is bad policy to attack a rival system of illumination"; that such tactics meet with their own reward; and that retaliation is not only undesirable but inexpedient.

Library-Lighting.

In the present and the last number of *The Illuminating Engineer*, we have devoted a considerable amount of space to the exhaustive description of the method of illuminating the Carnegie Libraries in New York, as presented by Mr. L. B. Marks at the Convention of the Illuminating Engineering Society. In doing so we have been actuated mainly by consideration of the exceptional and complete nature of the results which Mr. Marks's paper contains, and which, we think, should serve as a very valuable record to those studying the lighting of libraries in the future.

With the possible exception of schoolroom lighting, it is difficult to think of any conditions under which good illumination is more essential. A library, exists for reading, and the mere act of continuous reading, even under favourable conditions is one that entails a quite exceptional amount of effort on the eyes; in the case of libraries devoted to science, technical matters, and serious reading generally, there is also a degree of mental effort to be considered, which is accentuated by imperfect day or artificial lighting.

In addition it must be recalled that many libraries are not only erected at great expense themselves, but contain accumulated reading matter which it is often literally impossible to replace, and which is collected only by the long and laborious effort of many years.

A library therefore represents emphatically one of those cases in which the combined assistance of the architect and engineer is essential. In most libraries, the conditions of daylight illumination are exceptionally important, and whether they are favourable or the reverse depends on the structure of the building. They are also very frequently buildings on which considerable care has been lavished in order to secure agreeable results from the architectural point of view, and in which, therefore, it is natural to make special efforts to secure that the system of illumination is in harmony with the general scheme. We are pleased to observe that the conditions of illumination in the New York libraries described by Mr. Marks are the result of co-operation of this description. It will be interesting to observe how far the methods adopted in this case are ultimately accepted as a recognized basis for the scientific illumination of libraries. But this is only one among many recent instances in which the value of the services of an illuminating engineer has been recognized in connexion with the lighting of an important building.

Another instance in which the appreciation of good illumination on the part of the architects concerned seems to have led to very successful results, is presented by the new public library in Fifth Avenue, New York, described by Mr. J. F. Musselman in a recent number of *The Electrical World.* Special attention was given to the illumination of the shelves of books in order to secure that their titles could be clearly read.

Another feature of the arrangements is that fire-proof material is employed everywhere throughout the stack-rooms, these being provided with adequate artificial illumination. This, again, is a feature that ought to be borne in mind in the building of special homes for libraries.

Moreover, it should be borne in mind that a very large proportion of earnest readers are unable to visit libraries during the daytime, and in their case some good system of artificial illumination, at once absolutely safe and physiologically correct is extremely essential.

Now that so many libraries are being erected, and new illuminants are available, this aspect of the matter deserves special attention.

A Tax on Light.

The action of the German Government in proposing a tax on gas and electricity, for power and lighting, has naturally given rise to a considerable amount of discussion among the technical journals in that country. For our part we are reluctant to criticize the legislation of a foreign country when devoted to subjects that are, strictly speaking, their own concern; but we must confess that, on the present occasion the creation of a tax on the lines proposed seems to establish such an undesirable precedent that comment is justifiable.

The details of this proposed tax have now been published. Gas is to be taxed at the rate of $\frac{1}{2}$ pfennig per cubic metre (about $1\frac{1}{2}d.$ per 1,000 cubic feet), and there is to be a corresponding tax of 0·4 pfennigs per unit on electricity. In addition, we understand that a specfiic rate on illuminating apparatus is to be levied, amounting to 10 pfennigs (about $1d.$) in the case of incandescent gas-mantles, and varying from 5 to 50 pfennigs in the case of electric lamps of various kinds, according to their candle-power.

As we have repeatedly and emphatically pointed out, adequate illumination is not a luxury but an absolute necessity — as vital as good sanitation or fresh air. The great difficulty against which reformers have had to contend until recently has been the lack of recognition of this fact, and people are still inclined perpetually to "scrimp" the illumination down to a margin which it would frequently be preferable greatly to exceed, simply from motives of economy. Anything, therefore, that tends to induce people to reduce their necessary amount of light is extremely to be regretted. Possibly the agitation that is now in progress against the imposition of this tax may not be without beneficial results in this connexion.

Cheaper Electric Lamps.

Some excitement has been caused in the electric lighting industry by the announcement of a considerable reduction in prices, under the circumstances, of certain metallic filament lamps. It is freely predicted that this is only the prelude to a more wholesale reduction.

From the consumer's standpoint, a *bona fide* reduction in price without a corresponding reduction in *quality* is obviously a great gain. The high prices of metallic filament lamps have hitherto militated against their wholesale acceptance, and a fall in cost will have the beneficial effect of inducing the consumer to adopt a better standard of illumination.

But at the same time it must be recognized that any change of this description carries with it certain dangers, from which we suffered in the days when only carbon filament lamps were available, and which we would do well to take precautions to avoid now that similar conditions seem likely to recur. The usefulness of the present standard specification, as prepared by the Engineering Standards Committee, admirable in scope as it undoubtedly is as regards carbon filament lamps, must be impaired by the fact that, in the nature of things, it will soon be rendered obsolete by the greater development of the metallic filament. The time is now coming when some such protection against the possible introduction of inferior articles is needed in the case of lamps of this description.

It has often been stated that in the past, vast numbers of defective carbon lamps, which could not be disposed of at home, not infrequently because they did not comply with the required specification, were shipped over to this country and sold at a ridiculously low price.

This greatly harassed the sale of genuine lamps, at a reasonable price, in this country, and indirectly prejudiced the development of electric lighting. The bad results obtained from the use of inferior lamps naturally tended to bring the system into disrepute. In the absence of any legal prescription as to the performances of metallic filament lamps, regarding the marking of lamps with a specified pressure, candle-power, life, and consumption, we may well fear a repetition of these evils, and it is to be hoped that authoritative action in this respect may soon be taken, without unduly interfering with the natural development of the lamp industry. Meanwhile we observe that the subject is under consideration in Germany, a set of experimental and tentative regulations for the purchase of their own lamps having been provisionally adopted.

With this matter we hope to deal in greater detail on a future occasion.

LEON GASTER.

Review of Contents of this Issue.

Mr. A. P. Trotter (p. 975) continues his series of contributions, the present section again dealing with the subject of PHOTOMETERS. On this occasion the HARCOURT and BUNSEN types of instruments are described. Some directions as to the construction of sensitive grease-spot screens are given, and the principles on which the action of such screens is based explained.

Mr. Chas. W. Hastings (p. 979) deals with the EDUCATION OF THOSE CONCERNED WITH THE PRODUCTION AND UTILIZATION OF LIGHT, paying special attention to the system of examination undertaken by the City and Guilds of London Institute.

Prof. J. T. Morris and **Mr. J. G. Farrow** (p. 985) contribute the results of some researches on the ABSORPTION OF ARC-LAMP GLOBES. A number of different globes were examined, polar curves of distribution of light being plotted in each case, and the results are summarized in a comprehensive table. From these experiments the authors draw one important conclusion, namely, that it is only possible to form a correct estimate of the absorption by determining the mean spherical candle-power; for this purpose a globe-photometer seems desirable, as the work is otherwise very laborious.

Mr. J. Rosemeyer (p. 991) contributes a discussion of MODERN DEVELOPMENTS IN THE ARC-LAMP, dealing, in this section, particularly with progress in the enclosed arc-lamp, and the advantages that have been secured by completely enclosing the arc so as to prevent the air making a partial entry, and thus causing the rapid oxidation and formation of ash on the part of the carbons.

Mr. W. B. v. Czudnochowski (p. 997) contributes a preliminary account of the recent EXHIBITION OF NAVAL ARCHITECTURE AND SHIPBUILDING IN BERLIN, from the standpoint of illumination.

The **Special Section,** in the present number, is again devoted to the papers read at the SECOND ANNUAL CONVENTION OF THE ILLUMINATING ENGINEERING SOCIETY. On this occasion the PRESIDENTIAL ADDRESS of **Dr. Louis Bell** is reproduced (p. 999). This deals mainly with STREET-LIGHTING, Dr. Bell emphasizing the fact that modern conditions demand an entirely different order of illumination from what was considered sufficient a few years ago, and giving some of the impressions derived during his recent tour in Europe, with the object of studying Continental developments. One feature of lighting in the United States to which he draws attention is the tendency to illuminate an entire town with equal brightness, instead of specializing in the illumination of the most important thoroughfares.

The comprehensive paper on the ILLUMINATION OF THE CARNEGIE LIBRARIES IN NEW YORK, by **Mr. L. B. Marks,** and the subsequent discussion, is completed in the present number (p. 1009), full particulars being given of the order of illumination provided on the tables and on the bookshelves, and the fixtures and methods of placing them adopted in order to secure these results.

A paper by **Mr. H. E. Ives,** describing the use of his COLORIMETER IN ILLUMINATING ENGINEERING (p. 1019), also appears in this section. In this paper Mr. Ives gives particulars of researches with his instrument on various types of illuminants and various coloured surfaces, and presents a table comparing the colour-values of these different sources. A spirited discussion followed this paper, in which **Mr. MacFarlane Moore, Mr. E. L. Elliott, Mr. E. P. Hyde,** and others took part.

A paper by **Mr. E. D. Wrightington** describes his impressions of European STREET-LIGHTING BY GAS (p. 1024). One feature of American street-lighting which differs from Continental experiences in many towns is referred to by the author. A much larger amount of light, he states, is derived from show-windows, illuminated signs, and other private lighting in that country.

Mr. T. J. Litle (p. 1025) discusses MODERN GAS-LIGHTING CONVENIENCES, dealing particularly with the existing methods of automatic extinction and kindling of gas-lamps, by the pneumatic, electrical, and other methods. The discussion of this paper, here reproduced in abstract, turned largely on the question of insulation for electric igniting systems.

A paper by **Dr. Clayton Sharp** and **Mr. Preston Millar** (p. 1031) describes some experiments with the integrating globe-photometer, including an investigation of the errors arising from the presence of foreign bodies within the sphere, and their effect on the performances of globes of various sizes.

The paper by **Messrs. V. R. Lansingh** and **J. R. Cravath** discusses the APPLICATION OF THE CONCEPTION OF THE FLUX OF LIGHT TO PRACTICAL PROBLEMS OF ILLUMINATION (p. 1036). This is followed by a table containing some actual results in watts per square foot obtained in the case of a number of different illuminants and rooms equipped with wall-paper and ceilings of different character.

An abstract is also given in this section (p. 1005) of the discussion of the papers by Dr. A. C. Humphreys, Mr. L. B. Marks, Dr. A. H. Elliott, Mr. J. E. Woodwell, Mr. E. G. Perrot, and Mr. L. J. Lewinson, in our last number.

Among the other articles occurring in this number attention may be directed to the description of a method of ILLUMINATING SHOP-WINDOWS BY HOLOPHANE REFLECTORS on p. 982. Particulars are also given of some demonstrations of the effect of using suitable reflectors, to concentrate light in any desired direction, and diffusing globes in order to distribute the light in a more scientific manner.

Another article refers to the suggested scheme of utilizing ELEVATED STREETS IN NEW YORK and its probable effect on conditions of street-lighting (p. 996).

On p. 1043 will be found an abstract of a recent paper by **Prof. Blondel,** dealing with RECENT PROGRESS IN INCANDESCENT LAMPS, and reviewing the scientific principles on which the recent modifications are based.

An article by **Mr. F. Musselman** (p. 1042) describes the scheme of illumination employed for the ILLUMINATION OF THE STACK-ROOMS IN A NEW YORK LIBRARY, and an article on p. 1041 gives some particulars of a suggested basis of a STANDARD SPECIFICATION FOR METALLIC FILAMENT LAMPS, as suggested in Munich.

The **Correspondence** columns in the present number (p. 1049) contain letters on a wide range of subjects. **Dr. Stockhausen** writes to reply to Dr. Voege's recent remarks on the subject of the effect of ULTRA-VIOLET LIGHT IN ARTIFICIAL ILLUMINANTS ON THE EYE.

Mr. A. J. Marshall wishes to modify the views attributed to him in a previous number on the subject of the advisability of using LIGHT SYMBOLS ON DARK BACKGROUNDS for physiological reasons.

Dr. E. W. Marchant discusses in greater detail the method proposed by him of measuring the absorption of arc-light globes, replying to the criticisms of Mr. A. Denman Jones on this point.

A description is also given of a modification of the HARRISON UNIVERSAL PHOTOMETER, which enables this instrument to measure ILLUMINATION IN A HORIZONTAL PLANE.

At the end of the number will be found the usual **Review of the Technical Press** and the **Patent List**.

TECHNICAL SECTION.

[*The Editor, while not soliciting contributions, is willing to consider the publication of original articles submitted to him, or letters intended for inclusion in the correspondence columns of 'The Illuminating Engineer.'*

The Editor does not necessarily identify himself with the opinions expressed by his contributors.]

Illumination, Its Distribution and Measurement.

By A. P. Trotter,

Electrical Adviser to the Board of Trade.

(*Continued from p.* 889.)

The Harcourt Photometer.—The photometer in use at the present day in the official tests of the Metropolitan Gas Referees, is essentially that of Bouguer, and the historical order may be interrupted to describe it. These officials and other gas engineers use the word photometer to include a diverse collection of gas-testing apparatus, and the particular instrument which would generally be described as a photometer is called by them a photoped (Fig. 50).

It consists of two plates, each having a hole 21 millimetres ($\frac{7}{8}$ in.) square. Between these a piece of suitable paper is pinched. A short tube slides within this, and carries a diaphragm having a rectangular opening 25 millimetres (1 in.) high, and 7 millimetres ($\frac{9}{32}$ in.) wide. Two rectangular spaces on the white paper are illuminated by the two lights, and by sliding the tube these spaces can be arranged so as to meet without perceptible overlapping, provided that the dimensions of the lights are small compared with their distance from the diaphragm.

It is important that the angle of incidence of the light shall be the same for each half of the screen. "This," wrote Rumford in the first of the two letters to Sir Joseph Banks, "may be easily performed by actually placing a piece of looking-glass, 6 or 8 in. square, flat upon the paper, in the middle of it, and observing by means of it the real lines of reflection of the lights from that plane, removing it afterwards as soon as the lights are properly arranged."*

In the Harcourt photometer a mirror is mounted above the screen, and is tilted slightly forwards. This is shown in the illustration.

If the photoped is symmetrically placed with respect to the two lights, the reflection of one in the mirror appears centrally over the other. If this is not the case the photoped is turned on its stand until the adjustment is exact. A dark screen 350 mm. ($13\frac{3}{4}$ in.) square, with a square hole in it, is placed between the observer and the photoped, and various other screens are suitably placed to cut off stray light. The official description of the material to be used for the screen is as follows: "The paper used in the photoped of the photometer shall be white in colour, unglazed, of fine grain, and free from water marks. It shall be as translucent as is possible consistently with its being sufficiently opaque to prevent any change in the apparent relative brightness of the two portions of the illuminated surface, when the head is moved to either side."

One of the lights is generally fixed at 1 m. from the paper screen, and the other is moved on a slide by means of a rod. This rod carries a graduated scale which is read against a fixed pointer. The movable light is adjusted

* Thompson, *Phil. Trans. Roy. Soc.*, 1794. p. 68.

until the illumination of the two halves of the screen appear to be the same.

The angular adjustment with reference to the lights has a twofold effect on the balance of illumination of the screen. It is evident that if the screen faces directly towards one light, it is receiving the maximum illumination that is possible at that distance, and that the illumination due to the other light will be less. It is possible to use the rotation of the photoped as a fine adjustment. After making an adjustment for the balance of two lights in the ordinary way, with the photoped symmetrical, one light is moved to give, say, 2 per cent difference of

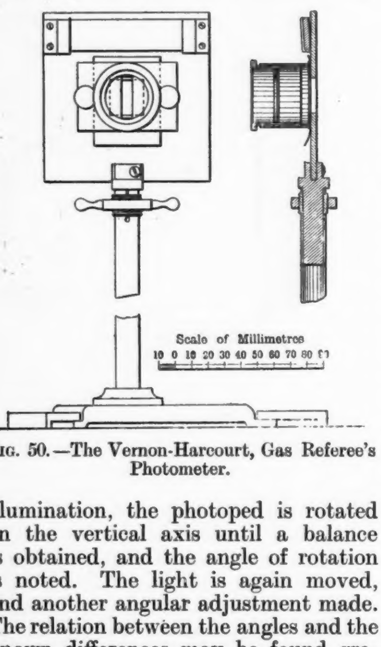


FIG. 50.—The Vernon-Harcourt, Gas Referee's Photometer.

illumination, the photoped is rotated on the vertical axis until a balance is obtained, and the angle of rotation is noted. The light is again moved, and another angular adjustment made. The relation between the angles and the known differences may be found graphically, and an angular scale may be graduated for photometric measurements.

The Bunsen Photometer.—Having departed from the historical order, the description of the Ritchie photometer, which is the prototype of many varieties, may be postponed, and the well-known Bunsen photometer, of which there are only two forms, may be taken. It is a singular fact that while elementary textbooks of physics generally include a brief description of the Bunsen photometer, that description, except in a very few cases, is not only wrong and misleading, but is discordant with a simple experiment which any one can make, and the same mistake is to be found in books on photometry. The Bunsen photometer is usually described as consisting essentially of a spot of grease on white paper, or more scientifically, "a paper screen made unequally translucent in different parts, either by means of a circular, or better still, ring-shaped spot of grease or stearin, or even by covering a part of a thin paper with a second thickness."*

This screen is placed between the two lights, and according to one well-known book, "the method consists in sliding the photometer disc along the scale until the spot appears of the same brightness as the rest of the paper; the intensities of the lights are then proportional to the squares of their distances from the disc." Another excellent textbook says: "The lights to be compared are placed on opposite sides of this screen, and their distances are so adjusted that the grease-spot appears neither brighter nor darker than the rest of the paper, from whichever side it is viewed." It is difficult to believe that the writers of these descriptions can ever have tried the simple experiment. If a sheet of paper with a spot of grease on it is placed between two lights, it is generally possible to find a position at which the spot, when viewed from one side and at a certain angle, becomes almost invisible. But a change of the point of view will alter the balance, and the appearance on the other side is always quite different. The law of diffusion of light through translucent substances makes it impossible that there should be a complete disappearance. Some writers having, perhaps, made some such experiment, and feeling rather uneasy about the result, attribute the departure from their preconceived notion, to a defect in the preparation of the grease spot or to want of uni-

* Kohlrausch, 'Physical Measurements.'

formity in the two surfaces of paper of which the disc is made. This widespread mistake is due to a desire to make the description simple. The erroneous description is often illustrated by a representation of two lights and a disc between them, provided with a grease-spot of this imaginary kind.

Mr. W. L. Dibdin, describing Bunsens original photometer,* which was inv'ented in about 1841, says that the disc of paper marked with grease was enclosed in a box in which was burning a small gas-flame. The flame illuminated one side of the disc, the reverse side of which was turned to one of the lights under comparison, and the distance noted. The box was then turned round, so that the disc faced the second light; a second reading was taken, and the distance thus found used for ordinary calculation. It appears that a system of double weighing was used, and it is probable that in this method a disappearance of the spot was aimed at.

The modern Bunsen photometer consists of a grease-spot on a piece of paper, but it is always provided with two mirrors equally inclined, which enable both sides of the spot to be observed without any change of position of the observer, and the views of the two sides are seen at the same angle (Fig. 51). The angle is immaterial, an angle of 130 degrees or 140 degrees between the mirrors is convenient (see Plan, Fig. 52). The two images are necessarily separated, and some care is needed to avoid shadow of the mirrors on the disc. More or less complicated arrangements of prisms have been proposed to bring the images together, but these cannot be used without eye-pieces.

When the balance is effected the spot does not disappear, but the appearance of the two sides is identical

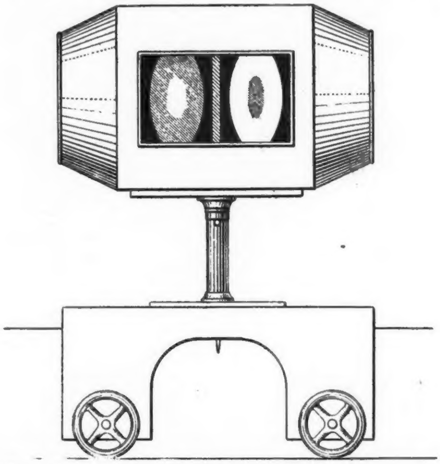


FIG. 51.—Bunsen Photometer, front view, showing the spot out of balance, owing to the illumination of the disc being greater on the right than on the left.

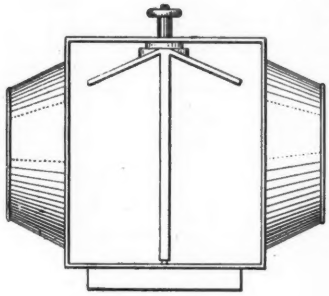


FIG. 52.

Bunsen Photometer, plan, showing disc-holder and inclined mirrors.

In order to avoid stray light the screen, or the disc, as it is called by gas engineers, and the mirrors are always protected by a box. The box is mounted on a carriage which slides on a bar. In photometers having pretensions to high accuracy a double bar or two rods are arranged as an optical "bench." For most purposes the simple bar is better. The carriage may run on wheels, or may be mounted on a mere saddle lined with cloth to reduce friction and to give a smooth, easy motion. The carriage is provided with an index—it sometimes carries a prism or small mirror which reflects

* W. J. Dibdin, 'Practical Photometry,' p. 3.

the light of one of the lamps on to the scale. A shutter is sometimes used, concealing the index until a reading is to be taken. This is in order to prevent bias. The most conscientious observer is apt to have his judgment disturbed if he can easily see the index and scale while he is adjusting a balance. The box and carriage of this and most other kinds of photometer is called the photometer head.

To make a sensitive Bunsen spot requires some skill and experiment. Good white blotting paper is an excellent material, but it is liable to become dirty. Thin drawing-paper is almost as good, but the size with which it is hardened resists the wax. There should be no perceptible watermark. A variation from the simple round grease-spot is desirable, and it is a mistake to have a large one.

A good star-shaped or ring-shaped spot may be made as follows: Cut a star out of sheet metal, not less than $\frac{1}{16}$ in. (or 2 mm.) thick, about 1 inch (or 25 mm.) over the points; or a washer 1 in. in diameter with a hole $\frac{3}{8}$ in. (or 10 mm.) diameter. Fasten it to a handle, melt a little paraffin wax or ordinary candle-grease in a cup, warm the star or washer, dip it into the wax, and then let it drain. The amount of wax that drains off depends on the temperature. Lay the paper disc on a sheet of blotting paper, and press the waxed tool on it. If the temperature is suited to the kind of paper employed, a neat uniform spot, practically alike on each side, may be made. The disc is mounted in a holder capable of rotation on a vertical axis. This enables any slight difference between the two slides to be detected. If any material difference is found on reversal the disc should be rejected.

The only modification of the Bunsen disc that need be described is the Leeson disc. This consists of three sheets of paper; the two outer sheets are rather transparent, but not nearly so transparent as tracing paper, and the third sheet which is placed between them is of a stouter quality, and has a star-shaped hole. The difficulty of constructing such a disc is in holding the sheets closely together without cockling. It is not more sensitive than a good grease-spot.

Much theorizing has been done about the action of the Bunsen disc. One of Lambert's simple axioms and a list of imaginary coefficients have been used as the basis for a string of algebraical expressions. But it is difficult to see how this mathematical treatment can help any one to make a better grease-spot, or to use it to greater advantage when it has been made. Some calculations seem to aim at securing tolerably good results from very bad discs.

(*To be continued.*)

PROF. W. E. AYRTON, F.R.S.

It is with deep regret that we record the death of Prof. Ayrton, who passed away on Sunday, November 8th, at the age of sixty-one years.

Prof. Ayrton's many distinctions and achievements need not be detailed here; nor is it possible to do more than refer to his versatile and original pioneering work in the fields both of pure science and engineering, by which he won such wide-spread and deserved recognition. But it is of interest to recall his early work in illumination and photometry, carried out at a time when these subjects were less generally appreciated than at present.

Prof. Ayrton's unique educational work will also not soon be forgotten. As a teacher he possessed in a marked degree the power of inspiring students with his own enthusiasm and energy, and inducing them to share his own lofty ideals.

His loss will be very widely regretted, and we desire respectfully to join in the general expression of sympathy with his sorrowing relatives, and in particular with Mrs. Ayrton, whose distinguished researches on the electric arc and other matters are doubtless well known to our readers.

Artificial Illumination and the Education of Those Concerned in its Production.

BY CHARLES W. HASTINGS.

(*Concluded from p.* 486.)

IN the June number of *The Illuminating Engineer* the writer summarized some of the educational requirements of the illuminating engineer; he will proceed to more definitely handle the subject in this article.

Practically the only educational course available is that set down by the examiners appointed by the City and Guilds of London Institute. The sections devoted to gas engineering and gas supply have been greatly improved; this improvement commenced with the appointment, as examiner, of Mr. Alfred F. Browne, one of the engineers of the South Metropolitan Gas Company, and was followed up by Mr. J. H. Brearley of the Longwood, Huddersfield Gas Works, and by the appointment, quite recently, of Mr. W. Doig Gibb, the immediate Past-President of the Institution of Gas Engineers and engineer of the Newcastle and Gateshead Gas Company. It would be far too heavy an undertaking to review the past questions set for students, but in the programme for the session 1908–9 is to be found ample proof that the study of illumination takes its proper place. To-day with gas engineers all that appertains to the advancement of gas consumption is matter of most vital import; the engineering of gas works and the manufacture of gas has reached almost perfection. The appreciation of machinery in the works has received the closest attention and the carbonization of coal has so greatly improved that to-day it is possible to obtain from the coal the utmost quantity of luminous gas; this having been accomplished, all those associated with gas undertakings are turning their best attention to the question of supply, distribution, and the methods of using gas as an illuminant; the advances made are simply astounding, and the younger men are naturally being trained to appreciate for themselves, by means of research and experiment, the still latent powers of gas illumination. This is being brought forward by the examinations already mentioned. In the Ordinary Grade under questions on gas engineering we find the following, which bear directly upon the education of the illuminating engineer:—

> The fitting up of premises for the supply of gas for light, heat, and power; the construction, testing, and fixing of gas meters. The influence of temperature and pressure on the volume of gas.
>
> The construction of various types of gas-burners; the simpler physical and chemical principles involved in the combustion of gas. The economy and efficiency of incandescent lighting as contrasted with luminous flames. High pressure lighting.

In the Honours Grade the subject of illuminating gas is handled a little more deeply, although, of course, some of the same ground is covered; from the syllabus we select the following questions:—

> Chemical composition and physical properties of coal gas and the influence of each component upon the illuminating power and calorific power of the gas.
>
> Theory and practice of photometry, calorimetry, and pyrometry; full details of apparatus employed to be given.
>
> Gas lighting. High and low grade gases. Illuminating power. Flame temperature. Specific heats. Air supply. Incandescent lighting, theory and practice. Intensified lighting. Burners and apparatus.
>
> Gas in competition for light, heat, and power.
>
> Flow of gas in mains, theory and practice; high pressure distribution.

These questions form a very fair basis for the man on the works, and without knowledge on all these points the gas manager, even though he take no part or lot in the actual distribution and supply of gas to the consumer, would be very imperfectly informed and certainly not qualified for his position. In this article matters connected with the manufacture and production of gas, are not considered, being foreign to the intention of dealing with the education of those engaged in the uses of artificial light.

Turning now to the quite recently added examination in 'Gas Supply' we find considerably more questions affecting the illuminating engineer, and the following, certainly, are all subjects with which he should be thoroughly conversant. Taking first the syllabus for the Ordinary Grade we select the following as being most deserving of attention :—

Principles and construction of gas meters, including slot and stop mechanism. Repairing, testing, and fixing of meters.
Description and size of pipes in relation to requirements. Distribution of light. Testing of installations. Anti-vibrators. Movable pendants. Simple principles of ventilation. Methods governing pressure beyond the meter.
Theory and practice of luminous and bunsen flames.
Construction of flat flame, argand, regenerative, and incandescent burners. Regulation of gas and air supply to burners. Causes and prevention of mantle breakages. Influence of shades, globes, wall-papers, &c., on light efficiency.
Types and construction of outside shop and street lanterns. Principles of windproof lanterns. Suspension brackets and lamp pillars.

We now turn to the requirements from the more advanced student; these are dealt with in the questions set for the Honours Grade. Out of eight subjects, the following four are distinctly of value to the illuminating engineer :—

Specifications for interior fittings. Principles and construction of various types of burners and plants of intensified lighting. Lighting of churches, factories, and other large buildings. Theory and practice of ventilation by gas. Lighting for special purposes, such as billiard rooms, &c. Switch or automatic lighting and extinguishing.
Efficiency of flat-flame, incandescent, and other burners. Low and high-pressure lighting. Theory, manufacture, composition, and testing of the incandescent mantle. Illuminating effect of different methods of lighting. Flame temperature. Air supply. The hygiene of gas.
Public lighting. Testing for illuminating power and illuminating effect. Influence of reflection. Advertising and illuminating devices. Automatic lamp-lighting appliances.
Gas in competition for light, heat, and power, and the chief legal obligations affecting gas supply.

These then are the chief subjects for study, but there is one almost insurmountable difficulty: How can we learn without a teacher? It is true that appended to the programme or syllabus there is a list of works of reference; but many will be of but little use to the student. The examiners also suggest at the end of the list periodicals, namely, *The Journal of Gas Lighting*, *The Gas World*, and *The Illuminating Engineer*. This is a big undertaking, and a rather expensive one for the student—expensive in the time that must be given to the perusal of even these three periodicals. The author knows full well the value of them all, and if the student could bring himself to keep a commonplace book in sections and write it up week by week, or day by day, he would have the most complete epitome of all the subjects. But life teaches us that each hour of the day brings us all the work to do for which we are paid, and it is difficult for the "brainy" young man to find time to give more than two or three hours a day to practical reading.

Then, again, many of the subjects we have drawn attention to require hours of close work in the laboratory or the photometer room. Some gas works are "well found," and, under certain restrictions, these departments might possibly be placed at the disposal of the student. But such scientific luxuries are not to be found in all gas works.

Now what is required is the help of thoroughly practical lecturers who could give courses of lectures in certain districts, these might possibly be associated with the local technical schools.

This is done abroad. For instance, mention may be made of some most interesting particulars of the work done, in association with the Education Committee of the German Association of Gas and Water Engineers.

At Carlsruhe they have opened a research station which cost close upon £5,500, and of that amount £3,683 was contributed by the owners of gas undertakings. Many of the manufacturing firms interested in gas production gave offerings in kind : mantles, burners, lamps, self-lighting appliances, governors, globes, instruments for testing the components and heating value of gas, instruments for measuring high temperatures, &c. In order to equip the station tests were made of the conditions of gas, water gas, and mixed gas ; problems of room-lighting by inverted incandescent gas lamps as against the new metallic filament incandescent electric lamps, the relative cost being standardized ; these and many other matters for the common good have been carried out by the executive of the research station at Carlsruhe.

Münich has also been busy in much the same direction, and is taking very active measures to educate the workmen employed at the several gas works.

In Dessau, under the German Continental Gas Association, a foreman's school has been in existence for ten years ; during the last year seventy-five students entered, and many of these obtained remunerative appointments.

In Bremen some fifty pupils have passed through the school, receiving both theoretical and practical instruction, particularly in gas distribution and supply; such subjects as the general properties and applications of gas, leakages, services, meters, regulators, lighting systems, burners, &c., all being handled during the course.

At Carlsruhe the training of students as lighting or illuminating engineers, receives very close attention. The course comprises eight terms' attendance at the High School ; a thorough grounding is given in chemistry, mathematics, machine construction, and electrical engineering ; the aim of the course being original work and the "Mecca," the diploma of Doctor in Engineering. Students who have completed the machinery course are encouraged to turn their attention to illumination, and take a supplementary course of two terms for the study of chemical technology, practical testing, and technical work immediately concerned with gas lighting. Dr. Eitner lectures two hours a week on technical analysis. There are four hours' laboratory practise on the technology of gas lighting. Dr. Bunte also lectures on gas lighting, and devotes four hours to the laboratory work, which includes such subjects as gas analysis, photometry, calorimetry, carburetting methods, brilliancy of flame, &c.

Enough has been said to show that advances are being made in Germany, and signs are not wanting that much will be done in the near future in this country. Reference has been made to the work of the City and Guilds of London Institute. *The Journal of Gas Lighting* has recently published two comprehensive articles upon 'Examinations in Gas Supply,' the author giving ideal answers to certain past questions that have been set. The perusal of these articles by intending students will be most helpful and encouraging. The splendid work done by the Gas Light and Coke Company, and the lectures established by them for the training of their distribution staff, must also not be overlooked. The South Metropolitan Gas Company, again, have their own educational department, and so have many gas undertakings throughout the kingdom.

What, then, are the conclusions to be arrived at—First, that the man who intends to practise as an illuminating engineer must have a thorough knowledge of gas manufacture, distribution, and supply. That he must also have the ability to test and analyze gas, be able to use the photometer in its many forms, to prepare specifications of the points of light required for a given area ; the best method and system of lighting to be adopted, the aggregation of illumination, and the quantity of gas to be consumed by the system adopted.

There is, no doubt, a great future for the illuminating engineer, though how far he will be disassociated from the gas engineer in matters connected with illumination by gas we cannot venture to predict ; but it is certain that engineers and managers of gas works must have a sound knowledge, both practical and theoretical, of the science of illumination.

Demonstrations of the Use of Holophane Reflectors for Shop-Lighting.

WE were recently invited to inspect the exhibition of the use of Holophane diffusing globes and reflectors for show-window lighting at Messrs. Julius Sax & Co. in Charing Cross Road, to whom we are indebted for the use of the photograph of the illustration appearing on the following page.

Several features in this exhibit seem to deserve special commendation, in that they show very clearly the advantage of using light for specific purposes, and restricting it to directions in which it can be usefully applied.

Attention may first be drawn to the method of illuminating the contents of the window as a whole. This is achieved by a row of metallic filament lamps equipped with holophane concentrating reflectors, by the aid of which the light is mainly thrown down upon the contents of the window without the actual lamps being visible to the eyes of those on the pavement. In addition to this, however, a certain amount of light is allowed to escape sideways and illuminate the sign screening them; the sign thus serves the double purpose of protecting the eyes of the observer and an advertisement.

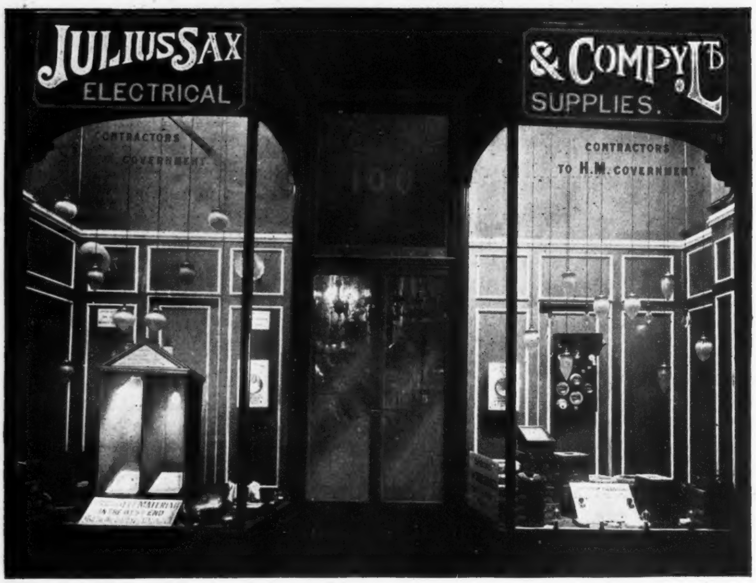


FIG. 1.

The diffusing effect of the globes is also clearly shown by the actual contents of the windows, which contain naked lights side by side with corresponding lamps placed inside holophane fixtures, and the absence of glare and better distribution of light resulting is made manifest by alternately turning on one system or the other. An example of a neat combined diffusing bowl and reflector is shown in Fig. 2. Another point of interest is the inclusion of coloured lamps within some of the globes in the left-hand window. These are turned on and off at intervals, and are, of course, mainly intended to attract attention. Incidentally, however, they bring out the scientific method of distribution of light adopted in this type of fixture very clearly, for the appearance of the globes containing red and green lamps, and the resultant distribution of illumination, are just as satisfactory as in the case of those containing ordinary white lamps, a result that could hardly be anticipated in the case of globes in which the crystals had been moulded in a haphazard manner. The holophane glassware has been particularly devised on scientific principles.

Yet another apparatus for the demonstration of the use of concentrating reflectors is to be seen in the left-hand window. It merely consists of a partitioned box. In the partition to the right is placed a naked tungsten lamp with no reflector; in the left partition the same type of lamp is fixed, but in this case carries a holophane concentrating reflector. Although the lamps yield roughly the same candle-power, the resultant illumination on a piece of paper placed in the base of the divisions is very striking—perhaps even more so, in fact, than the illustration suggests.

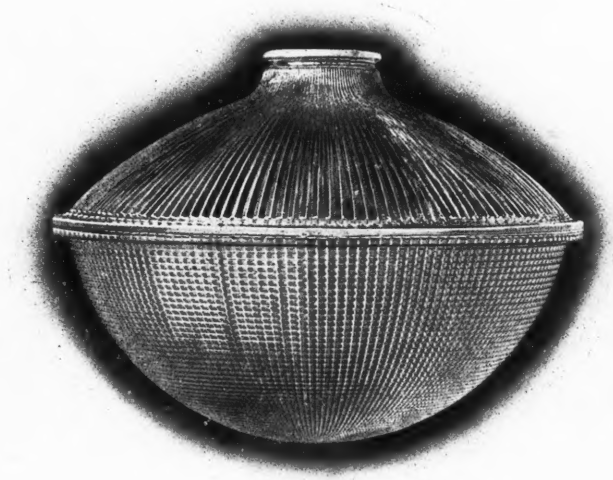


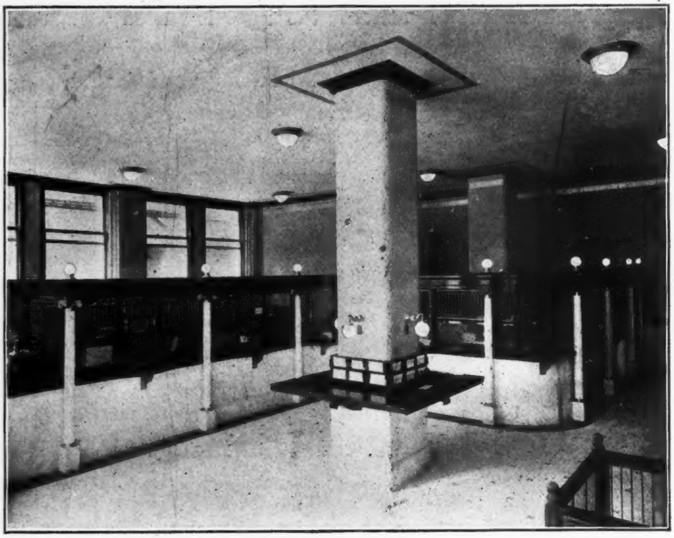
Fig. 2.

Too Vivid Illuminated Signs.

According to *The Westminster Gazette* the National Society for Checking the Abuses of Public Advertising are getting up a memorial objecting to the erection of illuminated signs of abnormal size and brilliancy along the Thames Embankment, and a conference at the L.C.C. is about to discuss the whole question very shortly.

Illumination of a Chicago Bank by means of Holophane Reflectors.

THE illustration shows the method of illumination by Holophane diffusing shades, of the Jackson Trust and Savings Bank, Chicago. The hemispherical fixtures distributed over the ceiling serve to produce the desired uniform illumination, without glare, over the floor-area, and in addition, it will be seen that local shades serve to concentrate light over the counters, &c., where business is actually transacted.



Jackson Trust and Savings Bank, Chicago.

A Method of Tracing Daylight Illumination.

A RECENT number of *Annalen der Elektrotechnik* contains a reference to a method of studying and recording the intensity of daylight illumination which, it is suggested, might be of service in researches in school rooms, &c. The daylight illumination merely plays upon a selenium cell, which is placed in series with a suitable source of E.M.F. and a recording milliam peremeter.

The alterations in the resistance of the cell with varying illumination causes a curve to be traced out, which, it is claimed, is a serviceable indication of the strength of the illumination.

As an illustration of the use of the method a curve showing the recorded variation in the light during the solar eclipse on Aug. 31st, 1905, as observed in Algiers, is exhibited.

The initial illumination due to the unobscured sun reached 75,000 lux, but this, at total eclipse, was reduced to about 5 lux only.

Whatever be the merits of the selenium cell as an absolute light-measurer, its applicability for *comparative* measurements of illumination, and especially as a means of easily obtaining permanent records of defective conditions, deserves very careful attention.

The Absorption of Arc-Lamp Globes.

BY J. T. MORRIS, M.I.E.E., AND J. G. FARROW, B.SC.

THE amount of light cut off or absorbed by various globes used with arc-lamps varies greatly, and from the discussion of the subject in the columns of *The Illuminating Engineer* it is obvious that widely differing opinions are held.

In an article by one of us on 'Tests on Recent Flame Arcs,' which gave rise to this discussion, the measurement of the absorption of the arc-lamp globes was only a side issue, and could, therefore, receive but cursory attention.

The tests about to be described were made with the object of accurately determining the light absorbed during its passage through the globes, and also ascertaining the difference in absorption by the same globe of the light of arcs of different colours.

Short Discussion of Previous Work.—The work of Dr. Sumpner in 1893, of Messrs. Guthrie and Reidhead in 1894, of Messrs. Westerdale and Prentice in 1906, and of Dr. Marchant, has been consulted; and the opinions of Dr. Marchant and Mr. Denman Jones, as expressed in the 'Correspondence' columns of this journal, have likewise been carefully considered. These reveal great diversity in the values obtained, ranging from absorptions of 90 per cent or more, down to values of 2 per cent and even 0·0 per cent! In view of these discrepancies, the authors considered it essential to be able to repeat any given test on another day, having confidence that the result obtained would agree with the previous measurement to within some three or 4 per cent. That these conditions have been realized is proved by the results shown in Figs. 1 and 1A, Figs. 2 and 2A, and tabulated in Table I.

Method.—The carbons were arranged axially one above the other on an extension of a hand-feed lamp, so that the arc itself was some 2 ft. above the pinion which was used for controlling the length of the arc. The image of the arc was projected upon a screen close at hand, and by means of this arrangement the arc was maintained constant in length throughout each test. For convenience in adjusting the arc and handling the globes, the positive carbon was placed below the negative.

It was then possible to lower any one of the globes in an inverted position over the arc without altering its performance in any way. Only those globes were tested which allowed the free passage of air right through them, the metal cups at the bottom of some of the globes tested (which are used to regulate the air supply or for other purposes) being removed in order to facilitate the circulation of air.

There is, therefore, good reason to believe that the distribution and intensity of light from the arc itself was unaffected by the presence of the globe.

In practically every case the observations of candle-power were made at every 5 degrees; each test made under new conditions was repeated on another day, and if the agreement between these two tests was not sufficiently close a third test was instituted. In the photometric observations the sum of two beams was measured—these beams being taken from opposite sides of the arc, and making equal angles from the top carbon—this arrangement minimizing any irregularities due to wandering of the arc.

Errors due to the fact that an opal globe is not a point source of light have been practically eliminated by working with the arc at a considerable distance [some 22 ft.] from the photometer.

Particulars of Arcs employed.—The first set of tests were carried out with ordinary carbons of the open lamp type, the positive being 18 mm. in diameter with a 4 mm. core (style:

TABLE I.

Description of Globe.	Ordinary Carbons.				Flame Carbons.				+ Flame Per Cent – Ordinary Per Cent	Previous Results
	Date.	M.S.C.P.	Per Cent Loss.	Average Per Cent Loss.	Date.	M.S.C.P.	Per Cent Loss.	Average Per Cent Loss.		Per Cent
Naked Arc	1/10/08	436			3/11/08	896				
	7/10/08	423			16/11/08	886				
	17/10/08	434			18/11/08	915				
Clear Glass (13 inch)	2/10/08	368	14·6	14·5	29/10/08	741	17·5	14·8	+0·3	9
	12/10/08	373	13·5		2/11/08	776	13·6			
	13/10,08	364	15·5		17/11/08	779	13·4			
Slightly Opalescent (11 inch) ...	9/10/08	362	16·0	15·5	31/10/08	681	24·2	23·8	+8 3	27
	14/10/08	367	14·8		3/11/08	688	23·5			
Small Opal (8 inch)	12/10/08	350	18·7	18·2	30/10/08	744	17·3	17·2	–1·0	16
	14/10/08	354	17·8		3/11/08	746	17·0			
Large Opal (16 inch)	13/10/08	312	27·6	26·8	2/11/08	604	32·8	31·7	+4·9	41
	19/10/08	319	26·0		17/11.08	624	30·6			

$\overline{+}\ \overline{+}$ —Fabius Henrion Nancy—608), and the negative 11 mm. in diameter and solid (style: —C. Conradty Nuernberg—Marke, C—). A pressure across the carbons of 55 volts was required to maintain a steady current of 8 am-

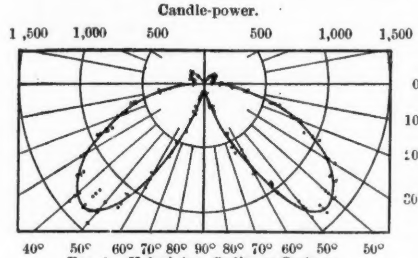


FIG. 1.—Naked Arc, Ordinary Carbons, 55 volts, 8 amps., 4 m/m.

peres when the real length of the arc was adjusted to the constant working value of 4 mm.

At a current of 8 amperes the efficiency of these carbons was practically 1·0 mean spherical candle-power per watt; but tests at their nominal current of 10 amperes would probably show a greater efficiency. Flame carbons of the brand used in the D.C. Excello lamp were used for the second set of tests, the positive being 10 mm. diameter with 4 mm. core (style: "Krone Excello," 104 ♛ C. Conradty), and the negative 9 mm. diameter with 2·5 mm. core (style: "Krone Excello," 105, C. Conradty).

The current and real length of the arc were maintained at 10 amperes and 10 mm. respectively, and 34·5 volts across the carbons were required for this purpose.

These carbons were found to have

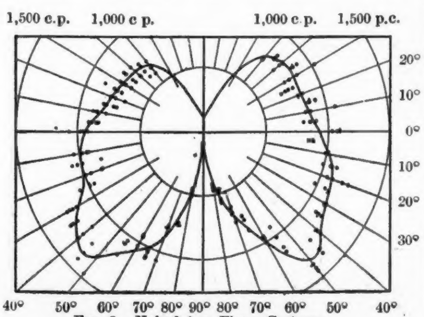


FIG. 2.—Naked Arc, Flame Carbons, 34·5 volts, 10 amps., 10 m/m.

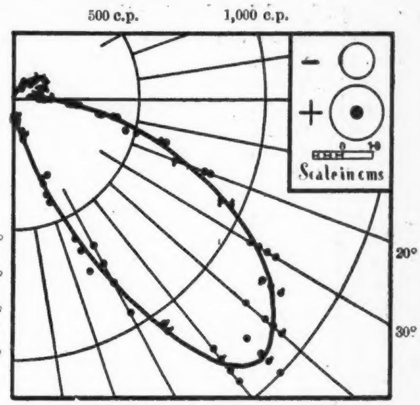


FIG. 1A.—Naked Arc, Ordinary Carbons, 55 volts, 8 amps, 4 m/m.

an efficiency of 2·6 mean spherical candle-power per watt at their nominal current, this figure naturally being less than that which they give when tested in the inclined position for which they are intended.

Degree of Accuracy.—Very close agreement was found to obtain between the results of separate tests made under the same conditions; especially was this the case for the tests with ordinary carbons, as may be seen by inspection

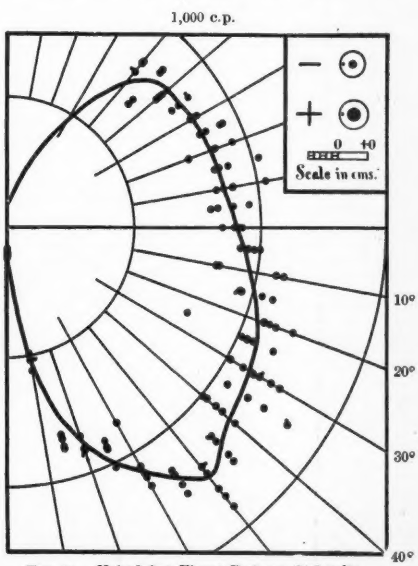
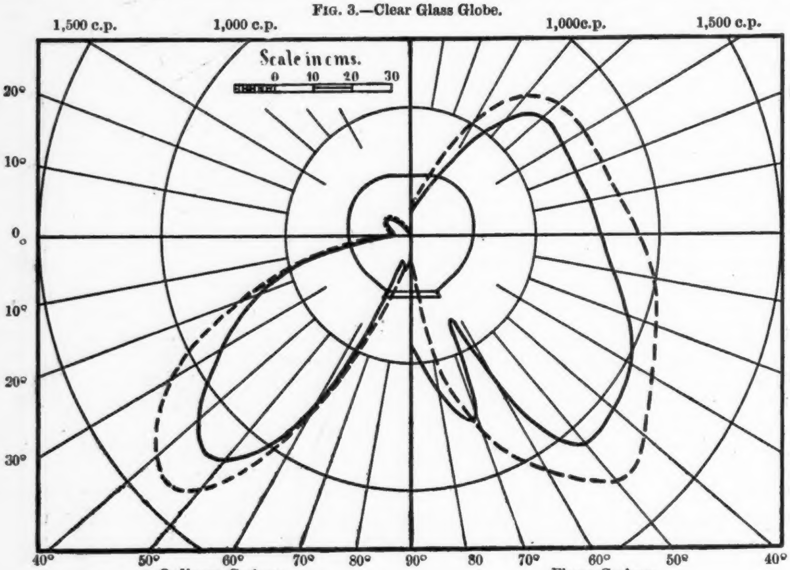


FIG. 2A.—Naked Arc, Flame Carbons, 34·5 volts, 10 amps., 10 cms.

of Figs. 1 and 1A, showing the observations made in the tests on the naked arc. The agreement obtained in the tests with flame carbons was slightly less close, because fluctuations of the flame arc itself alter the distribution of light more than those of the ordinary carbon arc. The observations taken in the tests on the naked flame arc are recorded in Figs. 2 and 2A.

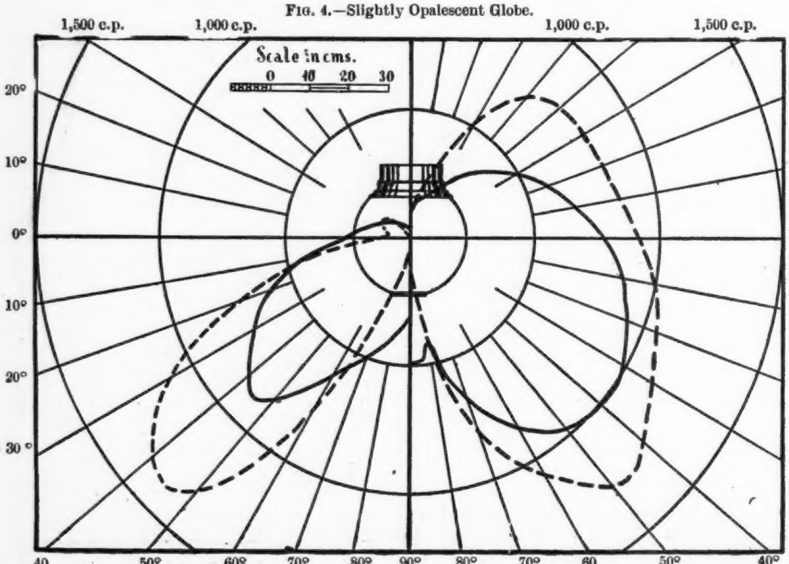
From examination of the results obtained, the authors conclude that

FIG. 3.—Clear Glass Globe.



Ordinary Carbons. Flame Carbons.

FIG. 4.—Slightly Opalescent Globe.



Ordinary Carbons. Flame Carbons.

the mean results do not differ from the actual facts by more than 2 per cent for the ordinary carbons, and 3 per cent for the flame carbons.

Discussion of Results obtained.—Figs. 3, 4, 5, and 6 give the mean polar curves for each of the four globes tested, the left-hand side of each figure referring to the tests with ordinary carbons, whilst the right-hand side refers to those with flame carbons. For purposes of comparison the mean

FIG. 5.—Small Opal Globe.

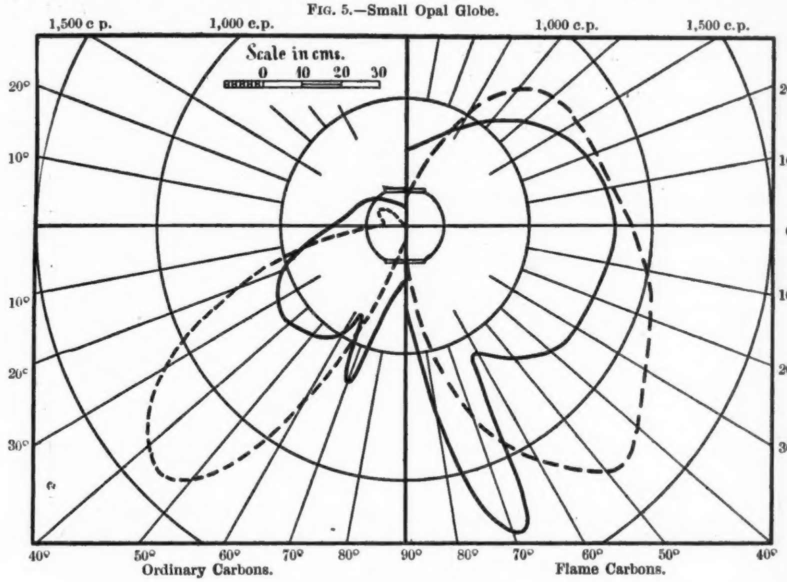
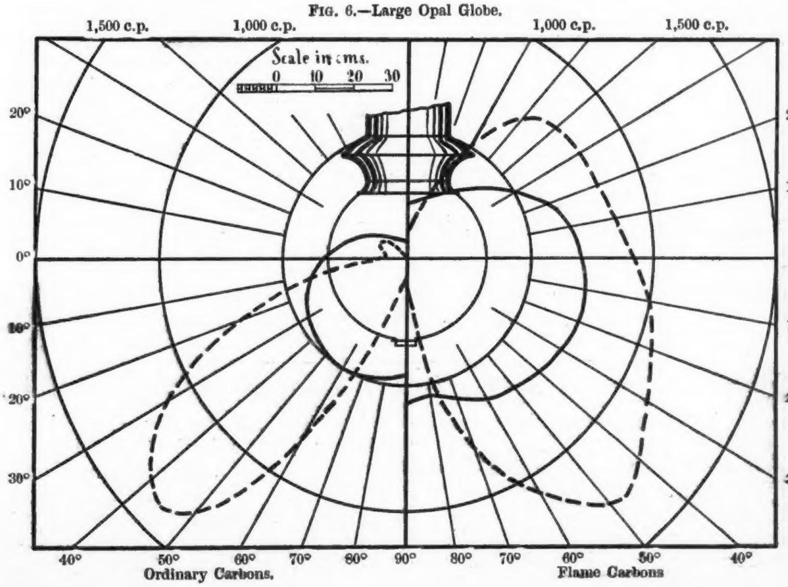


FIG. 6.—Large Opal Globe.



curves for the naked arcs are indicated by dotted lines, and the full black curves exhibit the distribution of light resulting from the addition of the globe. The outline of the globe to which each figure refers is drawn to scale in the centre of that figure.

The first globe tested (Jandus ordinary, plain glass) was from 2 to 3 mm. thick; it had a conical lower rim, and no metal fittings. It will be noticed that the obstruction of the conical rim greatly reduces the candle-power in a direction 65 degrees to 70 degrees below the horizon; whilst the candle-power in directions from 70 degrees to 90 degrees below the horizon is increased by the direct light from the arc, and light reflected from the upper surface of the globe. This globe cuts off the same percentage of blue and of yellow light.

The second globe (Excello) was of thinner glass, having a slight milky opalescence, and appearing to the eye to have greater density in its upper and lower portions than in the central zone; the metal fittings which were left in position on the upper and lower rims are shade-lined in the diagram. In the case of the irregular distribution of light from the ordinary carbons the globe becomes a source of light, and thus renders it more uniform; but the distribution from the flame carbons is rendered less uniform, because the more dense upper portion cuts off a larger percentage of light than the central zone.

The shadow cast by the narrow brass ring at the bottom of the globe is practically neutralized by diffused light from the globe itself. Blue light appears to suffer a smaller loss (16 per cent) during its passage through this globe than yellow light (24 per cent).

The third globe (Jandus flame, opal globe) was of medium and uniform density, its thickness being about 2 mm., and the rims cylindrical and equal in size; there were no metal fittings. Owing to the larger solid angle subtended by the aperture, and the fact that the globe became a source of light, the irregularities noticed in the polar curve of the clear glass globe are here accentuated. Yellow light appears to pass through this globe more readily than blue light; this fact was previously noticed during the tests for absorption by means of a glow-lamp.

The fourth globe (Crompton-Blondel) was a large opal globe having greater density than any other tested, and varying in intensity in the same way as the Excello globe described above; the aperture at the top was screened by the casing of the lamp which was left in position. This globe produced similar effects to those given by the Excello globe.

General Conclusion.—For purposes of comparison Table I. has an additional column giving results previously obtained by the incandescent lamp method. A study of these figures will reveal the fact that there are discrepancies in the earlier values ranging from 9 to 1 per cent, yet as a rapid approximation it served its purpose.

Lastly the tests recorded in the present article prove conclusively that it is impossible to determine the absorption of a globe by a single pair of measurements of the candle-power, in one direction, *i.e.*, with and without the globe; but that it is essential to determine the mean spherical candle-power for the two cases, which is a decidedly laborious piece of work unless a globe photometer be accessible.

The Third Annual Meeting of the American Gas Institute.

THE third annual meeting of the above society took place in New York on October 21st, the Presidential Address being delivered by Dr. A. C. Humphreys.

A number of papers of exceptional interest were read, including two entitled 'The Photometry of Gas' and 'Better Gas Illumination,' by Mr. C. O. Bond and T. J. Litle respectively.

Of considerable importance was the Report of the Committee on the National Unit of Light, with which we mean to deal in our next number.

Modern Arc-Lamps and their Applications.

BY J. ROSEMEYER,

Director of the Regina-Bogenlampen-Fabrik.

A RECENTLY issued publication of the Museum in Munich describes the progress of artificial lighting from the days of the hearth-fire, the pine-torches, the stone oil-lamp, &c., up to the intense sources of the present day.

The craving of the age for more and more light has led to the development of sources of greater and greater brilliancy, of which the modern arc-lamp is a characteristic example. This tendency towards concentration has been accompanied by a corresponding gain in efficiency. For instance, the modern electric arc-lamp, under the most favourable conditions, may consume but $\frac{1}{6}$ of a watt per Hefner, as compared with 3·5 on the part of the old carbon glow-lamps, *i.e.*, an increase in efficiency of twenty times the older value. Indeed, the development of arc-lamps alone in recent years has been so wide as to render it almost impossible for any one who is not a specialist in this field to keep himself informed of all the most recent results.

The first arc-lamp is, perhaps, to be attributed to Volta, who observed that when a current is led across two sticks of pure carbon in contact with one another, and these are subsequently withdrawn, the current continues to flow across the gap produced, thus creating an arc. The mechanism of an arc-lamp consists merely in a device to withdraw the carbons on the application of the current, and to permit a corresponding feeding together to compensate for their gradual burning away.

Yet, although it was early realized that the light from such a lamp could be increased by suitable composition of the electrodes, it was a long time before the ordinary open arc-lamp, using simple so-called pure carbons, was eventually rendered obsolete by the modern developments. Nevertheless, the old open lamp had certain obvious drawbacks. For instance, it required attention every ten hours in order to put in new carbons, it consumed too much current, its regulation was often far from perfect, and its performances were all too dependent on the nature of the carbons that happened to be used. At the recent exhibition of methods of shoplighting in Berlin no open arc-lamps of this kind were exhibited, showing clearly that they can no longer compete with modern flame-arcs and "economy" lamps (*Sparlampen*).

It was about fifteen years ago that the plan of enclosing the arc with the object of excluding the oxygen, and so prolonging the burning-life of the carbons, was generally adopted. Such lamps would burn for about 80 to 100 hours without recarboning; moreover, the slowness with which the carbons shortened enabled a very simple mechanism to be employed. The lamps were also an improvement upon the simple open-arc from the point of view of security against fire. Unlike the open-arc (taking, as a rule, about 40 volts and 10 amperes), these lamps require about 80 volts and about 5 amperes.

It was soon realized, however, that these advantages were only purchased at the cost of efficiency, for the enclosed arc consumed as much as 2·8 watts per H.K.—a value that appeared far too high in comparison with smaller sources, such as glow-lamps. This result has been so materially improved that recent tests of the Reichsanstalt on enclosed lamps gave about 1·47 watts per H.K. This was accomplished mainly by the improved design of the glass-globes, This efficiency, however, is still too low. The exclusion of air was not sufficiently complete, with the result that the carbons burned to ash, and deposited in the form of a semi-opaque film on the globe. Apart from the loss of light so occasioned, the burning-hours are unfavourably affected by this property.

One can, indeed, secure a longer life by increasing the diameter of the carbons, and building the lamp itself on a correspondingly greater scale. The efficiency is, however, in no way improved thereby, partly because the air is still insufficiently excluded, and partly because the use of carbons

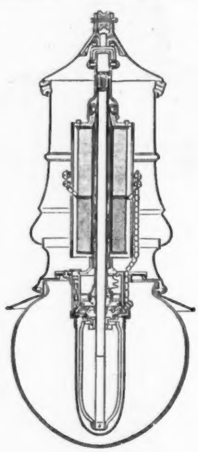


Fig. 1.
Sectional View of Regina Arc-Lamp.

of great diameter itself leads to a marked diminution in light.

Some time ago the author came to the conclusion that the efficiency of the enclosed arc could be materially improved, by excluding the oxygen more completely, and by hindering the condensation of the gases generated in the arc itself; by so doing the temperature of the arc and its surroundings are inincreased, and the carbons are heated to a greater distance from the incandescent tips. The adoption of this principle led to the construction of the Regina, Helia, and Reginula lamps.

In order to secure the exclusion of the air more effectually it was necessary to introduce an entirely new principle in the construction of arc-lamps, according to which the frame containing the various parts of the mechanism of the lamps, and the globe surrounding the arc, are made in one single piece which can be effectually rendered air-tight; in this way the conditions present in the ordinary type of enclosed arc-lamp, which enable the outside air to creep in, and the hot gases within the globe to escape, are avoided. By removing the cover from such a lamp the regulating magnets, carbon holders, &c., are rendered easily accessible, and the various parts are easily separable from one another.

The mechanism is also of a very simple nature, and special efforts are made to reduce wear to a minimum. Rubbing contacts and rotating spindles, &c., such as are liable to jam, are not employed. The movement of the carbons is actuated by a solenoid, fixed in the upper part of the enclosing frame, and containing an adjustable number of turns of wire, by the alteration of which the permissible strength of the current taken by the lamp can be regulated. One important consequence of the method of completely enclosing the essential parts of the lamp described is that the lamp is independent of wind and weather, and can be used in an atmosphere of acid fumes, in dusty foundries, and textile works, &c., for many years without needing readjustment.

In spite of, or in a sense, because of this very simplicity, however, several years elapsed before this method of enclosing the lamps was brought to perfection. In particular difficulties were experienced in devising a satisfactory method of leading in the current into the carbons and carbon-holders. Originally sliding contacts of various kinds were employed, and proved very unreliable. A sudden movement of the regulating lever in the lamp causes such contact-pieces to jump away, and thus to cause a momentary interruption in the current, and the temporary creation of a small arc. Naturally the repetition of these small arcs causes a roughening in the place where they originate, and this interferes with the successful leading in of the current, and may hinder the free passage of the carbon up and down. Under such conditions the carbon "sticks," and it was a not uncommon practice in the case of the older lamps, to poke the lamp with a pole, in order to free it again.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

Types of Regina Arc-Lamps.

Such belabouring might be initially of temporary value, but frequent repetition of the process soon became necessary, and eventually, as the abrasion of the contact became accentuated, there came a time when further blows proved ineffective. The lamp would then be sent to the works, where a mechanic would put it in order again by merely removing the excrescence where the sparking had taken place. In the Regina lamps, therefore, a patented arrangement has been in use involving the use of a flexible spiral conductor, permanently attached to the carbon, and so permitting no disturbance of contact.

The carbon-holder is also specially designed to meet the same conditions for it enables a reliable grip of the carbon to be obtained without any rubbing contacts ; as soon as the carbon has been raised the necessary amount the holder grips it with perfect security, and while the lamp is in action, maintains the arc in exactly the same condition, maintaining the current at an exactly constant value, facilitating the running of several of these lamps in series. The core attached to the upper carbon likewise swings free within the solenoid surrounding it, and executes its functions without rubbing. The mechanism also comprises an air-damper and a series-resistance, the latter built into the lamp or, in the case of the larger sizes, enclosed separately. The Regina, Helia, and Reginula lamps all utilize essentially the same mechanism and only differ in size.

An ordinary Regina lamp consumes about 0·8 watts pre mean hemispherical candle-power as compared with 1·47 watts in the case of the ordinary enclosed lamp; it utilizes carbons about 13 mm. in diameter, of homogeneous composition, and burns without attention for about 200 to 300 hours; the tests of the Reichanstalt have given 257 hours.

A Helia lamp consumes only 0·5 watts per candle, partly because thinner carbons are used, and partly because a core containing luminescing material is introduced. It is a well-known fact that the efficiency of carbons is increased by diminishing their thickness, but this result is of particular consequence in the case of enclosed arc-lamps, for which a well-defined relation exists. Within certain limits a reduction in specific consumption of $\frac{1}{100}$ of a watt per H.K. is attained for each square millimetre section that is removed from the core. In addition, by increasing the current density we secure a more stable seat for the arc and steadier burning; when the arc does not completely cover the cross-section of the carbon adjacent heated parts tend to conduct away the heat.

FIG. 6.—Illumination of Printing Office, Composing Room, Dortmund.

In the case of ordinary open arc-lamps the method of increasing the illuminating power by diminishing the cross-section of the carbons is not permissible, for by this means the short life of the carbons, amounting to only 10 hours or so, would be still further reduced; the same holds good to a less extent for enclosed arc-lamps, in which the air is only partially excluded. It is only in the case of the completely sealed-in arcs that it is possible to increase the light-efficiency without unduly reducing the life. Were one to be content with a life of only 15 to 20 hours in the case of the carbons used in the Helia lamp, a consumption of only 0·3 watts per H.K. could readily be obtained by using carbons of somewhat smaller diameter.

Six millimetre carbons (approximately 29 square mm. in cross-section) last about 40 to 60 hours in the case of the Helia lamp. An ordinary lamp would achieve this result with carbons about 9 mm. in diameter *i.e.*, about 54 sq. mm. in cross-section. Under these circumstances about twice as much carbon would be burned in the same time, and consequently a corresponding amount of ash produced, which would soon deposit upon the inner globe. Moreover, the luminous efficiency of such lamps is not satisfactory, since the specific consumption corresponding to the approximate doubling of the cross-section of the carbons would be about 0·33 watts per H.K. higher than is the case for the Helia lamp. The life of the carbons in the Helia lamp varies, according to the current employed, between 40 to 60 hours.

The Reginula lamp possesses the same main characteristics as the Helia lamp. Carbons of the same composition are employed, but somewhat shorter, and of smaller diameter to correspond with the smaller current used.

The relative advantages of these three types of lamps naturally depends upon the local conditions. When a workshop is to be illuminated, and a strong general illumination is desired, and where the works possess a generating station of their own so that current is cheap, the Regina lamp is preferable; therefore this lamp is specially stoutly constructed to meet the demands of foundries, &c., where the lamps are not infrequently subjected to rough handling. In such a case it is only necessary to insert carbons about three to four times a year.

Such lamps are specially adapted for use in those works where a large number of arc-lamps, perhaps 100 or more, are used. The inconvenient necessity for continually recarboning such a large number of lamps is avoided, and the efforts of a staff of attendants who would otherwise be constantly engaged carrying carbons about the shop can be dispensed with. Another advantage is the fact that it no longer becomes necessary to keep a large store of carbons in stock. 1,000 Regina lamps only use about 800 mks. in the year in carbons, whereas the same number of ordinary open arc-lamps would require about 20,000 mks. sterling. Reckoning half the cost of the carbons for the labour in replacing them we obtain 1,200 mks. in the case of the Regina lamps, as against 30,000 mks. in the case of the open arcs.

(To be continued.)

The Moral Effect of Light.

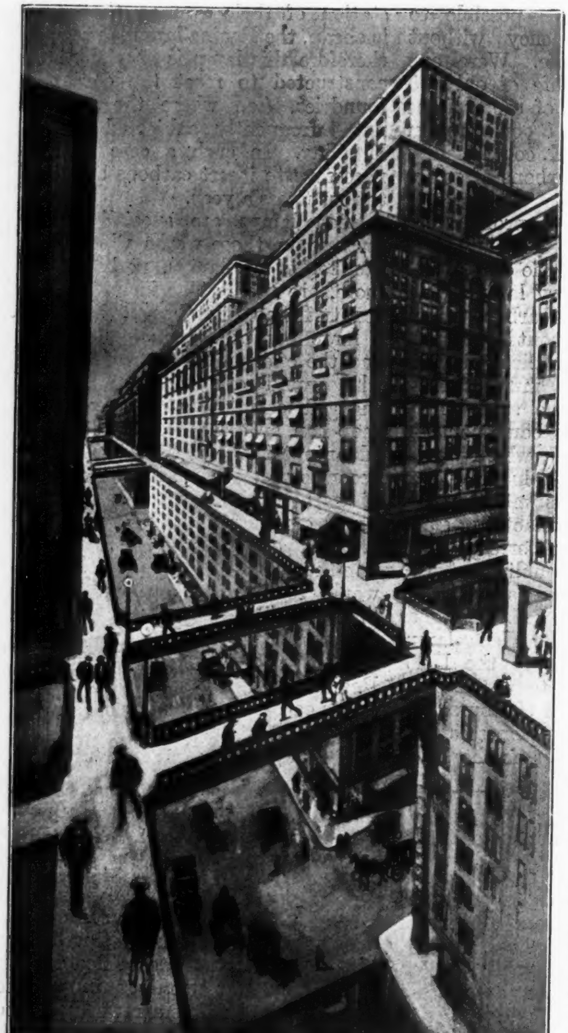
In our October number (p. 843) some remarks were published on the need of good illumination from the moral standpoint.

We notice an interesting illustration of these remarks in a recent description of the Borstall system of dealing with juvenile offenders. Good boys, it appears, are allowed to have light in their cells for half an hour longer each night, and in addition can keep pictures, photographs, &c., on their tables. This is an interesting example of the value that is attached to light, an extended period of illumination taking the form of a reward for good behaviour.

Elevated Streets in New York.

WE observe in a recent number of *The Architect and Contract Reporter*, to whose courtesy we are indebted for the use of the block accompanying the reference, a note on an interesting suggestion regarding the construction of elevated streets, which is attributed to Mr. C. R. Lamb, an architect of New York.

In order to avoid the abrupt rising face of the sky-scraper, which is both open to objection from the architectural point of view, and also obscures a considerable amount of light from the street below, it is proposed to set back the front of the buildings at certain heights, thus enabling an elevated street to be contrived following the contour of that at the base of the building.



Suggested Elevated Street, New York.

The general adoption of this plan would have a very important bearing on the conditions of daylight illumination in streets, and certainly the growing height of buildings in the United States — the Singer building in New York is over 600 feet high— is bringing the question of sky-illumination into greater prominence.

Probably, too, the creation of elevated crossings of this nature would materially influence the conditions of artificial illumination, for lamps could then be permanently attached above the street below, possibly enabling lampposts to be dispensed with, and bringing the conditions more into line with those representative of indoor-illumination.

Some Notes on the Exhibits dealing with Illumination at the Berlin Exhibition of Shipbuilding and Naval Architecture.

BY W. BIEGON VON CZUDNOCHOWSKI.

THE first German exhibition of naval architecture was opened on June 2nd of this year in Berlin, under the management of the *Verein Deutscher Schiffswerften*, with the patronage of Royalty.

Although the exhibition was mainly devoted to the technical details of the design and equipment of vessels, mention may be made of a few exhibits which were of special interest from the standpoint of illumination. For example, attention may be drawn to the methods of lighting adopted in the saloons, &c., on the Transatlantic, East Asiatic and African lines, where a high standard of comfort and convenience is demanded. Even on the modern man-of-war the degree of illumination required is very different from that which would have been considered ample in the days of Nelson.

Thus J. D. Heymann of Hamburg exhibited a model of an oval reception-room, executed in the "Empire" style, as adopted on the Hamburg-American line. The daylight illumination of this room was provided by a central skylight round which were four niches.

The artificial illumination was provided by twenty glow-lamps grouped round the skylight and seven portable lamps distributed on the tables in the room.

Again, the Hamburg-South-American Line show a nursery, receiving daylight-illumination from a skylight of painted glass, and artificial illumination from a series of glow-lamps, some distributed on the walls and ceiling and others above this diffusing skylight.

Equally elaborate is the illumination of a smoking-room on the African line, which is wainscoted in marble.

Of special interest, again, are the suites of "State" and "Emperor" rooms, as arranged on the Norddeutsche-Lloyd boat, George Washington. The former presents a combined bath and bed room, the second a drawing-room, breakfast-room, and bedroom, done in the "Biedermeier" style. In both cases glow-lamps are mounted upon a white ceiling, and there are also lamps let into niches in the walls which are covered with diffusing glass.

In considering the interior lighting of a warship the decorative aspects of illumination are of minor importance; it is only essential to provide a good, steady illumination, satisfactory from the hygienic point of view, by as simple means as possible.

The rooms exhibited include a berth for ten lieutenants, the captain's rooms, and part of the hospital and dispensary on the new 15,000 ton cruiser Blücher, and the operating room of the 18,000 ton battleship Nassau.

In all the exhibits, however, certain general principles prevail. A uniform illumination and absence of shadows and glare is essential, and therefore in most cases a considerable number of small sources, distributed over an extensive area, are employed, clusters of lamps of concentrated brilliancy being avoided. It is also the invariable custom to abstain from using hanging fittings liable to be displaced by the motion of the ship.

Naturally the various types of metallic filament lamps now on the market (see *The Illuminating Engineer*, pp. 586–590), occupy a prominent position. On a steamboat the greater efficiency of these lamps has proved a great convenience, for in this case the pressure of supply adopted can be specially selected to suit the lamps, so that the full benefit can be derived from their use. Thus in many cases, as, for example, on the H.A.P.A.G. boats Pennsylvania, Pretoria, Patricia, and Great Waldersee, it has been found that a single dynamo of given output sufficed where three were formerly necessary. Moreover, a great drawback to the use of metallic filament lamps on board ship has been removed by the manufacture of lamps capable of being burnt in any position.

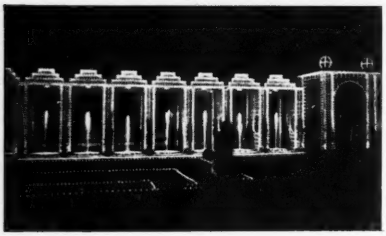


Fig. 1.—Scheme of Illuminating Gardens at Berlin Shipbuilding Exhibition.

Glow-lamps are also extremely effective for decorative and spectacular lighting, *e.g.*, for regattas, fêtes, &c. For such purposes the A.E.G. have brought out special metallic strips equipped with 8 or 16 equidistant miniature water-tight holders, connected in series so as to carry a series of 14 volt 2 H.K. lamps. This strip is cheap and convenient for outline work. Such strips are also employed for the purpose of outlining flower-beds, &c. In the small garden attached to the exhibition 35,000 small lamps are utilized for decorative effects in this way. Fig. 1 shows some such decorative effects, including a series of fountains illuminated by high-voltage, inclined carbon arc-lamps. In this case a pleasing colour contrast was obtained by utilizing white light for the fountains and glow-lamps giving a yellow light for outline purposes.

The use of the arc-lamp on board ships is practically confined to a single important application, namely searchlights. The exhibit of the *Reichs-Marine-Amt*, for example, illustrates the use of searchlights on battleships, gunboats, and even torpedo-boats. Searchlights are, however, an important adjunct even in the merchant service. For instance, they are utilized by ships passing through the Suez Canal to distinguish the various landmarks, buoys, &c.

Among the exhibits of this class may be mentioned those of the Siemens-Schukert-Werke, who utilize the method of making truly parabolic mirrors invented by Prof. Munker of Würnberg in 1886. A special form of searchlight designed in co-operation with the Prussian Department for Public Works, and credited with 75,000,000 H.K., is also exhibited by the firm J. Pintsch. The same firm exhibits lamps for lighthouse, beacon, and buoy illumination, burning compressed oil-gas, petrol, alcohol, and electric glow-lamps. Special mention may also be made of the automatic apparatus of this firm, depending upon the use of selenium, whereby lanterns are automatically lighted when darkness falls, and subsequently extinguished in the daytime.

Lastly, mention may be made of the automatic copying apparatus for the production of photographic prints of the Neue Photographische Gesellschaft of Berlin and other firms. Some of these devices employ high-voltage enclosed arc-lamps, others Cooper-Hewitt mercury-vapour lamps. In any case the sensitive paper, superimposed over the tracing from which the print is to be made, is caused to pass at a uniform rate over a glass cylinder within which the source of light is placed, so that each part is exposed to the region of greatest intensity in turn. By using a series of tracings, joined end to end, we can arrange to print off, automatically, a large number of separate drawings in turn. Or, by joining the ends of a single tracing together and mounting round the cylinder, we can print off a number of duplicates of the same diagram.

SPECIAL SECTION.

The Second Annual Convention of the Illuminating Engineering Society (*continued*).

PRESIDENTIAL ADDRESS.

By Dr. Louis Bell.

(Delivered at the Second Annual Convention of the Illuminating Engineering Society, Oct. 5-6th, 1908).

I NEED hardly say that it gives me great pleasure to meet the Society at this Second Annual Convention. But it is not for the purpose of obvious congratulations on the gathering that I arise now, but rather for the purpose, if I may put it so boldly, of bringing before you reasons for repeating the cry of Ajax for " more light."

Unfortunately we, in these times, can only call for more light—we have not the privilege of Joshua in holding the sun and moon still to provide it for us. Things were done in a better way in the olden times, they have always said.

The topic which I wish to bring before the Convention definitely, then, is the topic of street-lighting : some of the things which underlie it, some of the things which are needed to make it sound in practice as well as in theory.

Man is becoming more and more a nocturnal animal. It was not more than two hundred odd years ago, perhaps, about the time that Philadelphia was founded or a little later, that the first attempts at systematic street-lighting were made. One has but to consult the evidences of old books and old prints to see very plainly that our ancestors and contemporaries of the founders of Philadelphia had very little to show in the way of public lighting. A candle flickering in the wind near a window, the horn lantern casting a feeble glimmer down the street and dribbling oil on the passers-by, and the pine torch or a flambeau with asphaltum, borne by a torchbearer hurrying through the crowd, and thrusting his smoky weapon in the face of the passers by—these were about all that the world could boast of two hundred or two hundred and fifty years ago in the way of street-lighting.

The activities of men are so far transferred from day to night, at the present time, that it becomes absolutely necessary to make provision for those who are travelling about after nightfall, and for the general business that is carried on at night—business of the theatres and concerts, and business of people hurrying from one place to another in the ordinary routine of their day's work extending until after sunset. For all of these purposes light, and plenty of it, is necessary, but this light we have to a rather limited extent in most cities.

The fundamental criticism against most attempts at street-lighting lies, not in the illuminants used, nor in their application, so much as in an improper adjustment of the illumination to the needs of the city. Street-lighting has been a growth and an evolution, but like all growths, it has proceeded to a certain extent along the lines of least resistance. Lamps were put, not in the best places for them, but where they can be put in with the least disturbance to individuals.

The result is, that looking over a city, particularly an American city, however good the intention of the city government, however excellent the technical skill of those who furnish the light, much is still left to be desired. The difficulty lies in the fact that we spread out our illumination too thinly, so to speak. We do not carefully discriminate between streets, the nature of the usage of which demands considerable light, and those streets which are perfectly well lighted with a much less quantity of light. We attempt to follow out a general American theory that all men and all things are free and equal, and distribute a very finite amount of light over a very large area, with some approximation to uniformity, lest we hurt the feelings of our good fellow-citizens by insinuating that Z street does not carry the heavy traffic, and is not so crowded with by-passers in the evening as A street—in point of fact, we all know in going through a city that there are certain great avenues of evening traffic, certain places where light is needed all night, and every night, and a great deal of it. The commonest failure is the failure to recognize this simple fact of attempting a certain degree of uniformity, never exactly uniformity, of course, which is quite improper when one considers the use to which the various streets are put.

There should be what there generally is not—a very careful adjustment of the resources of the city in the matter of public lighting, so as to convenience the greatest amount of the evening traffic possible. That means in streets which are largely used during the evening, illumination commensurate with their importance should be used, but for streets where the night traffic is light, and where passers-by are few, —such a street only needs light enough to enable people to get about comfortably. There is still a third class of street which needs individual treatment, sometimes gets it and sometimes does not, and that is the outlying street, the merely suburban road, the country road which comes within the province of the municipality to illuminate. In places of that sort funds are seldom available for making anything like serious illumination, but a great deal for the convenience of the public can be done.

The purpose, the fundamental purpose of lights in these outlying, little-used streets, which yet need some light, is merely to serve as markers of the way; in other words, in these unfrequented places, streets where illumination of the first order is unnecessary, and that of the second order needlessly great, the important thing is to so distribute the light that the illuminants serve to mark the way and clear the passage for the passers-by. In such places the somewhat common practice of using very large units of whatever kind is obviously improper. One marker a mile of 10,000 candle-power is not anywhere nearly so good as half the amount of light put out at short distances in smaller units; in other words, where you are using a light merely as a marker to show the way, clear the way for driving or motor-cars or pedestrians, and cannot undertake a general illumination, the next best thing is to go to small units and locate them so as to get the best results obtainable from the energy in whatever way it may be applied.

There are three distinct classes of streets which have to be considered in taking up the problem of the theoretical character and practically useful illumination. First, there are the chief streets, the heavy arteries of traffic which need all the light they can get. Then there are the secondary streets, making up the bulk of an ordinary city, which need to be well-lighted, but do not require a blaze of illumination, because they are used in an entirely different way from the main streets. And, finally, the tertiary streets, in which the lighting is practically merely to show the way.

In our ordinary practice here these classes run into each other by such gradual transitions that one can hardly tell whether there was any fundamental idea in the minds of the persons who laid out the streets or not. Our chief streets, as a rule, all over the country, are really poorly lighted, the secondary streets not particularly well-lighted—sometimes a little better than they should be, and sometimes not quite so well—and the tertiary streets frequently rejoice only in one illuminant every long block, utterly useless for practical purposes except within a very short radius, and utterly failing, too, in the proper marking out of the way. As regards the absolute amount of light required there will be always a great difference of opinion. In the principal streets where the traffic is constantly heavy, I do not think that one would go far wrong in following the principle that one should have light enough to see to read a paper by at a pinch. I would not recommend the citizens to sit out on the curb and read their evening papers, but I think the chief streets of the city should be always so well lighted that if any one has to consult a notebook to find his way, or wants to take out a letter and consult it for any purpose, he should be able to read it without having to walk a half block to get under the nearest light. As to the secondary streets, much less amount of light than that is desirable, and not so much is necessary, in fact. The tertiary streets can carry a still less amount.

In connexion with this matter I may say that the foreign practice in England and on the Continent is to provide in the different streets light enough to read a paper by. This summer I travelled miles through the chief streets of the European cities, and was able to read very fine print in the Baedecker every step of the way by the light of the street lights alone. That is the ordinary standard of goodness which is lived up to in the large foreign centres. In the secondary streets we want merely plenty of light to go about with, and in the tertiary streets merely enough to see the way.

In actual amount the London canon in lighting calls for an average of something like a quarter of a foot-candle, as against our one-tenth, one-eighth, or one-quarter that amount in the ordinary American city. The secondary streets on the other side are about down to the illumination of the ordinary street here. The tertiary streets are still less lighted, perhaps half as much, but the light is invariably secured by comparatively small units, either gas or electric, instead of putting up very big units either gas or electric. So much for the general arrangement, and the general design of the illumination.

Now as to its manner. In the first place, whatever the intensity adopted, it is desirable to have a fairly uniform distribution. By that I do not mean uniformity at the expense of low maxima, but it is undesirable so to scatter one's lights as to have a great deal of light here and there and none between. Secondly, it is desirable to diffuse that light so as to make it as useful as possible. One of the great points of difference between the practice here and European practice is that diffusing globes are practically in universal use except in the United States, and therefore there is less uniform lighting here than almost anywhere else. Merely, if for no other reason, because the light is not diffused, the radiants themselves are of a different character, are intensely brilliant, and the result is a certain dazzling effect which very much decreases the practical usefulness of the light, on just the same principle that a bare lamp-post out in front of your eyes is a very inconvenient thing by which to read.

In the matter of distribution one cannot sacrifice too much for the sake of uniformity. It is a fact which one will find out readily by observation that you can light a street uniformly and yet badly. You can have a fairly good minimum on a street, and yet lighted badly for the purposes of a chief street. I can best instance that by mentioning two places which I have looked at, which point the moral very distinctly. One is a place in Paris where there is a tremendous concentration of illuminants. They are all small units and massed together, massed in a way that would show, if you deliberately sat down and figured the illumination, a result which would cause you to feel proud of it. Practically, however, the place is badly lighted. There is no effect of brilliancy; you can see fairly well all over, but as a place for a public circuit and avenue of traffic the thing is insufficiently lighted.

I call to mind another place in Berlin where the average intensity is probably not very much higher, not more than 50 per cent, perhaps, where the units used are of the same kind, but of very much greater intensity; the effect is beautiful. In other words, one cannot dwell either on the minimum in the street as a canon of good lighting, nor on the average as you see it along the street. You must bear in mind that a big bunch of light, throwing an immense amount of light out into the street, and being reflected from the house, adds a great deal to the efficient illumination of that street for the purpose for which we want street illumination. You can get fair uniform lighting, and you can take the same amount of energy and get less uniform lighting which will be quite as effective. In other words, you must look at the thing as a practical matter, and not as a mere theoretical matter of so many hundreds of a foot-candle. It does not take an expert in illumination to see whether a street is badly lighted or not, and it does not, consequently, take an illuminometer, with a measurement of the thousandths foot candle-power to find the half-way distance between lamps, to show that improvements are necessary. The thing is a strictly practical matter, and should be treated as such.

That brings up the question of the direction of measurement. How shall we measure the lights on the street? The customary measurement here is a tacit apology for bad lighting. The customary method of measuring here is a measurement practically half-way between the lamps with a disc, or other measuring instrument held normal to the latter. If one gauges his illumination solely by such readings as this, he can be guaranteed of a mighty badly lighted street in every case, because the tendency of competition, from whatever source it comes, is to secure that minimum at as low a maximum as possible, modifying the illuminant to be as badly as they can, subject to the condition of getting the low minimum, and the result is a badly lighted street. I could mention types of illuminants which have been deliberately specialized for the purpose of giving two-hundredths or three-hundredths of a candle-foot, at some point down the street, where, if the same illuminant was taken and designed, not to give a special form of illumination, but to give the best efficiency it was capable, it would not only be possible to make it light the distant parts of the street, but the whole of the street; in other words, there are cases in which the efficiency is deliberately sacrificed for the sake of what is nothing more or less than bad distribution.

Every effort toward economy should be an effort directed to increase the total flux of light, because, with our modern illuminants, there is this to be taken into consideration for street-lighting, at least, the intrinsic brilliancy is so high that some diffusion is necessary, and they are all of a character—all the modern ones—which permit you, in getting diffusion, to get redistribution if you want it.

There is no excuse, therefore, to-day, whatever there may have been ten years ago, for specializing distributions by means of design of the illuminant, because, at the present time, we must shield them. We can both distribute and diffuse at the same time if we want to, and, what is more important, when you light a street on any adequate scale you need all the spherical distribution you can get.

The customary practice in the matter of direction of measurement, is to measure the illumination after it falls on a plane 4 ft. above the ground, or at some other specified height, in any case measuring the resolved component on a horizontal plane. One-tenth of a foot-candle so measured means a great deal more than the tenth which we get on the normal system of testing.

One is sometimes tempted to wonder on what basis this particular measurement was chosen, and why the thing has not been more fully discussed. It has not been more fully discussed here because people do not like to talk about that little resolved component. It is so much nicer to talk about the normal; it is not discussed abroad with any great vigour, simply because in the first place the light is sufficient to give a thoroughly adequate measurement that way, with the measuring of the horizontal surface; and, in the second, because, as a matter of fact—it happens to be a rather curious reason, too—the lights in England and on the Continent are customarily placed at just about the point that makes it a matter of indifference to them which way they measure; that is to say, in measuring the illumination on the horizontal plane you measure the effect from the two lights. In measuring on the normal you obviously have to measure the effect from one, because that is the only one you assume you are using.

Now, at the distance and height at which big units are customarily placed abroad, whether gas or electric, only four or five times the height of the post being taken as the distance between lamps, a double or projected measurement of one lamp became substantially identical with its normal measurement; so that it ceases to be a vital question abroad whether you use one or the other, because the two are nearly coincident. That is, we take the normal measurement with an inward apology to ourselves, after passing by the convenience, or propriety, or even technical sufficiency of adding the one rather than the other. The thing which I wish to point out is, that after you reckon on illumination on the normal, for heaven's sake give us enough of it to see something by, and not the apologetic two-hundredths or three-hundredths of a foot-candle which has been too often talked about.

This brings up the question of economy in street-lighting, and, in particular, I want to devote a brief moment of animadversion to the so-called moonlight schedule. I think this curious minimum, which we have too long followed, of a couple of hundredths of foot-candle for our illuminant units came largely from the fact that that was supposed to be about the maximum intensity of moonlight in our latitude. We say that we can read nicely by a full moon, which gives one-hundredth, to two-hundredths of a foot-candle and we will be happy. In point of fact, moonlight is diffused, diffused with a vengeance, and from my observation I should say that moonlight, on account of its diffusion, was at least two or three times as good as an equal fraction of a foot-candle delivered from an arc-light, or Welsbach, or big incandescent lamp, or what not, merely because you have in the moonlight the complete diffusion and low intrinsic brilliancy which lets the eye do its best work. You do not have any trouble driving an automobile in moonlight if you have a good headlight; you might have trouble in driving an automobile, even with a good headlight in a brilliantly-lighted street, because the lights in the street flash straight in your face, and it is that practical value of diffusion which we all recognize when it is called to our attention, and that should be recognized in street-lighting.

If you are going in for an undiffused light you must furnish more of it; where you can diffuse your light, you can fall back on low values.

The moonlight schedule, which is the favourite method of economizing, is most deceptive. In the first place, normal moonlight in our latitude is less than two-hundredths of a foot-candle. In the second place, the half-moon intensity, instead of being half as good as a full moon, is only one-tenth as good. That means that there is a large element of specular reflection in moonlight, the same as from a piece of polished cardboard. The diffusion is very imperfect, but the actual fact, from the concordant measurements of three or four astronomers, is, that a half-moon is only one-tenth of the brilliancy of the full moon, and consequently your two-hundredths of a foot-candle, or 1500 in three or four days, has sunk to an insignificant figure, and there is only one week in the month when the moonlight rays are of a magnitude to be of any particular account.

Customarily the moonlight schedule is, perhaps, two-thirds of the full all night and every night schedule; you are going to get anything like proper illumination, three-fourths, or eight-tenths, or something of that order.

A second common effort at economy is through the means of half-night lighting. Half-night lighting from the standpoint of the needs of the public is a great deal better than the moonlight schedule, because, so far as the brilliantly lighted streets of the city are concerned, the legitimate activities of the city cease before morning, so that there is some reason in reducing the number of lights after midnight or one o'clock. If anybody has to economize rigidly, it is far better to put out every other light or something of that kind, than it is to run them on a regularly reduced moonlight schedule.

It is never desirable to go into half-night lighting or petty economies of that kind anyhow, but my purpose here is to point out that the moon is a bad thing to fall back on. If you have to cut down the illumination at certain times, from motives of economy, it is better to do it at your own time, and do it systematically than it is to depend on moonlight and weather conditions.

Now, as to the important things of the future in street-lighting. The first of them is a recognition of the fact that we are lighting the streets for people to use; that we should light the streets with reference to the use which is going to be made of them, and, on the whole, they should be much more brilliantly lighted than streets are customarily lighted in this country to-day. We need it, not only for the general purposes of the city, but for the police purposes, and there all night lighting is a very important matter. It is an old saw among electric men that an arc light is as good as a policeman. That may or may not be true in an exact sense, but it is certain that a well-lighted city, a city lighted well all over, is a safer city at night than the average poorly lighted city.

Finally, granted that the need for more light, and more light in the chief streets to a very considerable extent is admitted—two or three times as much as we have now—the next question which arises is by what means shall this need be satisfied? We are now in the transition period. As every engineer connected with the gas and electric light industry knows, the one thing which I think is perfectly safe to say, about which there can be very little doubt, is that the old illuminants, the old types of street lights, both gas and electric, have got to go, and have got to go very rapidly. The old time, glimmering arc-lamps, the faded out and worn out vertical Welsbach, both have got to go to the general scrap-heap, and go into oblivion, and they have got to do this before a very long while, and in their place we will have an entire different order of lamps, which, by increasing the efficiency, will enable the streets to be lighted as they ought to be.

We have come to a parting of the ways; we have got to turn away from our old ideals and head ourselves toward the new ones, to wit, the great god efficiency, whose worship has been too long left out of our devotion, owing to the minor deities of the engineering profession. Three or four years will work a change. The handwriting is on the wall plainly enough now for any one who cares to read it, and we are going to have, and we have got to have, and we ought, as illuminating engineers, to insist on having the kind of public lighting which has never been seen in this country except in one or two isolated spots. We need more light, better diffused and better distributed, and it is our duty, if we are to make any claims to be pioneers in the way of illuminating engineering, to keep at this subject technically and personally until we get the more light which we ought to have.

The Electrical Review, of New York, and *The Western Electrician*, of Chicago, have joined forces; the new journal is to be issued under the name of *The Electrical Review and Western Electrician*, and the address of the publishing offices will be in future 204, Dearborn Street, Chicago, U.S.A.

Discussion of Papers by Dr. A. C. Humphreys, Dr. A. H. Elliott, J. E. Woodwell, E. G. Perrot, and L. J. Lewinson.

(Papers read at the Second Annual Convention of the Illuminating Engineering Society, Oct. 5-6th, 1908; abstracted in *The Illuminating Engineer* for November.)

Report of Committee on Nomenclature and Standards.

By Dr. A. C. Humphreys.

After presenting this report, in the absence of Dr. A. C. Humphreys, **Dr. Hyde** added a few remarks. He said that all were agreed, in the abstract, as to the benefits of a common standard, but the practical realization of this desire called for much labour, and he thought much credit was due to the Illuminating Engineering Society for taking the initiative, and to the American Institutions of Gas and Electrical Engineers for responding so cordially.

The attitude of the industries concerned had been most appreciative. The campaign, however, was not yet over, and he hoped the Society would continue to assist the movement in which they had taken such definite initiative.

Dr. L. Bell, the President, thought the prospects of an international standard were bright, for continental nations were most sympathetic, and seemed to feel that the time was ripe for definite movement. All that had been necessary was the starting of the work, and he felt sure the committees concerned would soon bring their labours to a successful issue.

The Illuminating Value of Petroleum Oils.

By Dr. A. H. Elliott.

Dr. L. Bell, the President, said that any experienced photometrist was aware of the value of a good flame standard for the testing of gas, for which purpose electric glow-lamps, however desirable as the custodian of the primary standard, were inconvenient. Dr. Elliott's paper deserved very full discussion.

Mr. N. W. Gifford pointed out that Dr. Elliott's standard was already widely used as a working standard.

Mr. C. O. Bond said that his experience was confined to flat-wick oil standards, and confirmed Dr. Elliott's statement that a very satisfactory light was obtained up to 10 hours. After 24 hours, however, the wick tended to char, the flame became uneven and smoked, and the chimney eventually cracked in some cases. But in any variety of lamp utilizing a wick in actual contact with the flame the same difficulties would be encountered.

Mr. C. O. Bond also pointed out that it was important, not so much that no change in candle-power should occur with time as that we should be able to know definitely how much change would take place; in his experience the change had not been regular, though Dr. Humphreys had met with more success.

Both the Hefner and Pentane lamps, though excellent in many respects, were open to practical objections, and the latter was bulky and expensive; he thought, therefore, there was an opening for a simple oil standard.

Mr. R. C. Ware asked if Dr. Elliott had tried to eliminate charring by using asbestos wicks ?

Mr. N. A. Dutton thought that a lamp would burn with little loss of efficiency for 30 or 40 hours, provided the oil was kept at the same level; otherwise the drawing power of the wick was impaired.

Dr. E. P. Hyde asked why it was necessary that a lamp intended as a secondary standard should burn with the same candle-power indefinitely. Could it not be standardized at intervals during the day?

Was it possible to reproduce such a lamp accurately, provided the same oil and the same kind of wicks were used and could a Methven screen arrangement be applied?

Mr. E. L. Elliott asked whether the change in intensity was due to a change in the size of the flame or a change in intrinsic brilliancy.

Dr. L. Bell, the President, in closing the discussion, inquired whether any advantage might be derived by the use of a convenient and cheap hydrocarbon, and whether a flat quartz plate might not replace the chimney so as to avoid danger of cracking.

In reply **Dr. A. H. Elliott** thought the use of a definite hydrocarbon was unnecessary, for hydrocarbons of widely different nature could be used with substantially the same results as regards candle-power.

Ten hours was the longest period of burning he had employed, but a New York company used reservoir lamps that burned 24 hours, and stated that the intensity only altered 0·2 to 0·3 candle-power during that time. In these particular experiments he used bare flames, unscreened in any way; however, he had had little experience of broken chimneys, and thought that the incrustation of the wick mentioned by Mr. Bond might arise through the use of a poor quality of oil.

Dr. Elliott also expressed his desire that his results might lead to publication of similar work by others working in the same field.

He agreed that the Hefner lamp was too small a unit, and the colour was a disadvantage unless one was a skilled photometrist.

The Pentane lamp was clumsy, and the quality of the pentane in the reservoir gradually changed unless constantly renewed; moreover it required constant attention, and could not be used continuously, if only on account of the cost.

The asbestos wick might be very serviceable if it could be made sufficiently loose and fluffy. He had also tried felt wicks, but they became clogged at the end; it was a regrettable tendency of most wicks eventually to get hard and banded at the end, and therefore they were invariably replaced before any marked change in quality had occurred.

The change in candle-power of an oil lamp was due to a change in the size of the flame, and the initial shape of the flame was an important factor when standardizing a lamp.

The Intrinsic Brightness of Lighting Sources.

By J. E. Woodwell.

Dr. L. Bell, in opening the discussion, remarked that he was pleased to note a direct connexion was now traced between the contraction of the pupil aperture and intrinsic brilliancy.

Mr. D. McFarlane Moore was pleased to feel that the Society was giving special attention to several matters of vital interest in illumination, such as colour and intrinsic brilliancy. The effect of intrinsic brilliancy, as opposed to distance away of the source, was illustrated by the effect of a distant arc-lamp, which, when in the field of view of the observer, spoiled the entire effect of near and local incandescent lighting. Mr. Moore referred to the low intrinsic brilliancy of the vapour tube, and said that this quality avoided the necessity for using diffusing globes, which sometimes absorbed as much as 60 per cent of the light generated. He himself found that with a Moore tube operated at about 6 Hefners per foot an excellent illumination could be secured from an apparently very dim source. At 12 Hefners per foot the intrinsic brilliancy of the lamp approaches 1 candle-power per square inch.

Mr. Hering pointed out that when one spoke of "candle-power per square inch" of a source, projected area, as seen by the observer, was meant and not actual superficial area.

He also confirmed the suggestion that it was possible to see by the aid of a weaker illumination if there is no glaring source in the field of view.

Mr. V. R. Lansingh thought it was incorrect to assume that intrinsic brilliancy alone was the important factor; account must also be taken of the total amount of light transmitted to the eye from a source. For instance, a mercury vapour lamp, as a whole, was very trying to the eyes, on account of its high candle-power, irrespective of the fact that its intrinsic brilliancy was only 19 candle-power per square inch.

Mr. J. E. Woodwell, in reply, questioned Mr. Moore's figure of 60 per cent for the absorption of globes; it was inevitable that a certain amount of light should be lost in this way, but the results secured justified the sacrifice. But probably 25 to 30 per cent was a better estimate of the loss.

Mr. Woodwell thought that his definition of intrinsic brilliancy fell within the definition of the Geneva Congress; "intrinsic" was intended to convey information as to the actual brightness as a whole, and therefore the entire superficial surface should be taken. This, however, only affected numerical results, and not the principles for which he contended.

Mr. Woodwell admitted that further data were needed in the direction suggested by Mr. Lansingh; he thought that where there were multiple sources the effect resembled that of bird-shot, so to speak, as compared with a single bullet, and he was inclined to think that, in general, the effect might be attributed to the breaking down of adjacent cells on the retina.

Architecture and Illumination.

By E. G. Perrot.

After presenting the above paper **Mr. E. G. Perrot** added a few words referring to the general interest taken in the historic associations of Philadelphia, as illustrating the value of architecture and fine buildings as a means of recording the history of the past.

Mr. Perrot added that the illumination of the City Hall in Philadelphia was successful up to a certain point, but he thought that a little more attention was needed from the architect and illuminating engineer conjointly in order to bring out certain features of the building to the best advantage; this was typical of those instances in which the sympathetic spirit of the illuminating engineer could assist the development of illumination and architecture as well. The discussion was then opened.

Mr. A. J. Marshall agreed that the illuminating engineer and the architect ought to invite the assistance of one another, and generally co-operate in cases coming under the jurisdiction of both; but such co-operation ought to be mutual.

Mr. Marshall also doubted whether any real distinction could be drawn between "decorative" and "necessary" lighting of buildings. In any case the fixtures best adapted to the building were needed, and there was invariably some aspect of the fitness of things such as rendered architectural treatment. in a sense, necessary.

Mr. L. R. Hopton heartily endorsed Mr. Perrot's suggestion that the Society should publish details of successful work carried out by prominent architects and illuminating engineers in consultation.

Mr. J. F. Maguire was glad that Mr. Perrot regarded the selection of stock-fixtures as reprehensible, as this was a point on which he had been in controversy with some architects. It was very desirable that the architect should consult the illuminating engineer *before* his plans were fully completed; the need for early co-operation of this nature as illustrated by the case of the Engineering Societies' Building in New York, where the space allowed between the diffusing false glass ceiling and the ceiling proper proved to be only thirteen inches, with the result that the illuminating engineer could not obtain the perfect diffusing effect desired.

It was not reasonable to expect the illuminating engineer to produce wonderful effects when plans were designed and completed irrespective of his requirements.

Mr. E. G. Perrot, in reply, agreed that the co-operation between the engineer and the architect was needed in any scheme, and he himself was by training a structural engineer as well as an architect. This same need was initially experienced, and indeed is still felt to-day by the big engineering firms who construct "sky-scrapers."

Mr. Perrot next proceeded to explain his standpoint as regards "necessary" and "decorative" lighting in greater detail, referring to certain fixtures, which, however adequate for the purpose of illumination, did not meet the architect's ideas of proportion.

The architect needed the services of the illuminating engineer badly, and if he desired to use a certain system of lighting, his right course was to inform the engineer of this fact, before his plans were complete.

It was, however, necessary for the Illuminating Engineering Society to make its influence felt by sending out information, just as the Steel Corporations originally led the architect to appreciate steel girders at a time when 75 to 80 per cent of the profession knew very little about the matter. In the same way many architects to-day only fail to appreciate the importance of illuminating engineering, because they have not yet had time and opportunity to acquire a knowledge of the work of the Society.

The Intensity of Natural Illumination throughout the Day.

By L. J. Lewinson.

Mr. Carl Hering remarked that the figures on this subject in different text-books varied considerably, and therefore such a paper as this was very valuable.

The question why the eye was apparently satisfied at night with an order of illumination so much lower than daylight was extremely interesting. Apparently the maximum daylight illumination obtained, about 12,000 foot-candles, corresponded closely with the intrinsic brilliancy of an incandescent mantle, as deduced from the figures in Dr. Bell's book. It was difficult to conceive that a piece of paper exposed to daylight could be as bright as a Welsbach mantle, but this was suggested by the available figures.

Mr. J. E. Woodwell questioned whether either the horizontal or normal components of daylight illumination were so important as the vertical. Practically all light in a room enters by vertical windows, and is then reflected from vertical walls, &c.: measurements of this component were therefore needed.

Mr. E. G. Perrot remarked on the difference in daylight conditions at different times in the year, and thought that the results of this paper could only be rigidly applied to the month of September. In fact, the design of a building from the point of view of daylight illumination might be correct at one time of the year and not at another.

Dr. L. Bell, President, in closing the discussion, commented on the loose phraseology often employed in describing daylight illumination, and explained that these investigations dealt with the actual direct rays of the sun, and not stray light that had filtered through clouds and been again reflected to and fro before reaching the place of measurement.

Mr. L. J. Lewinson, in reply, said he had not dealt with vertical illumination, because of the uncertainty as to the direction in which a vertical photometrical screen ought to face. In all cases his measurements recorded sunlight *plus* skylight.

With regard to a statement in his paper that they were unable to read the instruments by a natural illumination of 2 foot-candles he thought this must be due to the differences of the light. Probably a local concentrated value of 2 foot-candles, coupled with a very dark sky, would have enabled the instruments to be read.

Design of the Illumination of the New York City Carnegie Libraries.

By L. B. Marks.

(Paper read at the Second Annual Convention of the Illuminating Engineering Society, Oct. 5-6th, 1908.)

(*Continued from p. 932.*)

RESULTS OF TESTS.

Results of tests of general illumination in all the principal working positions in the room are shown in foot-candles on the accompanying chart. The measurements were made on a horizontal plane approximately 3 ft. above the floor. The average of all values is 1–1.10 foot-candles. Data for this floor are as follows :—

General Illumination.

Watts per sq. ft.	0·78
Watts per c. ft.	0·05
Average foot candles on horizontal working plane	1·1
Foot-candles per watt per sq. ft. ...	1·4
Approx. spher. candle-power per sq. ft...	0·2
Approx. spher. candle-power c. ft. ...	0·012

FREE STANDING BOOK-STACKS.

Results of the vertical illumination on book-stacks are shown in foot-candles on the accompanying chart, the approximate location of the test-plate being indicated by the position of the foot-candle values on the diagram. The figures marked (*) indicate results of test obtained with the photo-

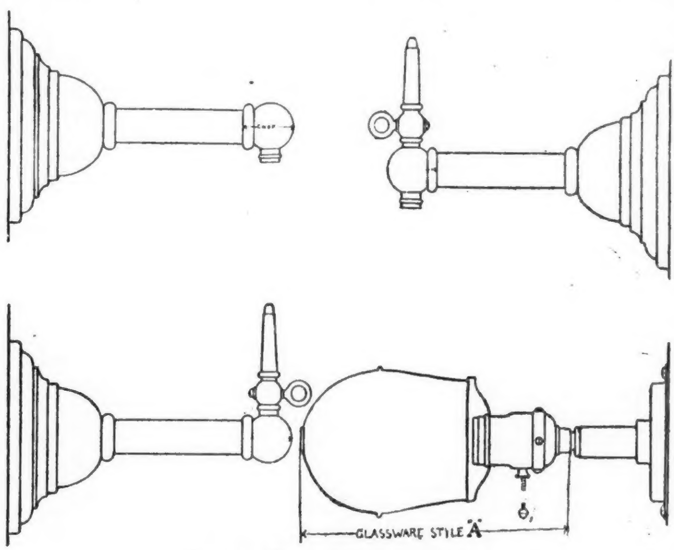


Fig. 14.—Fixtures Nos. 1, 2, 3 and 4.

First Floor.

Area, sq. ft...	2,950	
Contents, c. ft.	44,950	
Watts, general illumination		2,316
Watts, localized illumination		4,174
Total watts		6,490

meter on the shelves. Figures underlined indicate results obtained by viewing the test-plate through the photometer from the position which would probably be assumed by the average observer. This shows that a considerable difference is found when the test-plate is viewed from different angles, and when test-plates of different character are used.

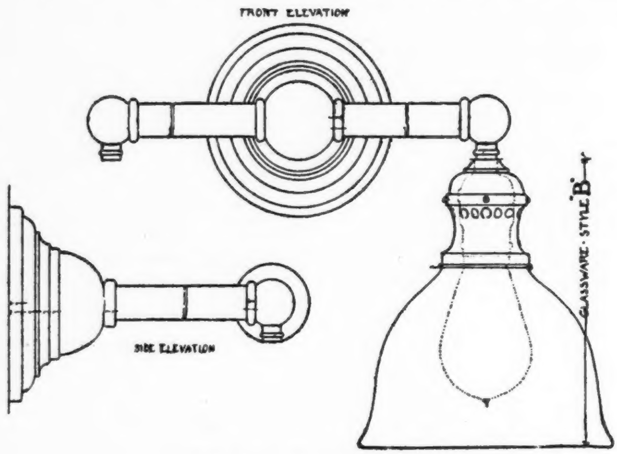


Fig. 15.—Fixture No. 5.

Fig. 16.—Fixture No. 6.

Tests were made to show horizontal illumination immediately in front of

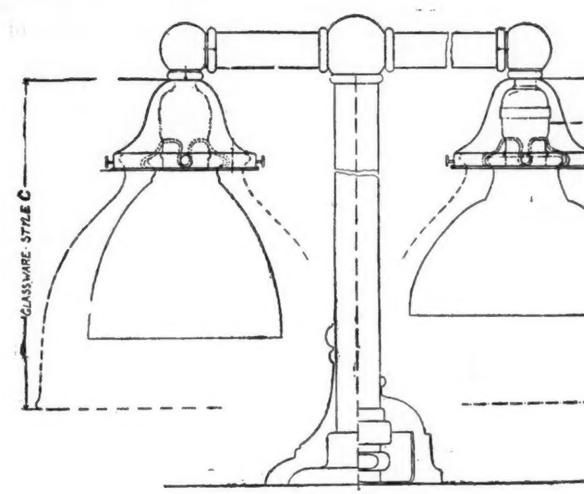


FIG. 17.—Fixtures Nos. 7L and 7R.

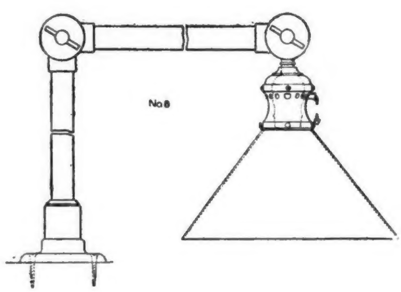


FIG. 18.—Fixture No. 8.

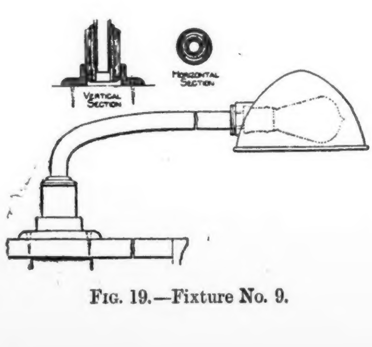


FIG. 19.—Fixture No. 9.

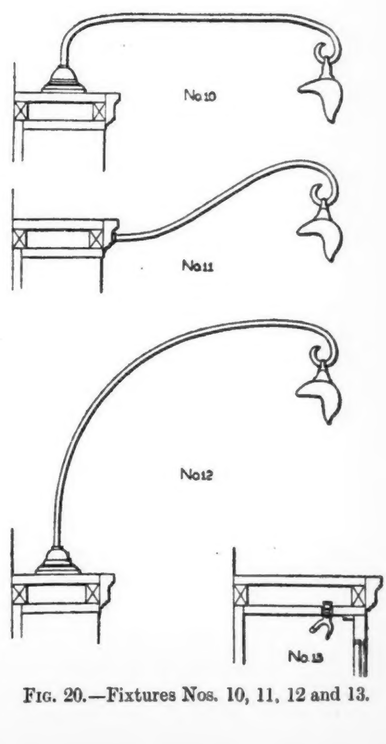


FIG. 20.—Fixtures Nos. 10, 11, 12 and 13.

the stack in position where one would be likely to hold a book removed from the racks for casual examination. The

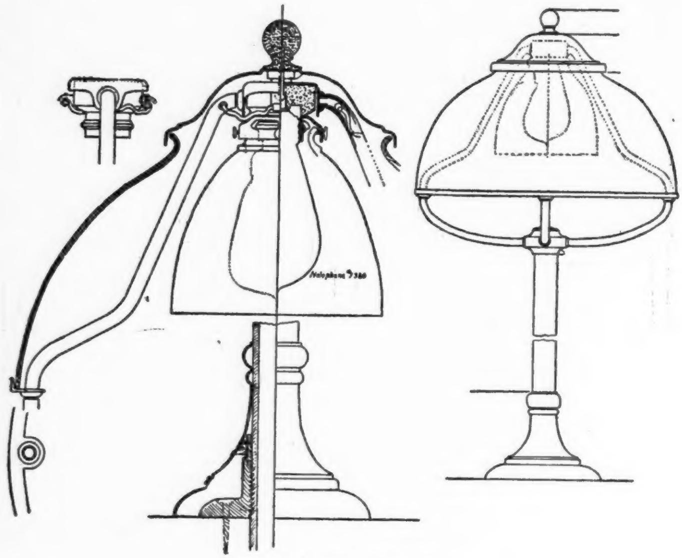


FIG. 21.—Fixture No. 14.

FIG. 22.—Fixtures Nos. 16 and 15.

FIG. 23.—Fixture No. 17.

results of these tests are indicated on the diagram in figures inscribed in rectangles.

SEVEN SHELF WALL BOOKCASES.

The illumination in foot-candles, as measured on vertical white blotting paper described in the tests of the aisle book-stacks, is shown in Fig 27; the figures underlined in this illustration represent the foot-candles, and their location on the diagram indicates the location of the test-plate on the bookshelves.

As in the previous test, measurements were made to determine horizontal illumination in front of the bookshelves. These values are indicated on the diagram in figures inscribed in rectangles.

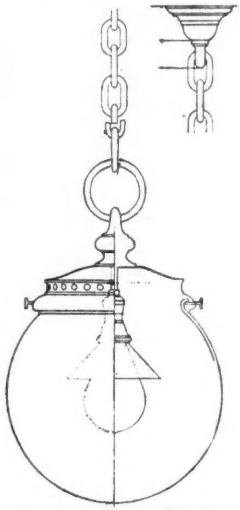


Fig. 24.—Fixture No. 18.

VERTICAL ILLUMINATION ON LOW BOOKSHELVES.

This test was conducted with a blotting-paper test-plate as described in the tests of the aisle book-stacks. The results are indicated on the diagram. The foot-candle values being placed on the diagram in such a manner as to indicate the location of the test-plate in the test.

ROUND READING-TABLES.

Test 1.—This test was made by placing the blotting-paper as a test-plate upon the surface of the table and viewing it through the photometer from the angle at which the average reader would probably view a book and receive a minimum amount of regular reflection. The foot-candles illumination, angle of view, and distance from the centre of the table to test lamp were as follows:

Distance from centre of table to test lamp.	Angle of view with the horiz.	Horizontal illumination.
6 inches	50°	7·9 ft. c.
12 inches	50°	7·5 ft. c.
18 inches	50°	7·1 ft. c.

The illustration shows a plan of this table and location of lamp and position of the test-plate.

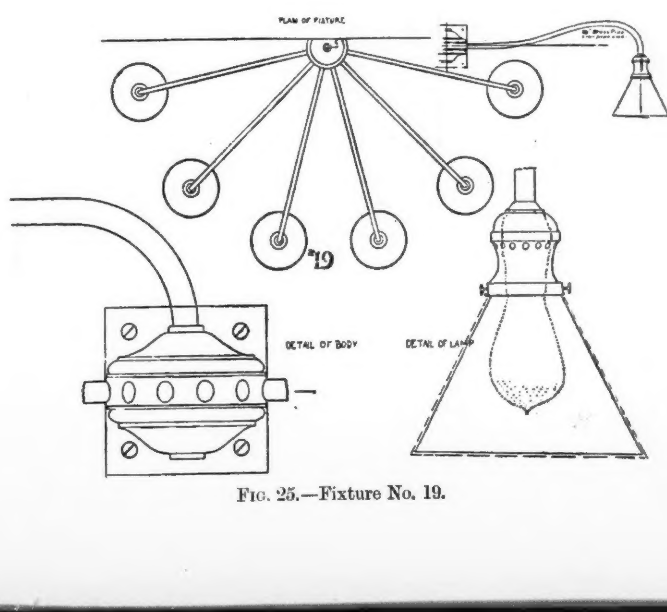


Fig. 25.—Fixture No. 19.

Test 2.—This test was made on the round table in a similar manner, except that the test-plate was viewed through the photometer from the angle at which a reader might view a sheet of paper placed flat on the table. It may be noted that the reader usually places his book near the edge of the table. at which position the effect of regular reflection is practically negligible. Results of measurements in this test follow:

Distance from centre of table to test lamp.	Angle of view with the horiz.	Horizontal illumination.
6 inches	40°	9·6 ft. c.
12 inches	50°	8·9 ft. c.
18 inches	67°	7·2 ft. c.
24 inches	90°	4·8 ft. c.

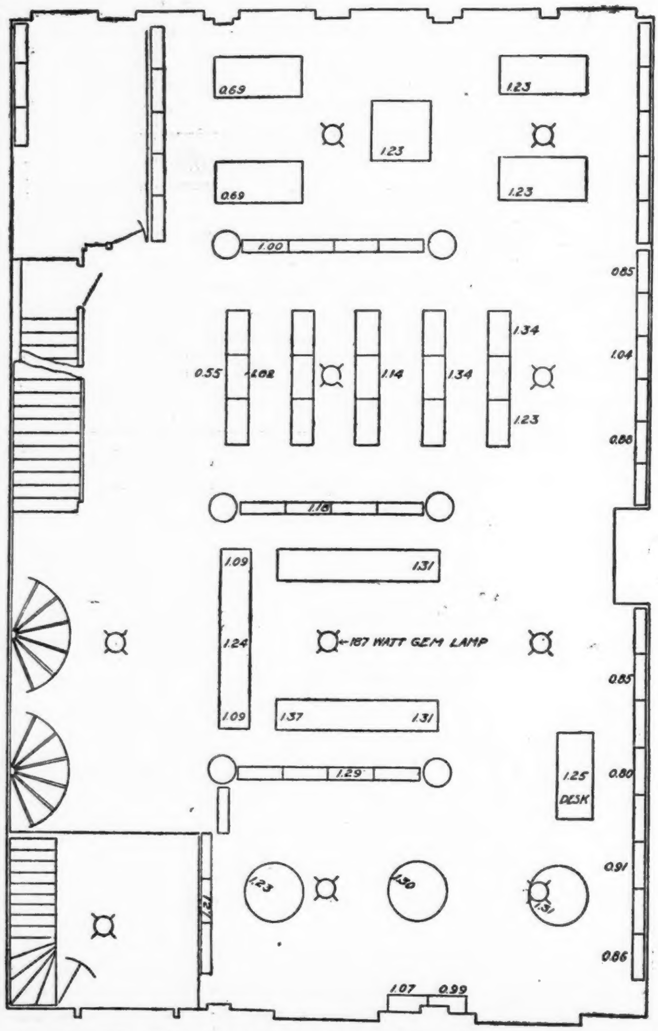
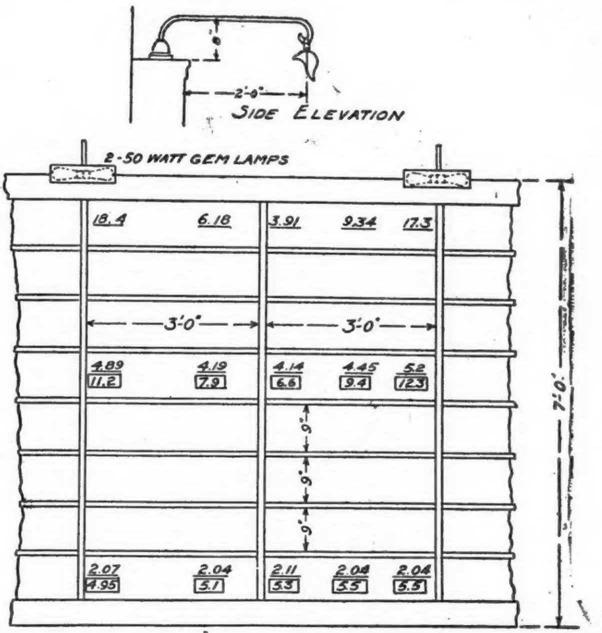
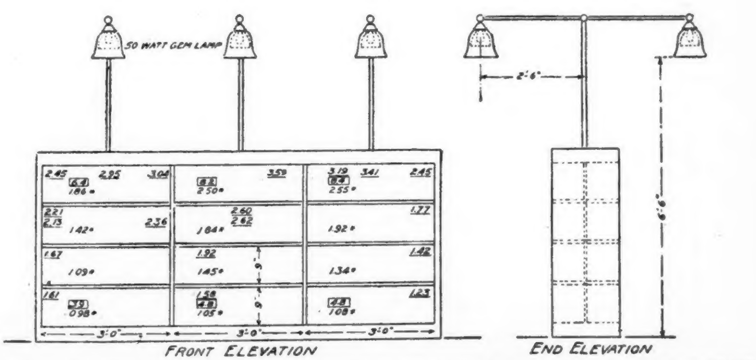


FIG. 26.—First Floor Illumination, all Local Lamps being Extinguished.



FIGURES UNDERLINED SHOW FOOT CANDLES VERTICAL ILLUMINATION IN POSITIONS INDICATED
FIGURES IN ▭ SHOW FOOT CANDLES HORIZONTAL ILLUMINATION 11 INCHES AND 47 INCHES ABOVE FLOOR

FIG. 27.—Illumination on Seven-Shelf Wall Book-Cases.



FIGURES UNDERLINED SHOW FOOT CANDLES VERTICAL ILLUMINATION IN POSITIONS INDICATED, WITH PHOTOMETER IN POSITION OF EYE OF READER
FIGURES MARKED WITH • SHOW FOOT CANDLES VERTICAL ILLUMINATION WITH PHOTOMETER ON SHELF
FIGURES IN ▭ SHOW FOOT CANDLES HORIZONTAL ILLUMINATION AT HEIGHTS OF 11 INCHES ABOVE FLOOR & AT TOP SHELF

FIG. 28.—Illumination of Free Standing Book Stacks.

The foot-candle values obtained in this test are shown on the plan, inscribed in rectangles.

RECTANGULAR READING-TABLES.

A plan of one of these tables, showing the location of the two lamps which provide local illumination, is shown. Horizontal illumination values determined, as in Test No. 2, of the illumination of the round reading-tables are given upon the diagram, the angle at which the blotting-paper was viewed from the photometer, being in each case approximately 45 degrees above the horizontal.

The foot-candle values are shown on the plans.

ROOF READING-ROOM.

These tests were made with the regular illumination attachment of the photometer. Results are shown in the plan in terms of foot-candles illumination, the figures showing at the same time, by their position upon the diagram, the location of the test-plate during the test.

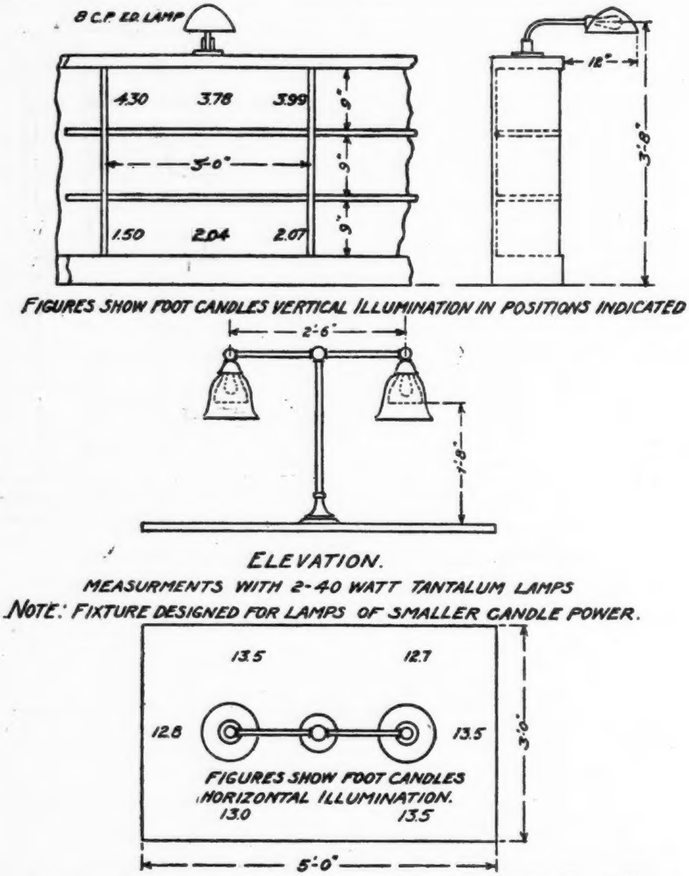


FIG. 29.—Illumination of Low Book Cases and Rectangular Reading Tables.

FEATURES OF THE DESIGN.

1. Freedom from glare; no unshaded lamps. Intrinsic brightness of lighting sources $\frac{1}{10}$ of a candle-power per square inch.

2. General illumination combined with localized illumination.

3. General illumination 1 foot-candle on horizontal working plane.

4. Illumination (horizontal) on reading-tables, average working conditions 5 foot-candles.

5. Illumination (vertical) on book-shelves 1½ to 4 foot-candles.

Illumination (horizontal) on book-shelves 4 to 8 foot-candles.

6. Combination of general and localized lighting designed to secure maximum illumination on the working spaces at minimum cost of operation for the required results.

Distance from center of table to test lamp	Angle of view with the horiz.	Horizontal illumination
6 inches	50°	7.9 ft. c.
12 inches	50°	7.5 ft. c.
18 inches	50°	7.1 ft. c.

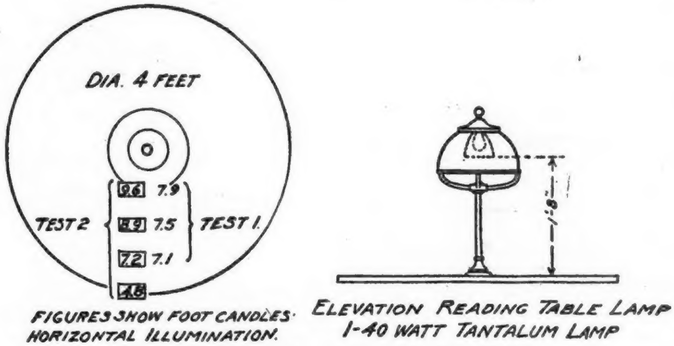


FIG. 30.—Illumination of Round Reading Tables.

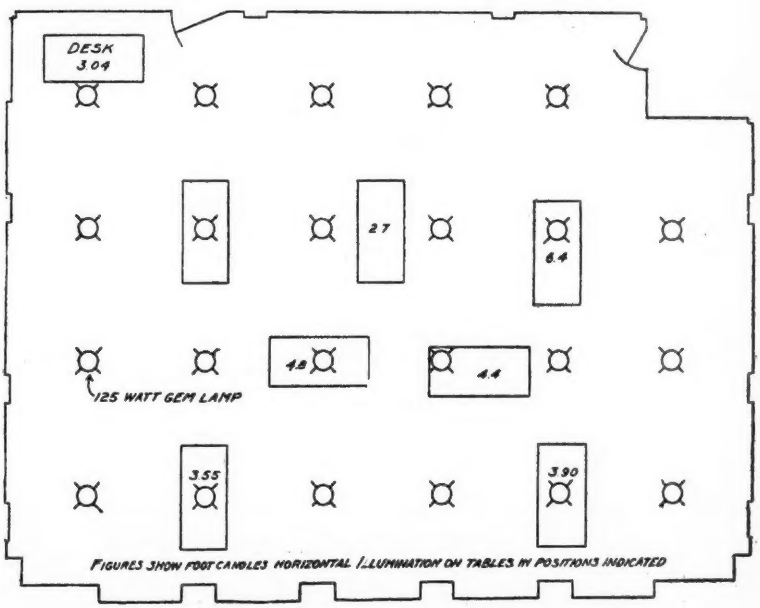


FIG. 31.—Illumination Measurements in Roof Reading Room.

Ceiling pendants for general illumination designed for efficient use of tungsten lamps.

7. Flexibility; design of switching arrangements for economical use of light; lights near windows placed on same circuits so far as possible.

8. Lamps for general illumination hung high, but low enough to avoid sharp contrasts on the ceiling.

9. Lamps for general illumination enclosed in 16 in. crystal glass globes roughed on the outside.

10. Lamps for table-lighting, with prismatic reflectors designed to throw the maximum light sideways instead of downwards; frosted lamps used.

11. Lamps for lighting low bookshelves screened from view by opaque parabolic reflectors. Lamps for lighting wall bookcases, backed by opaque trough reflectors.

12. Lamps for lighting free standing bookcases and reading-tables screened from view by green plated-glass domes.

13. Lamps for lighting exhibition racks screened by reflectors with green celluloid covers.

14. Wall bracket and column bracket-lamps provided with deep enamelled glass diffusing shades of sufficient depth to hide the lamp; frosted tip lamps.

15. Cheerful appearance of room.

DISCUSSION.

Mr. N. W. Gifford asked what was considered the really adequate order of illumination for a reading-table. Was the 5 foot-candles specified in this paper exactly correct? A recent commission on school lighting in Boston had arrived at the figure 2·5 candle-foot, but there seemed much doubt if this was exact.

Mr. P. S. Millar said that the library described in this paper was the only one ever visited by him which he considered well lighted. One could read in comfort and observe the titles of books in the rack without any difficulty. He thought the paper would be exceedingly valuable for future reference.

Mr. C. O. Bond thought there was special opportunity for valuable work which had an important bearing on eyesight in schools and libraries. Unfortunately there were very few instances of really good lighting to be studied. He fully believed in the necessity for constantly presenting educational papers of this description, even though many members of the Society might not yet be educated to the standard of appreciating all the complicated principles involved.

In reply, **Mr. L. B. Marks** said that he took up the work in connexion with this library with the express desire of fulfilling the need to which Mr. Bond had referred, namely the preservation of eyesight.

As a result of six months' study in various public libraries, he came to the conclusion that 2·5 foot-candles was not really enough in cases where foreign languages and characters and any poor type had to be read. In the libraries under his supervision a reader could obtain 10 candles by placing his book in the right position, though he might get only 2·5 candle-feet by arranging his book differently.

One difficulty experienced had been to devise a method of strongly illuminating the book-shelves, which complied with the æsthetic consideration insisted on by the board of architects; eventually they had obtained the necessary 5 candle-feet by local illumination, though the architects preferred general central lighting; another equally great difficulty had been to keep all lights out of the field of view.

With regard to Mr. Gifford's point, he thought that the problem in schoolrooms was essentially different; an illumination might suffice to meet certain fixed needs in a school that would not answer in the case of a public library.

Mr. Marks dealt lastly with a query of Mr. V. R. Lansingh's as to whether the average illumination quoted was determined by calculation of the available flux of light, explaining that whatever system was adopted, the results with diffusing globes compared favourably with those obtained by the aid of open lamps and prismatic reflectors.

The Ives Colorimeter in Illuminating Engineering.

By Dr. Herbert E. Ives.

(Paper read at the Second Annual Convention of the Illuminating Engineering Society, October 5th and 6th.)

(Slightly abbreviated.)

The Ives colorimeter is a practical instrument, designed by Mr. F. E. Ives, for the measurement of all colours in terms of three primary colours.

By means of the colorimeter it is possible to describe a colour accurately in terms of the red, green, and blue components of a standard white light. For instance, in place of the indefinite term "pink," a colour may be designated as

Red, 62; green, 31; blue, 50.

white being

Red, 100; green, 100; blue, 100.

These figures mean that by mixing red, green, and blue light in the proportions given there is produced to the eye the sensation of pink.

Two colours alike to the eye measure alike in the colorimeter. In this it differs from the spectrophotometer, which gives the intensity at every point in the spectrum but only an approximate indication of how the eye will compare the colour in question with another. In the colorimeter, therefore, we have a means hitherto lacking, of comparing numerically the visual effects of such dissimilar sources of light as a gas-flame and a mercury-vacuum arc.

Although designed to measure coloured fabrics by reflected light, the colorimeter may be used to study the colours of various illuminants, and in problems connected with their use.

A brief description of the instrument will be necessary. It consists essentially of an oblong box, at one end of which are placed four slits, one clear, the three others furnished respectively with a red, a green, and a blue colour screen. By means of levers the openings of the three coloured slits may be altered to read by scales from zero to 100. Within the instrument is a wheel of lenses which, when rotated rapidly by a small motor, causes the three colours to pass across the field of vision of an eyepiece, thus mixing them by persistence of vision. The optical arrangements are such that one observes a divided field, one-half consisting of the mixture of three colours, the other the colour to be matched, as viewed through the clear slit. For ordinary use a white surface reflecting the light of the sky serves as standard white, the fabric observed being illuminated by the same light. To make a measurement, the three levers are opened until white is matched, and the scales are adjusted to read 100 for each colour (this method compensates for slight differences in colour vision of different eyes); then any colour matched by moving the three levers can be read off in terms of red, green, and blue used to match white.

For measuring coloured lights this arrangement of apparatus needed modification. Since two different sources were in use—the measured light and a comparison source—the region in front of the instrument was divided by a partition. The light studied was allowed to fall on a flat surface of magnesium oxide placed before the clear slit. On the other side was placed the comparison light, to be described shortly.

The question of a suitable standard to serve for comparison light presented certain difficulties. Average daylight is the logical standard. Daylight, however, varies greatly in character from average, and, moreover, is apt to be so changeable during even a short interval as to render it useless for a series of comparative measurements. It was, therefore, decided to use some reliable constant source, afterwards reducing the figures obtained to average daylight. A practical consideration was that the comparison light should, if possible, be intermediate in character between the extremes of colour to be measured. The light finally decided on was that of a tungsten lamp operated at 1·13 watts per mean spherical candle.

With the apparatus so arranged the light from any illuminant could be measured and compared with any other. As illustration, the readings of a gas-flame and a Nernst glower were respectively (red, green, blue) 30·7, 38·7, 19 and 44·7, 71·7, 56·3. Choosing such an absolute brightness as will bring the two sources to equality in the red the following ratio is found :—

	Red.	*Green.*	*Blue.*
Gas ÷ Nernst	1	·78	·51

Table I. gives the results of a set of measurements on twenty-one different sources of light, expressed in terms of average daylight, the latter obtained in the way to be described below.

It was at first hoped to express the results in terms of the average daylight obtained by Prof. E. L. Nichols from spectrophotometer readings, and reported in the May number of the *Transactions of the Illuminating Engineering Society ;* but this idea was abandoned, mainly because Prof. Nichols's average daylight, as nearly as could be determined, is much yellower than any daylight observed in Washington during the period of the work, and is, indeed, considerably more yellow than sunlight.

It was, therefore, thought best (as most convenient) to use as the standard the average daylight during the time the work was carried on.

The " average daylight " of the table is obtained from fifteen sets of observations made during an interval of three weeks. They fall naturally into three groups : blue sky, partly cloudy or foggy sky, and entirely overcast sky. The averages of these groups, in terms of the comparison source, were :—

	Red.	Green.	Blue.
Blue sky	7·9	25·8	100
Cloudy	9·3	27·8	100
Overcast	11·2	30·4	100
Mean	9·5	28	·100

To facilitate comparison the values for red were made equal for all of the lights.

In the table the sources are arranged roughly in the order of their approximation to daylight ; sunlight and the carbon arc are near the head of the list, the Hefner at the foot. The figures for the Moore tube were obtained indirectly from observations made in the New York Post Office by Mr. F. E. Ives, with a glow-lamp as a comparison source. The helium tube is included, because it has been suggested as a primary standard. The tungsten, Nernst, tantalum, graphitized filament and carbon glow-lamps were run at their normal specific consumption as determined by measurement of each lamp for mean spherical candle-power, current, and voltage. This was found of the utmost importance, for two reasons : first, because the colour depends on the specific consumption ; secondly, because in all but one case the manufacturers' rated voltages were far enough wrong to place the lamps in a different order from the correct one. At the conclusion of the measurement the five lights were compared directly with each other for colour, on a photometer bench, and their relative positions in the list were found to be correct.

Following the colorimeter measurements of the sources themselves, a brief study was made of colour changes under artificial light. It is known that the colour of a surface illuminated by most artificial sources differs greatly from its colour under daylight. At the same time the change in all colours is approximately the same, so that they keep their relative places fairly closely. This fact may be expressed differently by saying that the change in colour of a white surface under artificial light is a fair guide to the change in colour of a coloured surface. Exceptions to this will occur to every one ; nevertheless, unless the source of light is quite selective, or the reflective power of the surface very selective, the rule holds good.

It was thought of interest to measure with the colorimeter the change of colour of coloured surfaces, under different lights, and then to see how closely these changes followed the altered readings for a white surface under the same conditions. The results should show whether the colorimeter readings for a white surface under varied illumination give a good indication of the readings for a coloured surface whose readings are known for daylight. For this purpose a number of coloured cloths and papers were selected whose dominant hues ranged throughout the spectrum; of these, several were chosen because they showed great changes in appearance under different lights. Mounted on a disc together with a white surface they were read under daylight, the light from a tungsten lamp, a glow-lamp, a Welsbach, and a Cooper-Hewitt mercury arc.

As was to be expected, the direct readings showed great differences in colour according to the kind of illumination. A lavender silk, for instance, gave the results :—

	Red.	Green.	Blue.
In Daylight ..	3	7·2	31·8
Under Welsbach...	10·2	15·4	17·6
Under Glow Lamp	20·2	20·9	16·2
Under Mercury Arc	6·5	5·5	44·

Making the readings equal in the red to fit them better for comparison, they became :—

	Red.	Green.	Blue.
Daylight... ...	100	240	1060
Welsbach ...	100	151	173
Glow Lamp ...	100	107	80
Mercury Arc ...	100	845	676

A large portion of the enormous difference is, of course, due to the change in colour of the light; in order to take this into account the following procedure was adopted: all measurements were reduced to the basis of white=100, 100, 100; that is, all the daylight readings were multiplied as before by the factors to make the daylight readings on white 100, 100, 100, and similarly the artificial light readings were multiplied respectively by the factors necessary to make white as given by them read 100, 100, 100. This being done, it follows that if coloured objects under different light change their readings in the same proportion as does white, their readings so reduced should be the same in all cases.

TABLE I.—Colorimeter Readings on various Sources.

Source.	Red.	Green.	Blue.
Average Daylight	100	100	100
Blue Sky, mean of five sets	100	106	120
Overcast Sky, mean of four sets	100	92	85
Sunlight, 2 P.M., August 19th	100	95	68
Sunlight, afternoon observations, 2 to 5 P.M.	100	91	56
Nichols' Average Daylight (acetylene flame and A. O. Co. blue glasses 5 and 1)	100	69	42
Carbon Arc, direct current	100	64	39
Mercury Vacuum Arc (Cooper Hewitt)	100	130	190
Moore Carbon Dioxide Tube	100	120	520
Welsbach Mantle, 1¼ per cent. cerium	100	81	28
Welsbach Mantle, 2¾ per cent. cerium	100	69	14·5
(Mantle preferred by Welsbach Co. for residential illumination.)			
Welsbach Mantle, 3¼ per cent. cerium	100	63	12·3
Tungsten Lamp, 1·57 watts per mean spherical c. p.			
Tungsten Lamp, 1·25 watts per mean horizontal c. p.	100	55	12·1
Nernst Glower, bare, 118 volts, ·4 ampere	100	51·5	11·3
Acetylene Flame	100	50	10·4
Tantalum Lamp, 2·5 watts per mean spherical c. p.			
Tantalnm Lamp, 2·0 watts per mean horizontal c. p.	100	49	8·3
Graphitized Filament, 3·1 watts per mean sperical c. p.			
Graphitized Filament, 2·5 watts per mean horizontal c. p.	100	48	8·3
Glow Lamp, 3·9 watts per mean spherical c. p.			
Glow Lamp, 3·1 watts per mean horizontal c. p.	100	45	7·4
Flaming Arc	100	36·5	9
Helium Tube	100	37·0	9
Gas Flame, open fish-tail burner	100	40	5·8
Moore Nitrogen Tube	100	28	6·6
Hefner	100	35	3·8

In the following table the results are given for seven miscellaneous colours under five sources.

TABLE II.

Change of Colorimeter Readings with various Illuminants.

Figures are reduced to the basis of white reading 100, 100, 100 for each light.

	Red.	Blue.	Buff.	Pink.	Pine Wood.	Lavender.	Dull Green.
Daylight ..	37·0 5·9 7·6	11·0 15·8 35·1	82·9 65·7 48·1	77·3 48·0 61·9	45·5 30·3 16·8	36·6 32·6 44·8	35·7 33·5 26·2
Tungsten ..	41·9 6 7 6·4	8·6 12·0 36·7	83· 60·2 38·5	88·3 52·1 73·8	49·8 32·6 21·0	47·6 37·7 68·8	30 5 28·7 24·2
Welsbach ..	40·5 6·8 0	11·0 13·9 41·1	82·5 62·8 44·0	82·8 51·4 65·7	44·6 29·2 15 0	34·2 28·2 51·6	33·5 31 7 26·1
Glow	44·4 7·7 0	9·7 12·7 43·6	83·3 62·8 42·2	92·7 61·4 74·0	50·5 35·0 17 2	49·0 41·4 79·4	30 3 31·1 29·9
Mercury Arc	17·4 4·5 8·3	21·5 11·0 33·9	87·4 73·6 42·9	68·2 49·4 77·0	36 5 32·3 12·4	38·9 27·7 48·9	35·9 31·8 22·1

It will be observed that, in place of the extreme differences obtained in the direct readings, the colours readings are not greatly different under different lights. In other words, the colorimeter readings roughly follow the change of illumination, as does the eye.

From these figures the best light of the five for matching colours is that of the Welsbach, while that of the Cooper-Hewitt, an extremely selective source, exhibits wide deviations. That the latter should be the case is to be expected. The radiation from the mercury arc consists of a few bright lines in the spectrum, and the effect on a white surface may be indistinguishable to the eye from the illumination obtained from a source with a continuous spectrum. A coloured surface, having its predominant colour in a different region of the spectrum from the mercury arc will not reflect its light but will reflect the light of the similarly appearing source with the continuous spectrum. It will appear dark under one source, bright under the other. Hence in the case of a selective source the colour of a white surface is no guide, either for the eye or for the colorimeter, to the effect on a coloured surface.

The result of the work thus far done with the colorimeter, as applied to illuminating engineering, may be summarized here. By means of the colorimeter the colours of all types of sources may be described in terms of a given standard such as daylight. The figures expressing the colour of a light are a fair indication of the change in the colour of objects illuminated by it.

The question may be raised as to just what the colorimeter readings mean, for instance, in terms of the spectrophotometer, or of the primary colour sensations. Strictly speaking, all that they give are the mixing proportions of three special colour screens. Measured on the spectrophotometer these screens are found to possess transmissions which are fairly narrow and well separated, whose maxima (taking into account the sensibility of the eye) fall at red$=0{\cdot}635\mu$, green$=0{\cdot}535\mu$, blue $=0{\cdot}455\mu$, or very closely at the wave lengths Maxwell chose for his primaries. As these colour screens are probably the best available for the purpose, and as the instrument is expected to come into general use for the measurement of colour, the colorimeter readings will constitute of themselves a sufficiently definite standard for many purposes.

It is desirable, however, to be able to reduce the readings to some fundamental standard. With this object in view the writer is now engaged in finding the values of the screens in terms of the three primary colour sensations. When this has been completed it will be possible to reduce colorimeter readings directly to colour sensations, or, given the spectrophotometer readings of a colour, to obtain from colour sensation curves the colorimeter readings.

The Ives Colorimeter in Illuminating Engineering.

DISCUSSION.

Dr. Bell expressed his sense of the value of the paper; there seemed a need for a simple form of instrument, such as that of Mr. Ives, designed for the comparison of colour-values.

Mr. D. McFarlan Moore agreed that the instrument was a useful one, but took exception to the tables of colour-values presented by Mr. Ives. He contended that the carbon dioxide tube ought to stand as the illuminant most closely resembling daylight, and was superior to the arc-lamp in this respect. This result had been confirmed by many workers on vapour-tubes, including Prof. Utzinger, who plotted a spectrum-curve of the carbon dioxide tube ,and found that it resembled average daylight very closely indeed, being, however, slightly stronger in the blue. Prof. Utzinger also preferred in such comparative work to utilize not three but *four* colours, namely red, yellow, green, and blue.

Mr. Moore also criticized the method employed by Mr. Ives in his tests of the Moore tube at the New York Post Office. Continuing, Mr. Moore declared that the carbon dioxide tube was unique for the purpose of matching silks, &c., and ought, in his opinion, to be selected as a standard spectrum.

Dr. E. P. Hyde made an explanation of the exact conditions under which the tests at the New York Post Office, referred to by Mr. Moore were carried out. He thought the Ives colorimeter served excellently to indicate the appearance of a white surface illuminated by lights of different colours, and might also be applied to coloured surfaces provided the sources studied did not radiate too selectively.

Mr. Ives said that he considered the Moore carbon dioxide tube the most satisfactory artificial illuminant for the comparison of colours, but thought that it resembled the blue sky rather than diffused daylight. It was however, very much bluer than the arclight.

Dr. Bell pointed out that probably no one illuminant could be considered the best for matching the colours of all classes of goods; the goods in a tailor's shop, and at the ribbon counter demanded different kinds of light.

Mr. E. L. Elliott expressed his appreciation of Mr. Ives's paper, but thought that it was impossible for the light from the carbon dioxide tube to be bluer than that of the mercury arc, as Mr. Ives's results would suggest.

Dr. E. P. Hyde stated that actual observation of the two sources confirmed this result. Those present were all of opinion that the mercury tube appeared the greener of the two, but that the carbon dioxide tube was certainly the bluer in appearance.

Mr. J. B. Klumpp asked whether the Ives colorimeter could be applied to the study of colour blindness.

Mr. H. E. Ives said that the colorimeter was an exceptionally sensitive instrument for this purpose. He also emphasized the fact that it was impossible to compare the effects of differently coloured lights by memory. If we entered a room lighted by one illuminant and, after an interval of an hour or so, a second room illuminated in an entirely different manner, we might believe the two to be the same; but, regarded side by side, the difference would appear startling.

He thought that Mr. Moore must be mistaken in supposing that four colours instead of three could be used for mixture. An observer using a spectrophotometer might examine four positions in the spectrum; but the Ives colorimeter actually mixed, in suitable proportion, the three primary colours.

Mr. Ives confirmed the statement of previous speakers that the Moore tube is bluer than the mercury arc. He also stated that in his experiments he had followed Dr. Nichols's attempt to express results, not in terms of light from the clear or diffused sky, but in *average daylight*.

Street Lighting with Gas in Europe.

By E. W. Wrightington.

(Abstract of Paper read at the Second Annual Convention of the Illuminating Engineering Society, Oct. 5-6th, 1908.)

Gas is used in Continental European cities in many forms. Low pressure upright lamps, such as are familiar in America are mainly used for side streets. High pressure gas is coming into extended use for main thoroughfares; the inverted lamp, however, is now replacing the upright type.

High pressure upright lamps are mainly employed where large units for special lighting are wanted; low pressure lamps are placed nearer together than in the United States, giving rise to a satisfactory distribution of light.

The efficiency of the upright lamp is exceeded by that of the newer inverted lamps. This can be explained: *firstly* because the proportion of light below the horizontal, where it is needed in the streets, is greater in the case of the inverted burner, and *secondly* because the use of inverted burners facilitates the use of suitable reflectors.

The number of mantles used is less than in the case of the upright lamps. The inverted lamp lends itself specially well to artistic treatment; an effective arrangement is secured by double-arm posts, staggered on each side of the street at intervals of 100 feet or so.

The author considers the most striking feature of the street lighting in Europe to be the use of high pressure inverted gas lamps, in very large units, up to 3600 mean lower hemispherical candle-power. The posts are placed near together, and the streets are almost as bright as if lighted by daylight. Yet the light is not glaring, even when the lamps are hung rather low, but beautifully diffused, the effect being very soft and pleasing.

From one to three mantles of large size are used for each lighting unit. These mantles are attached to the lamp non-collodionized. A by-pass is used, and the pressure, which amounts to about 60 inches, opens the valve, and the lamp is ignited. The mantles shrink to the proper size, and form naturally on the burner. At midnight one or more of the burners of each lamp may be extinguished

The author remarks on one important difference between the conditions in Europe and in the States. Wherever, in America, there is a traffic at night which would require such a great quantity of light as exists over here, very little outside illumination is needed. The streets in America are lighted by private citizens by means of window lamps and signs. For example, along Broadway, in New York, the so-called street lamps are hardly necessary, and the light which they give is almost entirely overshadowed by the private lighting around them. Wherever there is traffic, there are window lamps and signs; or putting it the other way, the signs and window lamps attract the traffic.

In continental cities, on the other hand, it is the rarest thing to find any windows lighted after dusk. The shutters are pulled down tight, and the lighting of the streets is dependent entirely upon the street lamps. Yet at the same time, a very great amount of light is needed, as the traffic both on foot and on wheels is very heavy. For this reason where lamps of 3600 candle-power, 100 feet apart, may be necessary in Europe, it is probable that such a very large amount of light would not be needed except for special lighting in the United States.

It is reasonable, however, to expect that small units, both under high pressure and low pressure, adjusted to suit local conditions, may be used in the United States. Inverted lamps giving on low pressure an output of from 30 to 40 candle-power per cubic foot of gas consumed per hour, and on high pressure from 50 to 60 candle-power, might well be installed at intervals, and should give a satisfactory illumination at a reasonable cost.

Modern Gas Lighting Conveniences.

By T. J. Litle, Jun.

(Abstract of Paper read at the Second Annual Convention of the Illuminating Engineering Society, Philadelphia, Oct. 5–6th, 1908.)

Modern incandescent gas lamps have reached such a high state of perfection and efficiency that it is well to direct attention to the various inventions and improvements that have been made for their ignition and control. These devices have naturally greatly popularized the gas system of lighting in the last few years, as it is generally conceded that when the proper methods are employed, illumination by gas is beyond criticism due to the remarkably perfect combustion in the modern burner, resulting in a greatly increased lighting efficiency, thus requiring fewer units than heretofore; moreover their more satisfactory colour value must not be overlooked.

The modern ignition of gas burners may be accomplished in various ways, but it may be divided broadly into two general classes; namely, electric and pilot flame.

The electric spark ignition may again be divided into two classes, the jump spark (high-tension) ignition, and the interrupted-circuit low-tension (make and-break) ignition. They may be further divided into other classes, differing somewhat in mechanical detail, but the following remarks will be confined to those above stated.

JUMP SPARK ELECTRIC IGNITERS.

The jump-spark igniting system is used where a large number of burners are to be ignited simultaneously, such as in shop windows, store interiors, churches, public halls, factories, &c. In this case use is made of an induction coil of such a size as to produce a spark of sufficiently high potential to jump the distance equal to the sum of the air gaps in the circuit. On account of its high potential, great care must be exercised to prevent leakage in the secondary circuit. To obtain good results not less than six standard dry cells should be used in the primary circuit. The push buttons may be located at any convenient points. For greater convenience, however, the whole electric outfit may be placed in a cabinet that is completely wired, and all that is necessary on installation is to run the secondary leads from the cabinet to the burners. Such a cabinet is illustrated in Fig. 1. The hundreds of inverted lamps which are used there are centrally controlled by grouping the gas pipe circuits, as well as the secondary circuit of the jump-spark ignition system.

In addition it may be mentioned that with this system any number of lamps may be ignited by a division of the secondary circuit; that is, if the rating

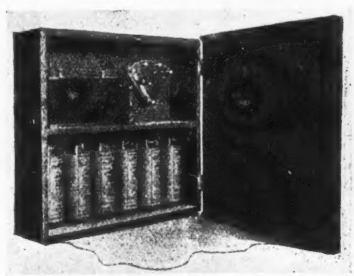


Fig. 1.–Cabinet containing Jump Spark Lighting Equipment.

of the coil is 20 burners, all that is necessary is to divide the lamps into groups of 20. The wire used in the secondary circuit may be very fine; phosphor bronze of No. 30 gauge, on account of its great tensile strength, has been very successfully used. This wire may be suspended from burner to burner, being practically invisible. In this case use is made of the secondary distribution switch shown in the upper right hand portion of the cabinet. The gas is usually controlled mechanically, either by providing a gas cock adjacent to the spark cabinet, or if the cabinet happens to be at an inaccessible point, the cock may be operated from a distance by a mechanical pull device. The latter system has been used quite extensively where the existing gas piping was not conveniently arranged for the placing of the shut-off cock.

AUTOMATIC ELECTRIC IGNITER.

The automatic electric igniter for an upright burner is shown in Fig. 2. With this attachment it is possible to place push buttons at any distance from the burner for igniting and extinguishing. The small magnets in the cylindrical shell open and close the gas cock, and the vibrating make-and-break produces the igniting spark. The ignition of the burner in this case is accomplished indirectly by a climbing flash-pilot, which remains flashing only so long as the ignition button is pressed.

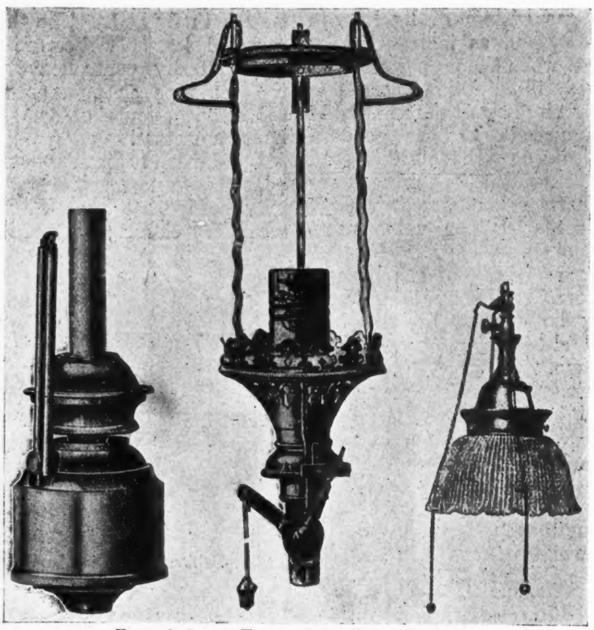
PENDANT ELECTRIC IGNITERS.

The pendant, or pull type of igniter, is operated at the burner; it consists of simply a gas cock to which is attached a pulling lever and an arm carrying a wiping sparker, which ignites a flashing pilot. In this case pulling down on the lever turns on and ignites the gas, while pushing up the lever closes the cock. See Fig. 3.

The above two igniters are designed principally for residence use.

PILOT IGNITION.

The pilot system of igniting gas burners on account of its simplicity, is probably the most widely used of all. See Fig. 4. In this case a very small jet of gas is maintained at the end of a small pilot tube adjacent to the mantle. The gas cock is operated by means of chains. This system is generally adapted for residence lighting. The pilot flame is so situated as to be well protected from ordinary drafts, and the consumption of gas is so slight ($\frac{1}{12}$ cubic feet per hour) as to be practically negligible. This system has been utilized very successfully on gas "arc" lamps, a sectional view of one of which is shown in Fig. 5.



FIGS. 2, 3, 4.—Types of Gas Lamp Igniters.

MULTIPLE PILOT IGNITION.

Under this heading may be mentioned the application of pilot ignition for a large number of burners, as shown in Fig. 6. In this system the pilots for igniting the burners are supplide with gas from an independent feed line, and in igniting it is necessary merely to turn the gas on to the main supply pipe feeding the burners ; when the gas reaches the mantles it is ignited by the pilots.

AUTOMATIC CLOCK CUT OFF.

In conjunction with both of the above systems, the automatic clock cut off is adapted to show-window and other forms of lighting where it is desired to extinguish the light automatically at any predetermined time. In this case the main shut-off cock supplying gas to the burners is provided with a weighted lever which is held in its open position by means of a chain attached to a catch in the rear of the clock, and when the clock train starts in motion this chain is removed from its supporting hook and the gas cock closes. This operation may be reversed so that the lamps may be ignited at any predetermined time.

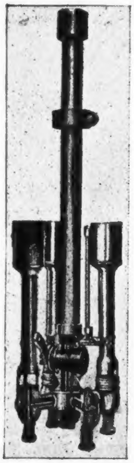


FIG. 5.—Section of Gas " Arc " Lamps.

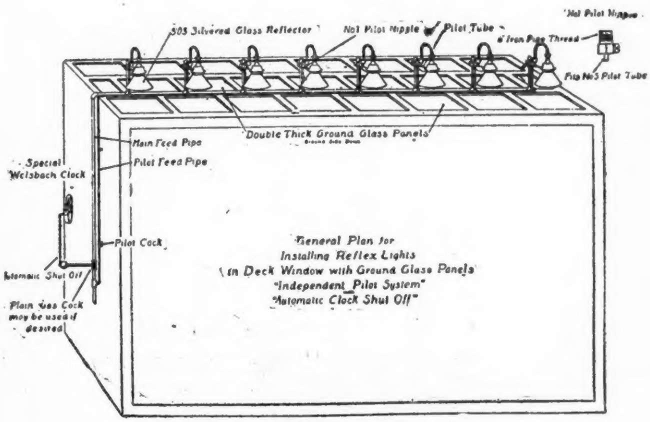


FIG. 6.—Independent Pilot System of Ignition.

PILOT IGNITION FOR CLUSTERS.

The latest application of the multiple pilot system of ignition is shown in Fig. 7. In this case several inverted burners are supplied with gas for pilots from a point immediately above the shut-off cock, which is concealed within the shell of the fixture, as shown in Fig. 8. The gas is ignited by pulling the white ring, which depends from the fixture. This arrangement is decidedly convenient for the shop-keeper.

PNEUMATIC PILOT IGNITION OF CLUSTERS.

In this case the lamps are ignited in very much the same manner as in the case above mentioned, but the gas is controlled by a pneumatic cock, as shown in Fig. 9. A small copper tube runs from the chandelier to the operat-

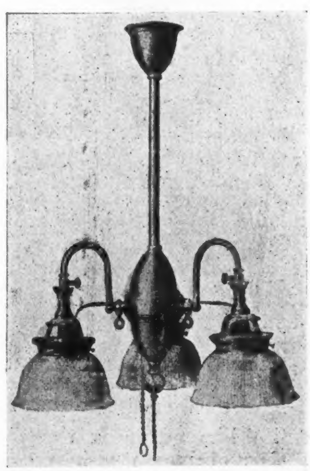
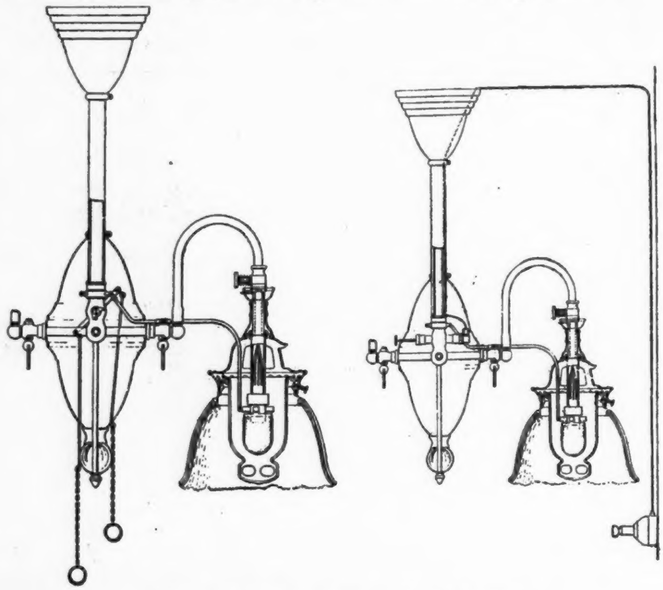


FIG. 7.—Gas Lamp Cluster.

ing push button, which is in reality a small plunger pump. On pushing the plunger inwardly, air compressed along



FIGS. 8 and 9.—Gas Lamp Ignition Schemes.

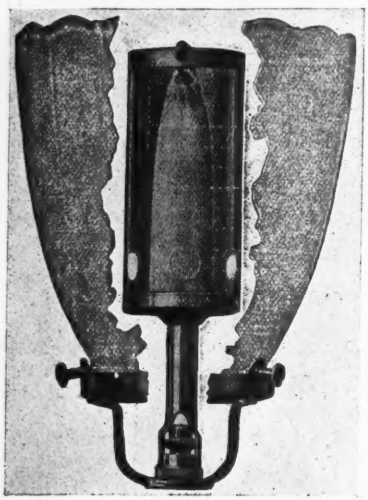


FIG. 10.—Miniature Gas Lamp.

the entire line advances the piston valve, thus opening it; in order to extinguish, the plunger is pulled outwardly, thereby creating a partial vacuum and the piston valve is moved into the closed position. In addition to being able to ignite and extinguish the gas from a distance, it is also possible to do so at the fixture, as the plunger is equipped with an extension terminated by a push button which projects through the shell, and this may be operated by hand. The pneumatic lighter is also applied very successfully to single burners—both upright and inverted.

MINIATURE GAS UNIT.

Under the heading of convenience may be mentioned the mantle arranged within a small mica chimney. It is provided in this form as a unit, which enables the consumer at one application to renew the mantle and obtain a new mica chimney. This result is rendered possible on account of the small size and consequent cheapness, just as is the case with the carbon filament lamp. These units consume less than 2 cubic feet of gas her hour—to be exact, 1·69 cubic feet, under 2 inches of gas pressure. The widespread application of this small unit can be readily appreciated when it is shown that the output is actually 51 candle-power with the above named consumption. It is admirably adapted to residence lighting where small units are desirable.

It may be used in place of the lava-tip burner without affecting the symmetry of the fixture. Standard electric glassware may also be used with it, as shown in Fig. 10; on this account is well adapted for combination gas and electric fixtures. The chain pull by-pass, with side pilot, may be applied to this unit.

MISCELLANEOUS.

So far the remarks have been confined to the various igniting schemes for incandescent gas burners; a great many ingenious devices have also been employed in connexion with gas "arc" lamps for outdoor use, such as in railroad stations and railway yards. In this case the "arc" lamp is attached to a mast-arm device, the operation of trimming the lamps being as shown in the cut. Another convenient application employed with the outdoor lamp is illustrated in Fig. 11, where the globe has been lowered on to the hook below the lamp and the operation of replacing a mantle is shown. The remaining mantles are protected from the wind by the cylindrical shell which automatically follows the globe on its removal.

Flexible metallic gas tubing has been very generally adapted for use in connexion with inverted burners. This tubing is made by spirally winding a corrugated metallic ribbon, with asbestos cord intervening, to make the joint gas-tight the corrugations serving not only to retain the asbestos cord but at the same time locking together the convolutions. In machine shop practice these tubes are suspended either from an overhead stationary gas pipe or from an inverted swing gas bracket. The latter makes it possible to shift the lamp over a considerable area.

FIG. 11.—Gas "Arc" Lamp with Globe.

DISCUSSION.

Dr. L. Bell, the President, opened the discussion, remarking incidentally that, according to his experience, most electric methods of ignition for domestic purposes were very apt to get out of order.

Dr. Clayton H. Sharp said that the problem of electrical ignition resolved itself largely into a question of insulation, which, in the case of the older systems, was often inadequate. Dr. Sharp also referred to the possibility of danger arising from the extinguishing of the pilot-flames by draughts of airs, &c., especially when water-gas is used.

Mr. F. N. Morton asked whether the self-lighting mantle was still being investigated, and whether the pyrophoric alloy-lighters were likely to be successfully developed.

Mr. V. R. Lansingh asked if pilot-lights on a multiple burner could be arranged so that only one single light of a group could be burnt, instead of a cluster.

Mr. H. Calvert inquired how many burners could be operated from a pneumatic system at once, and at how great a distance.

Mr. W. Forstall mentioned a case in his experience in which a pilot-flame was accidentally extinguished and the gas escaped for 48 hours; yet on his return there was only a very faint trace of the odour of gas.

Mr. F. Beck estimated the distance at which a single light could be turned on and off by the ordinary pneumatic arrangement at 20 yards for a single light. This distance was somewhat reduced for a series of lights. Among advantages of the system he claimed simplicity and greater safety. Electric lighters required to be installed and supervised by an expert. Pneumatic arrangements could also be contrived to turn on a series of lights on a chandalier either all at once or one at a time. In cases in which lights were to be ignited simultaneously electric ignition had the advantage that it could be operated at a greater distance.

Mr. C. W. Hare wanted to hear further experience of the pneumatic system in practical working.

Mr. L. D. Gibbs thought that troubles with electrical ignition very often arose from a system of wiring being adopted that was utterly incapable of doing what was expected. For instance, he knew of houses in which ordinary bell-wire had been employed.

Mr. N. W. Gifford knew of many cases in which electric ignition was used without complaint.

Dr. L. Bell, in closing the discussion, said he could confirm the suggestion that the average electric igniting failed through faulty insulation, a simple cotton-covered wire being often considered sufficient. Dr. Bell also inquired as to the practical working of the iron-cerium light recently developed by Dr. v. Welsbach.

In reply, **Mr. T. J. Litle** agreed that in the case of the "jump-spark" system, where a P.D. of several thousand volts was developed, a very perfect system of insulation was required. In cheap systems poor insulation was sometimes the cause of failure, and in many of the older installations the wires were simply embedded in plaster, which eventually caused the insulating covering to rot.

Many of the early burners were also badly arranged. In cases in which a "wipe-contact" was used the contacts sometimes stuck, thus permanently short-circuiting the battery. Nowadays this possibility was eliminated. Naturally, however, the batteries wanted occasional and proper attention.

Mr. Litle thought that the results of an escape of gas owing to the pilot-flame being accidentally extinguished were insignificant, because the gas used was so small, and the natural ventilation of the room changed its contents quicker than the gas was evolved. Explosion from this source was impossible, for the correct proportions to cause this result could never be attained in an ordinary well-ventilated room.

Unfortunately the self-lighting mantle had not yet been developed to a commercial stage. At present pyrophoric mantles might answer excellently for a few months, but apparently this quality was gradually destroyed by the action of heat.

The pyrophoric alloy of iron and cerium was as yet only in the experimental stage. In appearance the alloy briquettes resembled cast iron, but yielded a stream of sparks when scratched with a file. It was hoped that this would prove a successful type of gas-lighter, and would be used both for kindling gas-lights and in the cylinders of gas engines.

With regard to Mr. Lansingh's inquiry, pilots were all regulated separately: by the removal of the little pilot-adjusting screws all but a single burner could be put out of action.

Mr. Litle also referred to an improved form of pump with a cork piston, reinforced with a metallic washer on either side, for use with a pneumatic arrangement; the life of such a piston is longer than of the older leather-disc types.

The Integrating Sphere in Industrial Photometry.

By Clayton H. Sharp and Preston S. Millar.

(Abstract of Paper read at the Second Annual Convention of the Illuminating Engineering Society, Philadelphia, Oct. 5–6th, 1908.)

The authors commence their paper by making a brief reference to the various types of integrating photometrical devices that have been devised, including the lumen-meters of Blondel and Kenelly, and the integrating photometer of Matthews.

Their object in the present paper is to discuss the merits of the Ulbricht globe, and they preface an account of their experiments by a general treatment of the theory of the instrument. As readers of *The Illuminating Engineer* have had an opportunity of becoming acquainted with this in the recent contributions of Dr. L. Bloch and others, (*Illuminating Engineer*, April and July, 1908), we will proceed at once to deal with the latter section of this paper.

During the past two years experiments have been made with integrating spheres at the Electrical Testing Laboratories in New York with uniformly favourable results. Four different sizes of spheres have been used. Three, respectively 11 in., 18 in., and 30 in. in diameter, have been used with incandescent lamps (Figs. 1 and 2). One, approximately 80 in. in diameter (see Fig 1), has been provided for tests of arc lamps and large incandescent lamps, gas lamps, &c.

Description of Sphere.

The 18 in. sphere, illustrated in Fig. 1, is typical of the smaller spheres It is provided with a hinged door, A, through which the test-lamp is inserted. B is a shaft on the lower end of which a screw thread socket is fixed. As shown in the cut, this shaft and socket may be turned by pulling a cord which passes over the shaft pulley. To mount an incandescent lamp in the sphere, it is necessary merely to thrust the lamp base into the socket and rotate the latter by means of the cord until the lamp is screwed home. A reversal of this procedure unscrews the lamp. C is a small window fitted with translucent glass having the property of substantially uniform transmission of light of all wave-lengths throughout the visible spectrum. The brightness of this translucent glass, as viewed through the photometer from D is proportional to the total light flux of the source in the sphere.

Between the light source and the translucent glass window is placed a screen of the same kind of translucent glass with which the window is equipped This screen is reduced to the smallest possible dimensions, the only requirement being that all parts of the light-source shall be obscured from the translucent glass window.

The interior of the sphere is provided with a white diffusing coating, in the selection of which the following necessary features have been considered :—

Nearest approach to perfect diffusion.

Absence of selective absorption.

Permanency of surface.

All exposed interior parts of the sphere, such as lamp mountings, &c., are covered with the same coating.

The large sphere illustrated in Fig. 3 is composed of hemispheres separated along a vertical plane, and mounted upon flanged wheels running on rails, so that the hemispheres may be separated readily. The door A is provided in order to give access to a standard lamp socket F. The translucent glass window C is shown in Fig. 3, while the photometer attached to it is shown in Fig. 2. The light from the standard lamp F is obstructed in the direction of the window C by a translucent screen. The light-source to be tested may be located in any part of the sphere. The apparatus in this case is designed particularly for use with arc-lamps which are inserted through an aperture in the top of the sphere, or by separating the hemispheres. Other illuminants may, if desired, be inserted through an aperture in the bottom of the sphere (not shown in illustration). In all cases, however, the translucent screen H must be so located as to screen the light source under test from the window C. In other respects, the large sphere is constructed along lines similar to those of the small spheres.

SOME DIFFICULTIES ENCOUNTERED IN THE USE OF THE SPHERE.

A light-source having a large surface absorbs a certain percentage of the total light flux in a sphere. Thus the frosting on a lamp bulb in a small sphere, and an opal arc-lamp globe in a large sphere, may absorb enough light to reduce the illumination upon the translucent glass window materially. To obviate this difficulty, the larger spheres are standardized by an incandescent electric lamp standard, after the lamp to be tested has been placed in the position which it will occupy duriog the test. By this means the absorption by the test lamp is compensated for.

In the smaller sphere, the best means of overcoming the difficulty of light absorption is to use standard lamps of the same character as those to be tested, relying upon the substitution method implicitly.

Examples of the errors encountered in this connexion are as follows :—

Absorption of light by 12 in. opal globe in 80 in. sphere ..	3%
Absorption of light by enclosed arc-lamp in 80 in. sphere ..	5%
Absorption of light by discoloured bulb, 16 c.-p. lamp in 11 in. sphere	1%

As has been pointed out above, the screen between the lamp and the translucent window is the chief source of error in the sphere ; hence, it is to this feature of construction and arrangement that the experimental study of the authors has been chiefly directed. As a convenient means of testing the screening arrangement, use has been made of an incandescent lamp with very dis-symetrical light distribution produced by painting one side of the bulb black.

Tests of small spheres with a lamp of distorted light distribution, as described above, have shown that when an opaque screen is used and the un-

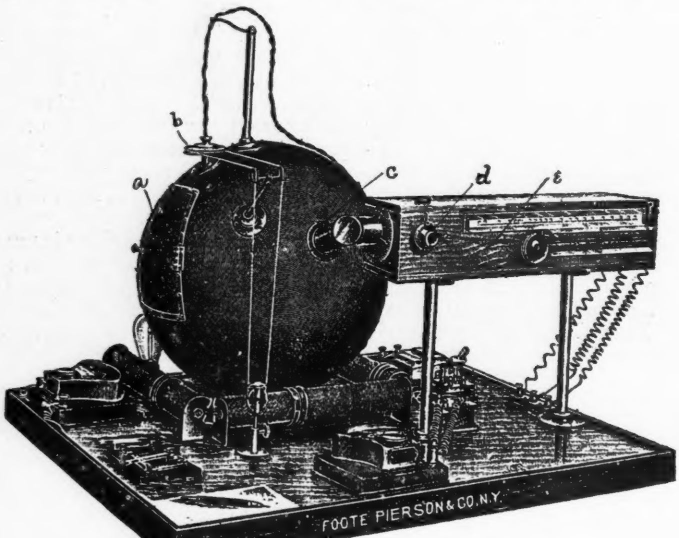


FIG. 1.—Eighteen-inch Integrating Sphere Equipped with Photometer.

obstructed light from the lamp falls upon that portion of the interior surface of the sphere which is opposite the window, the latter is brighter than when the same area of the sphere is covered by the shadow due to the opacity of the side of the lamp bulb which is painted black. This result indicates that the illumination of the window is influenced too little by the light which falls upon the opaque screen. Examples showing the extent of this effect appear in the following :—

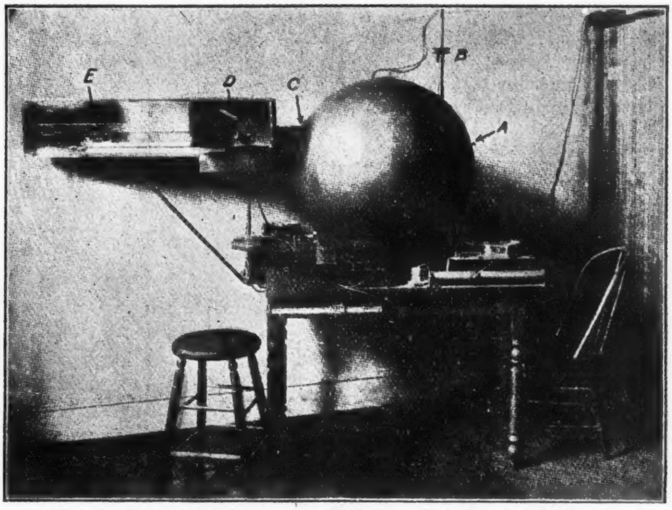


FIG. 2.—Thirty-inch Integrating Sphere Equipped with Photometer.

DECREASE IN WINDOW ILLUMINATION WHEN SHADOW FROM LAMP BULB FALLS UPON SIDE OF SPHERE OPPOSITE WINDOW.

Diameter of sphere Inches.	Per cent decreased window illumination.
18	11
30	6
80	negligible.

The screen must be of sufficient size to screen effectually all parts of the light-source from the window. Since it is desirable to use always one and the same screen, it is necessary to employ a screen approaching in size the largest light-source to be tested, the particular size varying with the location of the screen in the sphere. Under these circumstances, it has been found that when an opaque screen is used, the accuracy of results is dependent upon the size of the light-source tested. So, for example, in the 80 in. sphere the following differences have been found between results obtained with an opaque screen of the size which it is desirable to use, and those obtained with the smallest opaque screen which could be used in connexion with the particular light-source investigated.

Lamp.	Per cent difference between determinations with large and small opaque screens.
100 c.p. carbon filament	2
32 c.p. carbon filament	3
16 c.p. carbon filament	4
8 c.p. carbon filament	5
4 c.p. carbon filament (sign lamp)	10
2 c.p. carbon filament (sign lamp)	10

These data indicate that if an opaque screen were used an arc-lamp with an opal globe would receive an undue advantage in comparison with the same lamp equipped with a clear glass globe.

Errors due both to opacity of the screen and to variations in the relation between its size and that of the light-source may be eliminated by substituting for the opaque screen one of a particular translucency. The correct translucency must be arrived at empirically. It varies with sphere-diameter and with the screen-location. When a screen of correct translucency is obtained, a lamp with distorted light-distribution, as described above, will illuminate the window uniformly, irrespective of its orientation, and correct testing of lamps of different sizes may be made.

PRACTICAL OPERATION OF THE SPHERE.

In using the integrating sphere, entire reliance must be placed in the "substitution" method of photometry. If the "substitution" method could be followed implicitly, the dimensions, screening, &c., could be varied with impunity. Correct design becomes most important as lamps which are to be tested vary in type, size, and distribution characteristics. Substantially correct results could probably be obtained from an inaccurate sphere if standard lamps, whose total light-flux had been determined by other approved methods, were available in sizes and types similar to those which were to be submitted to test. As, however, it is not practicable to keep available a large supply of standardized lamps of various sizes and types, correct design is imperative.

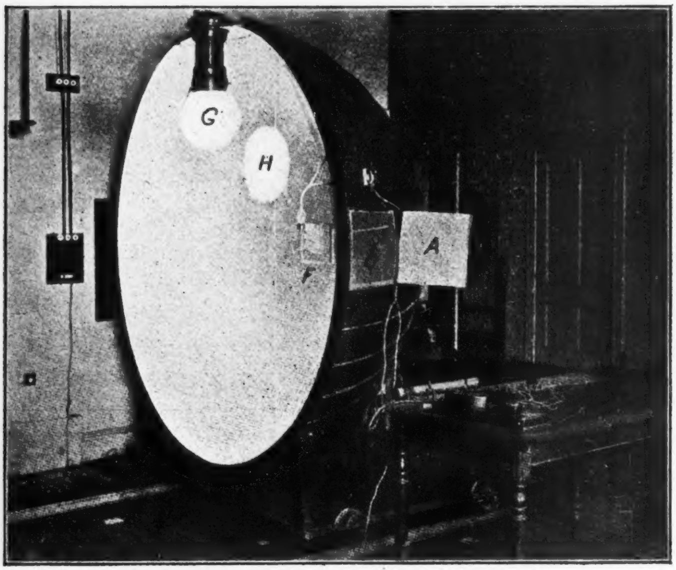


FIG. 3.—Interior of Eighty-inch Integrating Sphere.

Fortunately the result is attainable with much less difficulty than that experienced with almost any other photometric appliance. In even the smallest spheres with which the authors have had experience, after a proper screen had been found, little difficulty has been encountered in determining the mean spherical candle-power or total light-flux of any of the varied shapes of filaments encountered when the sphere had been standardized by a lamp of any particular filament shape; that is to say, even in a sphere so small as 11 in. in diameter, when correctly designed, the brightness of the window has been found to be independent of such differences in light-distribution as are met with in practice. If, however, it is desired to test frosted lamps in one of the smaller spheres, then standard frosted lamps must be provided. If it is desired to test lamps having discoloured bulbs, standardized lamps in like condition must be used. If this is not done a slight error may be encountered. This error becomes negligible in spheres 18 in. in diameter and larger.

ADVANTAGES OF THE SPHERE.

In practice the integrating sphere has been found to be a very practical device, possessing the following advantageous features :—

Simplicity of construction.—The parts are few and easily built. There is an entire freedom from the complication which has been the blight of other integrating photometers.

No adjustment of parts necessary.—A sphere, when correctly designed, needs no adjustment. The only thing likely to change is the character of the interior surface, the coating of which may have to be renewed from time to time. The only attention required is occasional cleaning to prevent dust from destroying the surface for photometric purposes.

Absence of flicker due to rotation of lamp.—This fact means higher precision and higher speed in photometric settings.

Greater facility in arc-lamp tests.—Since the total flux of light is utilized in the integration, all effects due to the wandering of the arc are minimized.

Elimination of breakage due to rotation of lamp.—A very important item, as those who have conducted tests upon metallic filament lamps can attest.

May be used in a light room where necessary.—This fact renders the use of the sphere practicable where other photometers could not be employed because suitable dark rooms are not to be had.

Higher accuracy than other integrating photometers.—A number of causes contribute to this greater accuracy. It is superior to photometers of the Matthews type, in that it gives a true integration of the light rather than a summation. All values of the luminous intensity of the lamp are taken account of, while in the Matthews type some important values may be omitted altogether and have no influence on the result. An example of this advantage has been seen in tests of magnetite arc-lamps.

The need for a practical apparatus for the determination of total light-flux has been emphasized of late years by the advent of many and varied forms of illuminants and by the impetus given to the study of light-sources and illumination as a result of the movement which culminated in the formation of the Illuminating Engineering Society. The comparison of different light-sources which has become most necessary and desirable in late years can be made with the closest approach to fairness, principally through a consideration of the total light-flux in terms of which best statements of lamp efficiencies can be made. The study of illuminating efficiencies is best facilitated through consideration of the light-flux. This involves a statement of the total light-flux of sources. Thus the study of both the production and the utilization of light is creating a demand for a simple means of determining light-flux. This means appears to be available in the integrating sphere.

DISCUSSION.

Mr. F. E. Cady asked if any investigations had been made as to the effect of dust on the interior of the globe.

Mr. H. Thurston Owens asked if the photometer had been used for gas-lamps.

Mr. A. A. Wohlauer inquired whether the theory of the globe could be applied to the predetermination of illumination due to walls and ceilings.

Dr. Clayton Sharp, in reply, said that dust ought not to be allowed to accumulate; however, if the substitution method is employed the properties of the globe as a whole ought not to be seriously prejudiced.

With a large sphere—having a detachable cover and an aperture at the bottom to promote the free circulation of air in the globe—gas-lamps would be tested in a satisfactory manner.

With regard to Mr. Wohlauer's query, he did not think the constant of the sphere could apply in the same way as those calculated by Mr. Lansingh and others for the illumination of a room, with reflecting walls and ceiling, the constants in this latter case being obtained in an entirely different way.

The Calculation of Illumination by the Flux of Light Method.

By J. R. Cravath and V. R. Lansingh.

(Abstract of Paper presented at the Second Annual Convention of the Illuminating Engineering Society, Philadelphia, October 5-6th, 1908.)

This paper presents certain methods employed by the authors in calculating the illumination of large interiors, and is intended to show the practical application of the suggestions made by Dr. Clayton H. Sharp in his Presidential Address before the First Annual Convention of the Illuminating Engineering Society at Boston, July 30th, 1907.

In this paper no attempt is made to describe in detail the methods of calculating illumination which were common previous to the time Dr. Sharp delivered his address, and which are now generally used. The most common method where accurate calculations were made was to plot a rectangular curve of illumination with the polar photometric curve of a single lamp as a basis. If there were a number of sources of light in a room the distance of each from any given point was determined, preferably, by a drawing made to scale. By adding together the illumination obtained from the various sources the total illumination on any one point could be found. The principal drawback of this method is the amount of labour involved. Moreover, to approximate to the true average illumination on a working plane, one must select a sufficient number of points equally spaced over the entire plane. The illumination must be calculated or measured for all these, but a true result is only reached by considering *both* the intensity at each point and the extent of the area over which it is distributed.

The suggestion advanced by Dr. Sharp was to the effect that the total amount of flux of light given out from the lamps should be calculated in lumens to determine the amount of light available, and that the average intensity of illumination in foot-candles on the working plane it is desired to illuminate be determined from the number of lumens falling on that plane.

The number of lumens given out by a lamp is the mean spherical candle-power multiplied by 12·57. In illuminating engineering calculations one is concerned principally with the flux of light, or, in other words, with the number of these lumens which fall upon a certain plane commonly referred to as the working plane. For example, in a large store, the working plane would be considered as being even with the tops of the counters, or about 42 in. from the floor. In a large general office room it would be the plane of the desk-tops, about 30 in. from the floor.

The lumen being that flux of light which will produce an average illumination of 1 foot-candle over a surface of 1 ft. square, it easily follows that if the total number of lumens emanating in the direction of the working plane and the number of square feet in the plane are known, we can easily arrive at the average foot-candle intensity by dividing the total number of lumens by the square feet in the room or plane. Thus, if there are 300 lumens falling on a plane of 100 sq. ft. area, there is an average intensity of 3 foot-candles over that plane.

To make practical application of these principles in the calculation of illumination it is necessary to determine with approximate accuracy the number of lumens given out from the lamps in the direction of the plane to be illuminated. When this is determined it is then necessary only to add together the number of lumens directed toward the working plane by all of the lamps in a room, and to divide this total by the number of square feet in the room to get the average foot-candles on the working plane, This method, of course, takes no account of the lumens directed toward the ceiling and walls, a part of which ultimately reach the working plane by reflection. This element of uncertainty, however, is the same as that which accompanies other methods of calculation heretofore used. Of course, in the majority of cases a certain proportion of the total number of lumens given out by the lamps is needed to illuminate ceilings and walls. Except where opaque reflectors are used, this portion of the problem can usually be neglected, because the ordinary opal, prismatic, and sand-blasted reflectors let through enough of the total lumens given out by a lamp to take care of ceiling and wall illumination.

This method further takes no account of the variations between maximum and minimum illumination which may exist in different parts of a room; and, in a large low room with a very few large sources of light, this method would not be of much value. Fortunately the number of rooms lighted in this way is on the decrease.

It is well to describe rapid methods for determining the number of lumens given out in different zones about a lamp. Assuming that the distribution of light about each lamp is practically symmetrical with reference to the axis of the lamp, and that the lamps are to be placed with axes vertical (these being the conditions now commonly prevailing with high candle-power incandescent lamps, Nernst lamps, and arc-lamps), it is very easy to determine the number of lumens given out within a certain number of degrees from the

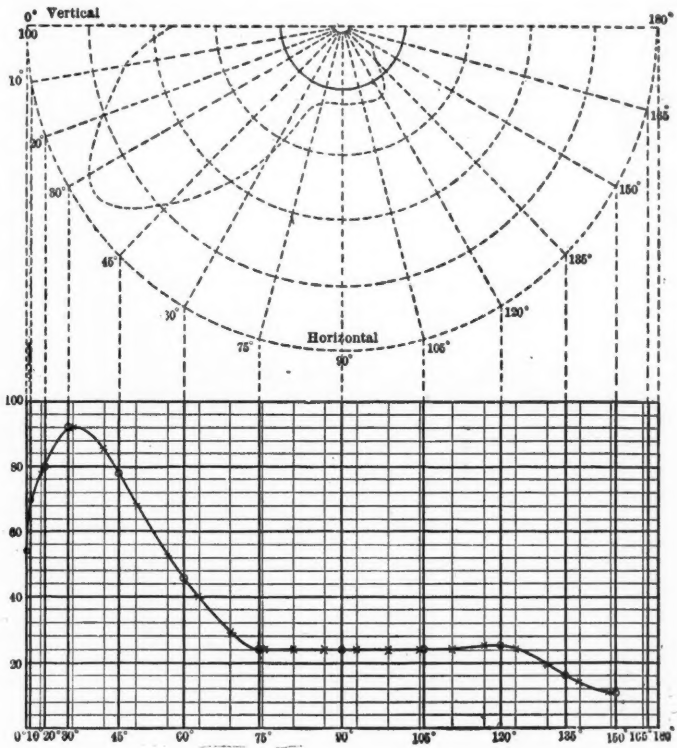


FIG. 1.—Rousseau Diagram for Gem Lamp with Bowl Reflector.

lamp axis or perpendicular. One of the quick ways to determine the lumens is to plot a Rousseau diagram.

The method of preparing Rousseau diagram paper is indicated by Fig. 1, in which the full lines represent the preferable Rousseau diagram ruling, and the dotted lines indicate the method by which the ruling is obtained. Rousseau diagram paper already ruled is now easily obtainable. In Fig. 2 is shown a Rousseau curve plotted for a Gem lamp of 50 mean horizontal candle-power in a prismatic bowl reflector. The polar co-ordinate candle-power curve, commonly known as the photometric curve of the same lighting unit, is also shown. The area of this curve shown in Fig. 1, the ruling is such that there are twenty equal divisions of the diagram as measured horizontally. As the average height of the curve represents candle-power, the horizontal distance instead of 20 should be 12·57, if the area is to represent lumens. The constant by which the sum of the candle-power readings must be multiplied in order to get the lumens in this case is, therefore,

$$\frac{12 \cdot 57}{20} \text{ or } 0 \cdot 62.$$

The author next proceeds to describe a further short cut which obviates the necessity of plotting a Rousseau curve, by the aid of a set of flux polar diagrams

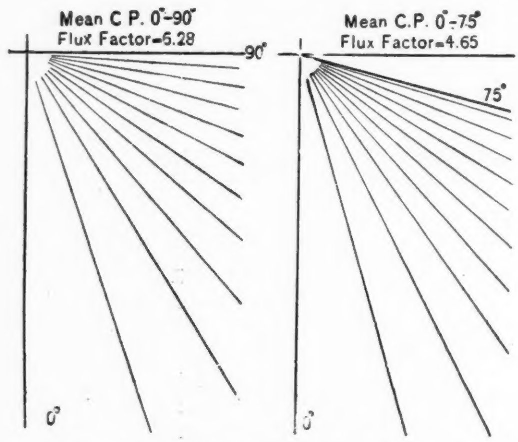


FIG. 2.—Flux Polar Diagrams 90 and 75 degrees.

Rousseau diagram between any two vertical lines representing degrees corresponds to the total flux of light in lumens given out in the zone bounded by those degrees. For example, the area enclosed by the curve between zero and 90 degrees (90 degrees being horizontal) represents graphically the number of lumens given out in the lower hemisphere; while the area enclosed by the whole curve from zero to 180 degrees represents the total number of lumens given out. To determine the number of lumens from the Rousseau diagram it is necessary only to ascertain the area enclosed by the curve expressed in proper terms. In the Rousseau with radial lines corresponding to the positions of the equally-spaced lines on the Rousseau diagram. Such a flux polar diagram for an angle of 90 degrees is shown in Fig. 2. If this diagram is made on transparent celluloid or tracing cloth, it can be laid over the ordinary polar-photometric curve with the zero line at the vertical and the 90-degree line at the horizontal. By noting and averaging the candle-power of the photometric curve at the ten points where the radial lines (not including the zero and 90-degree lines) cross the photometric curve, the mean hemispherical candle-power is obtained. As there are ten readings to be averaged, it is only necessary to add the readings and transfer the decimal point one figure to the left to obtain the average. This mean value of hemispherical candle-power multiplied by the flux factor 6·28 for the 90-degree zone, gives the total number of lumens in the lower hemisphere. Similar polar flux diagrams can be prepared for other zones. With a set of these flux polar diagrams, the illuminating engineer is in a position very quickly to find the lumens from any symmetrical photometric curve within any of the zones which are of practical use to him.

the other hand, in a very large room with few obstructions and light coloured walls, the light which emanates from the source at a considerable angle from the vertical ultimately falls on the working plane and becomes useful. The area illuminated by each lamp is very large in such a case, and each point in the working plane receives illumination from many lamps.

There is given herewith a table of constants based on all of the results of reliable tests on efficiency of illumination which have come to the notice of the authors. This table shows the

Table Showing Number of Watts Per Square Foot of Floor Area Required to Produce an Average of One Foot-Candle of Illumination—Watts Per Lumen.

INCANDESCENT LAMPS.	
Tungsten lamps rated at 1·25 watts per horizontal candle-power; clear prismatic reflectors, either bowl or concentrating; large room; light ceiling; dark walls; lamps pendant; height, 8 to 15 feet ...	0·25
Same with very light walls ...	0·20
Tungsten lamps rated at 1·25 watts per horizontal candle-power; prismatic bowl reflectors enamelled; large room; light ceiling; dark walls; lamps pendant; height, 8 to 15 ft.	0·29
Same with very light walls ...	0·23
Gem lamps rated at 2·5 watts per horizontal candle-power; clear prismatic reflectors, either concentrating or bowl; large room; light ceiling; dark walls; lamps pendant; height, 8 to 15 feet ...	0·55
Same with very light walls ...	0·45
Carbon filament lamps rated at 3·1 watts per horizontal candle-power; clear prismatic reflectors, either bowl or concentrating; light ceiling; dark walls; large room; lamps pendant; height, 8 to 15 feet ...	0·65
Same with very light walls ...	0·55
Bare carbon filament lamps rated at 3·1 watts per horizontal candle-power; no reflectors; large room; very light ceiling and walls; height, 10 to 14 feet ...	0·75 to 1·0
Same; small room; medium walls ...	1·25 to 2·5
Carbon filament lamps rated at 3·1 watts per horizontal candle-power; opal dome or opal cone reflectors; light ceiling; dark walls; large room; lamps pendant; height, 8 to 15 feet ...	0·70
Same with light walls ...	0·60
ARC LAMPS.	
5-ampere, enclosed, direct-current arcs on 110-volt circuit; clear inner, opal outer globe; no reflector; large room; height, 9 to 14 feet ...	0·50

It remains to determine how closely the results calculated as above agree with actual results obtained in installations which have been tested. The main chances of error in the above method lie in the reflection from walls, and in assuming too large or too small an angle from the vertical in which to determine the flux of useful light. In a small room with very dark walls and the lamps placed high, the zone of useful light as measured by the angle from the vertical would be small, sometimes not over 50 or 60 degrees. On

watts per lumen, or, in other words, the watts per square foot required to give 1 foot-candle average illumination in several types of lighting installations.

To apply it use the rule—

Watts per sq. ft.=foot-candle intensity ×constant from table.

The methods described above are only approximate at best, but probably they are no more open to error than other methods. They are certainly much more simple and rapid. The authors have used them for the past year.

DISCUSSION.

Mr. R. L. Lloyd, who said he was interested in the matter from a practical standpoint, mentioned the case of a concert-hall in his city, in which he had considered the lighting plant meagre and insufficient. He, therefore, attempted to work out a scheme based on the figures and tables published by the Illuminating Engineering Society, and although he had felt some little doubt as to whether the lights contemplated would suffice, they were actually found to be ample.

Dr. Bell remarked that this was an illustration of the work the Society were carrying out.

Mr. J. S. Codman drew attention to some figures in the table given by Mr. Lansingh, relating to the Gem and tungsten lamps. The tungsten lamp gave practically twice the light yielded by the Gem for the same power; why, therefore, were the watts per square foot, under apparently similar conditions, slightly more than twice as great in the case of the Gem lamp?

Strictly, however, if mean spherical candle-power be considered, the actual efficiency of the tungsten lamp worked out to about 1·86 times that of the Gem. It was possible that the reflecting power of the walls might differ somewhat in the two cases, owing to the "whiter" nature of the tungsten lamp.

Mr. T. W. Rolph gave a table of the angles at which readings could be taken to obtain the mean candle-power of lamps, in accordance with flux-polar diagrams devised by Mr. Lansingh.

Mr. A. A. Wohlauer referred to the apparent discrepancy between the results for the Gem and tungsten lamps, which he thought might be explained by the method of taking into account the light reflected from walls and ceilings in the two cases. The general value of the constants given, however, was in accordance with his experience.

Mr. P. S. Millar said the authors had taken up Dr. Sharp's suggestion as regards the use of the conception of flux of light in a very practical way. The ratio between the flux of light applied to a specific purpose and the total flux generated was a most useful factor in illuminating engineering, especially in the prediction of the results in rooms of various sizes; he hoped that the authors would take up this question in an equally thorough manner during the next year.

In reply, **Mr. V. R. Lansingh** drew attention to the desirability of using the term "lumens per watt," instead of the reversed expression, which, of course, was not a measure of efficiency at all; he and Mr. Cravath, at any rate, meant to persist in the correct term, and hoped others would help to reverse the present practice.

In reply to Mr. Codman's query he found it difficult to give any precise explanation, but one reason was that Gem lamps did not always run as they were rated; also colour-values might affect the matter.

With regard to Mr. Wohlauer's question, he wished to point out that his results were founded on actual practical experiment, and took into account the flux of light from the ceiling; but it was interesting to compare them with those obtained by the theoretical methods described in this paper.

Mr. F. W. Willcox, referring to Mr. Lansingh's suggestion regarding the method of expressing efficiency, said that the reason for adopting "watts per candle" was a practical one, in that it enabled us to deal with integral unity, and efficiencies were not so readily apparent in a practical form.

Applying the idea to "lumens per watt," he agreed with Mr. Lansingh's suggestion, because "lumens per watt" would be integral in the case of the tungsten lamp.

REVIEWS, ABSTRACTS, AND REPRODUCTIONS.

A Suggested Standard Specification for Metallic Filament Electrical Glow-Lamps.

(From the *Journal für Gasbeleuchtung*, October 3rd, 1908.)

A DISCUSSION recently took place in Münich on the subject of standard specifications and conditions of photometrically testing metallic filament lamps, under the chairmanship of Herr Paulus, Director of the Laboratory of the Münich Corporation Electric Light Works, the meeting being attended by representatives of various lamp-manufacturing companies, including the Vereinigte Glühlampenfabriken, as well as the Münich Supply Co.

Dealing first with the photometry of metallic filament lamps, it was agreed, in accordance with the result of the researches of Herr C. Paulus, that (except in the case of the tantalum lamp) the rotation method of determining mean hemispherical candle-power was preferable to the angle-mirror method for metallic filament lamps. A speed of 60 revolutions per minute was recommended. It was also recommended that lamps run at a consumption of not over 1·5 watts per H.K. should be used for standard and comparison purposes, in order to secure as nearly the same colour of light as that yielded by the source under test as possible.

The second point under discussion dealt with the question whether the lamps should be tested at the pressure required by the consumer, or at the desired candle-power, the latter method being eventually agreed upon. It was further decided that by the " useful life " of a lamp should still be understood the period of time during which the initial candle-power of the lamp is reduced by 20 per cent. Life-tests by overrunning were unanimously regarded as too uncertain for present recommendation.

The last questions brought up for discussion related to the quantities which were to be marked on the lamp and the permissible margin of variation in them.

Herr Paulus had addressed a circular letter to a large number of electrical supply companies, inquiring (1) whether the actual supply pressure at the outlets supplied was just as often above or below the declared value; and (2) whether the deviations above and below at any prescribed outlet were equally great.

As a result of these inquiries it appeared that, on the average, the pressure was low in the case of 25 per cent of the outlets, and high in the case of 50 per cent; the highest value of the P.D. at any outlet was, on the average, 4 per cent above the nominal value, and the lowest value 2 per cent below.

Most of those present, however, seemed to feel that no rigid recommendation as to permissible voltage-variation could be framed at present, and it was decided that the matter should be the subject of special consideration between the supply company and the lamp-makers. It was further laid down that only the specified voltage was to be marked on each lamp.

The above suggestions, however, were only of a purely tentative character, and are to be the subject of trial in the laboratory of the company in Münich.

Accidents in Factories and Workshops.

WE understand that the Home Secretary has appointed a Departmental Committee to inquire into the causes and circumstances of the increase in the number of reported accidents in certain classes of factories and workshops and other premises under the Factory Acts, and to report what additional precautionary measures are in their opinion necessary or desirable.

The Committee is constituted as follows:

H. J. Tennant, M.P. (chairman);

A. M. Carlisle (of the firm of Messrs. Harland & Wolff);

Sir William D. Cramp, I.S.O.;

A. H. Gill, M.P.;

J. B. Tattersall (president Oldham Master Cotton Spinners' Association, and vice-president of the Federation of Master Cotton Spinners' Associations):

J. S. Taylor (of Messrs. Taylor & Challen, engineers, Birmingham);

Henry Vivian, M.P.; and

Miss Mona Wilson.

The secretary to the committee is Mr. Alexander Maxwell, of the Home Office.

The Wiring and Lighting Equipment of the Stack-Room of a New York Public Library.

BY J. F. MUSSELMAN.

(From *The Electrical Review*, N.Y., Oct. 17.)

THE features of the arrangements in this library seem to be of a special character. The section described is 297 ft. long by 78 ft. wide, and contains about 63 miles of shelves to accommodate 2,700,000 volumes. Naturally security from fire is an important consideration.

Nothing combustible enters into the construction of the room or its furniture, all stacks and shelves being of iron, and all floors of marble slabs.

Special attention has also been given to the lighting of these shelves, in order that the title of any book can be ascertained without any difficulty. Many of these titles are somewhat dim, so that a high intensity of illumination is desirable: 0·7 candle-feet normal to the backs of the books on the lowest shelf was considered sufficient. The control of the various lamps and to illuminate the shelves and the passages between them is sectional, so that it is only necessary to light up the lamps in any particular locality where books are to be handled. Lamps can be controlled either from the centre aisle or the operating desk of the stack-room where the book-lifts to the reading-room are situated. Special lamps are also installed for use by the night watchman.

The interior of the whole stack-room is to be painted an egg-shell white, all conduit work, cabinets, &c., being finished in a similar manner, with the object of rendering the conditions for the distribution of light as favourable as possible. It is stated that the excellence of the arrangements is in no small measure due to the care of the architects —Messrs. Carrere & Hastings—who are responsible for the general design.

Inartistic Flashlight Advertisements.

THERE seems no adequate reasons why signs should not achieve their purpose of calling attention to some specified object, and yet be contrived in such a way as not only to escape offending artistic taste, but also to serve as an effective decoration. This aspect of the matter was recently emphasized in *The Illuminating Engineer* (Sept., p. 746).

Meantime we observe that a correspondent of *The Architect and Contract Reporter* has been pointing out that the flashlight advertisements on the top of the editorial building, "is a disgrace to Ludgate Circus." The Editor, however, explains that, while agreeing with his correspondent, his periodical has no control over the top of the building: otherwise the objectionable signs would soon be missing.

Scientific Publications Received

WE have to acknowledge the receipt of a very interesting and complete illustrated description of the Technische Museum für Industrie und Gewerbe in Vienna.

We have also received two brochures dealing with researches in Germany on the illumination of schoolrooms, &c., by Dr. E. Schilling, of Münich, and Prof. L. Weber, of Kiel. With these we hope to deal in greater detail on a future occasion.

We also take this opportunity of expressing our acknowledgments to those societies whose communications we have received during the past year, including the publications of the American Academy of Science; American Electrotechnical Society; American Institute of Electrical Engineers; American Gas Institute; American Philosophical Society; American Physical Society; Architects, Society of; Arkiv für Matematikoch Fysik (Stockholm); Bureau of Standards (Washington); Civil Engineers, Institution of; Electrical Engineers, Institution of; Faraday Society; Franklin Institute; Jassy, University of (Roumania); Marine Engineers, Institution of; Naturalists, Imperial Society of (Moscow); Smithsonian Institute; Society of Arts, Journal of; Tokio Mathematico-Physical Society; Western Society of Engineers.

The Progress of Electric Incandescence.

By Prof. A. Blondel.

(Abstract of Paper read at the International Electrical Congress at Marseilles, Sept. 14th to 20th.)

A wonderful revolution in electric incandescence has taken place since the last Congress of Electricians in Paris. In 1900 the carbon filament of Swan and Edison still held the supreme position in this domain. It may seem extraordinary that it did not occur to people to utilize the present materials earlier, but it must be recalled that the prevalent impression that Edison had covered the ground so thoroughly as to leave but little room for further effort, discouraged investigation.

During the period referred to (1880 onwards) experiments progressed in a doubly erroneous direction. In the first place, it was then supposed that all that was necessary, in order to make a more efficient filament, was to secure a conducting but highly refractory material. In the second place, there was an impression that one ought to select bodies with a high emissive power. Recent progress in the theory of ionization and incandescence have corrected both these views.

M. Blondel next proceeds to summarize the work of Wien, Lummer, &c., especially emphasizing the result that the efficiency of incandescence is improved by departure from the theoretical black body. For instance, Lummer found shiny platinum to be preferable in this respect, and this advantage is shared by filaments having polished grey surfaces. On the other hand, there is but little evidence of genuine selective radiation such as is attributed to the Nernst filament, and such as occurs is of a trifling character.

The most important point elucidated by the theory of ionization has been the realization of the fact that solid materials, such as carbon, which are relatively infusible, tend to vapourize gradually far below their boiling point. There is, therefore, no object in utilizing a substance for the manufacture of filaments which, though refractory, begin to vapourize at a low temperature. Carbon, as stated above, is open to objection from this point of view, and certain rare metals of high density, such as tungsten, have been found preferable.

M. Blondel next embarks on the historical résumé of methods of manufacture of filaments. He refers to the work of Howell and the development of the Gem metallized filament, and of the Nernst lamp. Many attempts have also been made to manufacture satisfactory filaments of metalloids other than carbon, but they have not been very successful. The chemical methods used in the manufacture of metallic filaments are here inapplicable, and elements of this class tend to form nitrides during construction. Moreover, their density being relatively low, there is no reason to think that the tendency to vapourization of such materials is less marked than that of carbon, but the reverse; and the author, having experimented in this direction in connexion with M. Bainville, subsequently abandoned the method. The Helion lamp, however, seems to have been carried to a further stage of development, and M. Blondel believes that the behaviour of the filament in question can only be explained on the supposition that a eutectic combination of carbon and silicon is formed.

The next section of M. Blondel's paper treats on the development of the metallic filament proper. He enters into the description and classification of the various methods in vogue in exceptional detail. Readers who are interested in this phase of the subject may with advantage refer to the recent article by Dr. F. Jacobsohn in our journal (May, p. 395, and June, p. 463). Naturally, in the space at our disposal, we can only briefly refer to the ground covered by M. Blondel in this paper. It is to be observed, however, that he expressly declines to offer any opinion on the subject of the value of the patents concerned.

The first method referred to by M. Blondel is that of simply drawing out the metal, of which the most conspicuous example is the Tantalum lamp, largely due to the work of Dr. von Bolton. The diameter of such filaments, however, is practically limited by the size of the aperture through which they are drawn, and this could hardly be reduced below about 0·04 to 0·05 mm., while a diameter of as low a value as 0·02 mm. is attained in the case of the tungsten lamp.

The second method is that of Kuzel, who prepares filaments by the manipulation of metal in a colloidal condition, lamps made by this process being sold under the name Sirius.

A third method, originally employed by Auer, is that of decarburation. This involves the manufacture of paste filaments mixed with some organic ingredient of a binding character, which is subsequently removed chemically.

Fourthly may be mentioned the suggested construction of filaments by chemical composition of a binary compound of the desired metal, *e.g.*, sulphides or oxides of molybdenum. Theoretically this method has the advantage that by subsequent chemical treatment of the compound the filament should shrink and render the production of thin filaments simpler. A number of patents have been taken out for processes of this description by Lux and the A.E.G., &c., but the method is attended by great practical difficulties.

Among other indirect methods we may recognize that of Cruto, and recently of Just and Hanaman, who proposed to deposit the desired metal upon a carbon core, and subsequently to decarburize the whole.

Other workers have developed a substitution method, according to which both the processes taking place in the above method are in operation simultaneously. This system has been attempted by F. Blau and the Auer Society, but it does not lend itself well to the manufacture of very thin filaments.

Lastly, mention may be made of a "cementation" process devised by Kuzel, which involves the formation of a eutectic skin alloy, with the object of increasing the resistance of a filament, and incidentally altering the quality of the light emitted.

Among the difficulties incidental to the manufacture of metallic filaments the author includes :—

1. The fact that the operation of forming a metallic filament in an atmosphere of hydrogen, &c., is a more costly and complicated process than the corresponding treatment of ordinary carbon ones.

2. The extreme thinness of the metallic filament, which renders the mounting of it very difficult, and the transport difficulties to which this gives rise.

3. Difficulties attending the mounting of a number of filaments within the same bulb; in this respect the single filament employed in the Tantalum lamp is a great advantage.

4. As a metallic filament in general consists of isolated metallic particles melted together, it is extremely fragile and easily broken by vibration; the fragility increases with the life of the lamp, rendering the duration of the latter very uncertain.

5. The softening of the filament in the hot state renders the manufacture of a lamp which will burn in any position a matter of some difficulty.

6. Another difficulty previously experienced was the problem of successfully attaching the filament to the leading in wires by the aid of a carbonaceous or metallic paste. At the present day this method is not employed; the filament is directly attached by the production of a miniature arc between the contacts, thus avoiding the tendency towards carbonization and occluded gases

The remaining portion of this paper is devoted to a survey of the main properties of the metallic filament lamps and their applications in practice. The author gives particulars of the connexion between pressure and candle-power, change of resistance, &c., of the various lamps on the market, their behaviour on alternating current circuits and the distribution of light; the Tantalum and tungsten lamps, on account of their vertically situated filaments, yield polar curves of distribution approximating to the law $I_a = I \cos_n a$.

Tables are also given comparing the running costs of the various types of metallic filament lamps with that of gas, and the paper concludes with a brief discussion of the best method of treating 220-volt circuits, the use of transformers, and the grouping of lamps in series, as exemplified by the Stearn system.

White Lights for Ships and Lighthouses.

Dr. H. J. Claiborne, in a recent number of the Quarterly of the United States Naval Institute, proposes an interesting departure in the existing methods of arranging night lights on ships, &c.

He seems to suppose that colour blindness is of much more common occurrence among those at sea than is generally credited, and that it is also no easy matter to devise tests to exclude the possibility of all dangerous cases being detected. Yet at sea, the confusion of colour—a mistake as regards the colour of the port and starboard lights of a ship, for instance may readily give rise to serious results.

He therefore suggests that the use of colour for distinguishing port and starboard lights, &c., should be abandoned, and that geometrical patterns of white lights, such as even the colour blind could easily distinguish and identify, should be substituted.—*The Electrical Review of New York.*

Review of the Technical Press.

ILLUMINATION AND PHOTOMETRY.

The subject of photometry received some attention at the annual meeting of the American Gas Institute. The report of the joint committee of the Illuminating Engineering Society and the Institutes of Gas and Electrical Engineers, relating to AN INTERNATIONAL UNIT OF LIGHT, was submitted by **Mr. Gartley**; these recommendations had previously been presented at the second annual convention of the Illuminating Engineering Society. While viewing sympathetically the suggestions of .the committee, the Institute decided to postpone definite decision in the matter until the data afforded by the Bureau of Standards, relating to the ratio between the British and United States candles, were completed, as it was hoped they would be shortly.

At the same meeting **C. O. Bond** presented a very comprehensive paper on the PHOTOMETRY OF GAS, in which he reviewed the history of the different flame standards in different countries. Special stress was laid on the necessity for adequate ventilation of photometer-rooms. The pentane standard was recommended, but the author thought there was also an opening for something less expensive. In conclusion, it was urged that the Institute should devote themselves to the consideration of the testing of candle-power of incandescent mantles and their standardization generally.

Kohler (*Z. f. B.*, Nov. 10th) describes a form of radiometer for comparing the HEAT-RADIATION OF GLOW-LAMPS. He suggests that this arrangement could be used, with caution, for the comparison of the intensity of lamps of the same nature; it is pointed out, however, that the readings of such an instrument gradually alter for some time after a lamp is switched on, owing to the heating up of the bulb.

C. Hering (*Illum. Eng.*, N.Y., Oct.) again discusses the question of the definition of the SPHERICAL CANDLE-POWER and the LUMEN. This matter was brought up at the recent convention of the Illuminating Engineering Society. Considerable differences of opinion seem to exist on the point. Hering argues that "spherical candle-power" is of the same dimensions as "flux of light," being connected by the relation:

$$\text{flux} = 4\pi \times \text{spherical candles.}$$

At a meeting of the society referred to, however, Dr. Clayton Sharp objected to this view, contending that spherical candle-power really merely represented an intensity and not flux. That such difference of opinion should still exist on the subject of the fundamental units of illuminating engineering, only shows, as *The Illuminating Engineer* remarks, that the subject is in want of scientific study, in order that all mistiness as to the nature of the terms used should be cleared up. Another matter referred to by C. Hering is the fact that in many cases the lumen is defined on the basis of the Continental light-unit, while in America the U.S. unit is understood. In this matter he advocates the general adoption of the same convention as that of the Bureau of Standards, with whom it is customary to express results in the U.S. standard of light.

The subject of the ULTRA-VIOLET RAYS IN ARTIFICAL ILLUMINANTS continues to receive attention in different quarters. Thus **A. Bainville** (*L'Electricien*, Nov. 7th) gives a résumé of the suggestions of Drs. Schanz and Stockhausen. **Granjon** (*Rev. des Eclairages*, Nov. 15th) likewise discusses the subject, but considers that the suggestion that there is anything to fear from these rays in ordiary illuminants is exaggerated, though, of course, it is quite right that precautions should be taken in the cases of sources known to be exceptionally rich in energy of this description.

O. Vogel (*Elek. Anz.*, Nov. 10th, Nov. 20th) gives an interesting account of the development of SOURCES OF LIGHT FOR THERAPEUTIC USE. He draws a distinction between the BLUE AND ULTRA-VIOLET regions of the spectrum, and suggests that light between 590 $\mu\mu$ and 350 $\mu\mu$ is the variety that is serviceable in this connexion. In particular he contends that it is mainly the BLUE that is valuable for deep-seated physiological action, and this was realized by Finsen. Very small wave-length ultra-violet light, though causing evident excitation of the outer epidermis, does not penetrate so deeply, and its action is, therefore, not sufficiently deep-seated to destroy germs, &c.

Among articles on general illumination mention must be made of that by **Bloch** (*J. f. G.*, Nov. 2nd), who gives an account of the ILLUMINATION OF THE STREETS OF BERLIN by high pressure inverted gaslights and new flame-arcs, and especially by the new white flame-arcs utilizing upright carbons. He states that neither method is invariably best. Each case must be considered on its merits, as *both* gas and electricity have made great progress.

J. F. Musselman (*Elec. World*, N.Y., Oct. 17th) describes the EQUIPMENT OF A NEW YORK LIBRARY. Special arrangements are made to render the building absolutely secure against fire, and special night-circuits are installed. The illumination of the stack-rooms seems to have also been the subject of special care on the part of the architects, the general scheme of decoration being in white, and arrangements being made to secure that the titles of all books on the stack-shelves can be clearly read.

An interesting possibility in lighting is dwelt upon in a recent number of the *Electrical World*, namely, the ILLUMINATION OF LARGE OUTDOOR SPACES by artificial light. Some illustrations are presented, showing the lighting of the grounds by small 6 ampere arc-lamps, slung overhead on wires, during the military tournament and cattle-show recently held in St. Joseph, Mo. The order of illumination is said to have approached that in good interior lighting, involving the expenditure of about 0·5 watts per square foot of ground area.

GAS, OIL, AND ACETYLENE LIGHTING, &c.

A SUBJECT of a considerable amount of discussion in the technical press has been the TAX ON GAS AND ELECTRICITY PROPOSED IN GERMANY, regarding which further particulars are now available. It seems to be intended to impose a tax of about 1¼*d.* per 1,000 cubic feet on gas, and the equivalent of one penny on incandescent mantles, and there are corresponding rates to be levied on electricity.

Among papers that have been read attention may be drawn to that by **T. J. Litle** at the Annual Meeting of the American Gas Institute (U.S.A.). The author dealt with GAS LIGHTING in a general and practical manner, paying special attention to show-window illumination, and the use of concentrating reflectors for this purpose. As an illustration of the illumination of interiors, mention was made of the problem of satisfactorily lighting a bowling alley.

Owing to the nature of the distribution of light from inverted mantles the author recommended that they should always be placed high up.

Finally he contends that an up-to-date gas company ought to retain one member on their staff who is specially competent to deal with problems of illumination.

Schumann (*J. f. G.*, Oct. 24) describes the results of some investigation into GAS ILLUMINATION IN MUNICH, including that in the streets, where values ranging from 0·2 to 0·3 lux were obtained in one case, and in certain school-rooms, where a range of illumination of 31 to 115 lux, with a mean value of 60 was obtained in one instance.

For school rooms the author emphasizes the need for good diffused systems of lighting, and states that the method of "semi-diffused" inverted lighting, with distributing bowls is preferable, because of the rapidity with which the reflecting power of the ordinary ceiling deteriorates.

Two recent articles in *The Illuminating Engineer* of New York call for mention. **H. Thurston Owens** discusses the development of the LANTERN AND LAMP-POST used for STREET LIGHTING BY GAS; these two items, he suggests, ought not to be considered separately, but to be develoved in such a way as to present an artistic whole.

E. L. Elliott discusses the DESIGN OF FIXTURES FOR GAS from the artistic standpoint, remarking that many fixtures of to-day are obviously merely adaptations of older styles. Gas, he says, has certain properties that enable fixtures designed for its use to be quite as effective as those for electric light, and he thinks it is undesirable for the design to imitate electrical development instead of proceeding on original lines.

Among other papers of general interest mention should be made of the PRESIDENTIAL ADDRESS of **Dr. A. C. Humphreys** at the annual meeting of the American Gas Institute; the report of the Committee on the international unit of light is mentioned elsewhere in this review.

A recent paper by **F. Haber** (*Z. f. B.*, Nov. 20) contains a detailed and interesting discussion of the structure of the Bunsen flame.

Recent numbers of the *Zeitschrift für Beleuchtungswesen* again contain short descriptions of a series of recent patents of interest. One of these deals with a type of MANTLE THAT IS NOT "BURNT OFF" initially: others deal with burners for the use of LIQUID COMBUSTIBLES. A recent number of *The Gas World* contains a reference to a NEW TYPE OF SELF-LIGHTING MANTLE, little red strips being attached which become incandesent when impinged upon by a stream of gas; this action is said to be preserved for several months.

The last number of *Acetylene* contains an abstract of a recent article on the subject of VILLAGE LIGHTING BY ACETY-

LENE. This may be accomplished by the aid of local generators placed inside each lamp-post, or preferably, by the use of renewable cylinders of dissolved acetylene.

ELECTRIC LIGHTING.

In the electrical press the proposed imposition of a TAX ON ELECTRICITY for power and lighting and ON ELECTRIC LAMPS has been the occasion of much comment, and a recent number of the *Elektrotechnische Zeitschrift* contains a study of the results of a similar tax in Italy.

The author sums up his conclusions by remarking that while it is hard, for various reasons, to tell definitely what the effect of the tax on electricity for lighting has been, there can be no doubt as to the hindrance it exerts on the development of electrical heating and cooking devices. In addition it is stated that the tax is a source of constant friction between the authorities and the local residential engineer, and that the smoothness with which the arrangements for its collection work depend very greatly on the ability and tact of the assessor.

There have been a number of articles, dealing generally with electrical developments, of exceptional interest. Thus **M. L. Flesch** (*L'Electricien*, Oct. 31, Nov. 7) contributes an up-to-date general review of the RECENT DEVELOPMENTS IN ARC AND GLOW LAMPS and mercury vapour lamps; the article contains some interesting remarks on the subject of the Nernst lamps, and the distinction between conductors of the first and second class, and the methods that have been suggested to render the Nernst filament (a second-class conductor) conducting.

E. Eichel (*Elek. Anz.*, Oct. 22 and 25) deals with the field of novel developments in electric lighting in the United States. He surveys the development of the magnetic arc, the mercury vapour lamp and other sources which have found more extensive use in the United States than in Germany.

One system of lighting he refers to is perhaps not very generally known in Europe: namely, the use of HIGH CANDLE-POWER METALLIC FILAMENT LAMPS IN SERIES on a constant current circuit, supplied by stepping down from a high alternating P.D. by means of a constant current transformer.

This system also finds application for the lighting of large open spaces, parks, &c.

B. Duschnitz (*Elek. Anz.*, Nov. 8 and 19) continues his exhaustive résumé of RECENT PATENTS on the subject of GLOW-LAMP MANUFACTURE. In the course of the present instalment he mentions what seems a very singular experience on the part of the Auer Co.

This company had experienced considerable trouble from a tendency of the glowing metallic filaments of lamps to warp in process of manufacture. This effect was traced to the action of the earth's field on the plastic glowing filament, and ceased when the earth's field was neutralized. They therefore take out patents covering methods of counteracting the effect by screening the lamp being tested with a suitable iron surrounding cover, or other means of prevention.

Several articles by **R. Boehm** and others likewise deal generally with recent progress in glow and arc lamps.

The use of transformers in connexion with low P.D. metallic filament lamps continues to excite some attention. *Electrical Engineering* for Oct. 29 contains an article on the WIRING OF 25 VOLT CIRCUITS, and it is stated that some of the buildings of King's College (London) have been completely converted to 25 and 50 volts respectively. A recent editorial note in an American journal, however, raises the question of the probable effect on the power factor of the service of the general adoption of a large number of small transformers on the lighting load.

E. Besser and **H. Remane** contribute correspondence to the *Elektrotechnische Zeitschrift* on the subject of the effects of OVERRUNNING METALLIC FILAMENT GLOW LAMPS.

Schreiber (*E.T.Z.*, Nov. 5) discusses the design of LAMPS AND FITTINGS FOR USE IN MINES. He recommends that portable lamps to be employed in this connexion should invariably be protected both with a stout glass envelope and a basket work wire covering.

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An International Unit of Light (*Rev. Electrique*, Nov. 15).
Granjon, A. Les Effets de Lumière Artificielle sur la Vision (*Rev. des Eclairages*, Nov. 15).
Hering C. The Spherical Candle versus the Lumen (*Illuminating Engineer*, N.Y., Oct.).
Kohler. Ueber einen Apparat zum Messen der Warmestrahlung elektrischer Lampen (*Z. f. B.*, Nov. 1).
Musselman, J. F. Wiring and Lighting Equipment of a New York Public Library (*Elec. World*, N.Y., Oct. 17).
Thurston Owens. Street-Lighting in Brooklyn (*Progressive Age*. Oct. 15).
Vogel, O. M. Blau oder Ultraviolet? (*Z. f. B.* Nov. 10, Nov. 2).
The Illuminating Engineering Society (*Elec. Rev.* Oct. 25, *Elec. World*, Oct. 17).
The Lighting of Large Outdoor Areas (*Elec. World*, Oct. 31).
America and a Unit of Light (*J. G. L.*, Nov. 10).

ELECTRIC LIGHTING.

Besser, E., and Remanè, H. Einfluss von Spannungsüberschreitungen auf die Lebensdauer von Metallfadenlampen (Correspondence. *E. T. Z.*, Nov. 19).
Böhm, R. Die Vorstufen von Metallfadenglühlampen (*Elek. Anz.*, Nov. 12).
Duschnitz, B. Metallische Leuchtfäden und Metallfadenlampen in der Fabrikation und in der Praxis (*Elek. Anz.*, Nov. 8, Nov. 19).
Dykes, A. H. Wiring for 25 volts (*Electrical Engineering*, Oct. 29).
Editorials. The Electric Light Situation (*G. W.*, Nov. 14).
Badly fitting Lampholders (*Electricity*, Nov. 20).
The Incandescent Lamp Situation (*Elec. World*, N.Y., Oct. 31).
The Small Consumer (*Elec. World*, N.Y., Nov. 7).
Eichel, E. Neuerungen der Amerikanischen Beleuchtungstechnik (*Elek. Anz.*, Nov. 22, Nov. 25).
Fasolt, F. Die Steuer auf Leuchtgas und elektrische Energie in Italien (*E. T. Z.*, Nov. 19).
Flesch, M. L. L'Eclairage Electrique (*L'Electricien*, Oct. 31, Nov. 7).
Mylo, R. Die Fernschaltung und Fernüberwachung der offentlichen elektrischen Beleuchtung in Berlin (*E. T. Z.*, Nov. 5).
Schreiber. Installationsmaterial für Beleuchtuug von Bergwerken (*E. T. Z.*, Nov. 5).
The German Tax on Gas and Electricity (*Electrical Engineering*, Nov. 19, *Z. f. B.*, Oct. 30, *E. T. Z.*, Nov. 12).
Progress in Electric Lighting by means of Metallic Filanet Lamps (*Electrician*, Nov. 13).
Illumination of Seventh Avenue, Manhatten Borough, New York (*Elec. World*, N.Y., Nov. 7).
Die neueren Bogenlampen (*Z. f. B.* Oct 30, Nov. 10, Nov. 20).

GAS, OIL, AND ACETYLENE LIGHTING.

Adams, A. D. Village Lighting (*Acetylene*, Nov., from *The Scientific American*).
Elliott, E. L. The Possibilities of Artistic Effects in Gas fixtures (*Illuminating Engineer*, N.Y., Oct.).
Haber, F. Ueber die Bunsenflamme (*Z. f. B.*, Nov. 20).
Humphreys, Dr A. C. Presidential Address, before Am. Gas Institute (*Progressive Age*, Nov. 2).
Litle, T. J. Better Gas Illumination (Paper read at meeting of Am. Gas Institute, Oct., *Am. Gaslight Journal*, Nov. 9).
Schilling, E. Bericht der Kommission für die Gasbeleuchtung von Warenhausen (*J. f. G.*, Oct. 31).
Schumann. Ergebnisse von Beleuchtungsmessungen (*J. f. G.*, Oct. 24).
Thurston Owens, H. The Development of Gas Street-Lighting Fixtures (*Illuminating Engineer*, N.Y., Oct.).
A German Tax on Light (*G. W.*, Oct. 31, Nov. 7, *J. G. L.*, Oct. 27, Nov. 3, Nov. 10, *J. f. G.*, Oct. 24, Oct. 31, Nov. 5, Nov. 14).
The Bamag Distance-lighter (*G. W.*. Nov. 14).
Self-lighting Incandescent Mantles (*G. W.*. Nov. 21).
Gas at the Franco-British Exhibition (*J. G. L.*, Nov. 3).
American Gas Institute. Third Annual Meeting (*J. G. L.*, Nov. 10, Nov. 17).
New Outdoor Lamps (*J. G. L.*, Nov. 17).
Proceedings of the 11th Annual Acetylene Association Convention (*Progressive Age*, Oct 15).
Etude sur le Bec "Intensiv Viseaux" (*Jour. de l'Eclairage de Gaz.*, Nov. 5).
Unveraschter Invertglühstrumpf (*Z. f. B.*, Nov. 10).
Beleuctung mit flüssigen Lenchtmaterialen, &c. (*Z. f. B.*, Nov. 10).

MISCELLANEOUS.

Drysdale, Dr. C. V. Sur le Rendement lumineux et l'Equivalent Mécanique de Lumière (*Jour. de Physique*, Nov., 1908).

Titchener, E. B., and Pye, W. H. On the After Images of subliminally Coloured Stimuli (*Proc. Am. Phil. Soc.*, Vol. XLVII., No. 189, 1908).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
Elek. Anz.—*Elektrotechnischer Anzeiger.*
G. W.—*Gas World.*
J. G. L.—*Journal of Gaslighting.*
J. f. G.—*Journal für Gasbeleuchtung und Wasserversorgung*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*

CORRESPONDENCE.

Ultra-Violet Light: Need We Fear its Effect upon the Eye?

(A reply to Dr. Voege's remarks on this subject. See *The Illuminating Engineer*, September, 1908, p. 775.)

BY DR. F. SCHANZ AND DR. K. STOCKHAUSEN.

IT may be pointed out that a valid answer to this query was furnished long ago, and many electrical engineers have experienced sensations that enable them to reply decisively on the question in dispute.

"Electrical ophthalmia" is a perfectly authenticated effect of the arc-light on the eye. Ordinarily we do not expose ourselves to the light in the same way as the engineers referred to above. But is a poison that has been so diluted as to give rise to no acute injurious sensations therefore no poison? That our eyes rapidly become wearied by the light of the arc, and that unpleasant effects on the eye have been recorded, can hardly be denied. Do not these records of injury in themselves suffice?

Recently, however, Prof. Birch-Hirschfeld has recorded injuries to the eyes—for instance, local disturbance of the colour-sense of those working with the mercury lamp—which were not accompanied by the special circumstances characteristic of electrical ophthalmia. He considers, moreover, that these effects, the existence of which is only with difficulty detected, occur anything but infrequently. But are the ultra-violet rays to be considered harmless even supposing that manifestations of their action have only been recorded in the case of the mercury lamp?

Dr. Voege also contends that our eyes are adapted to the use of daylight, and that, therefore, artificial illuminants, which contain a weaker ultra-violet element than daylight does, can hardly be deemed dangerous on this account. Yet his assumption that the ultra-violet rays in daylight are harmless is not well grounded. Even under ordinary conditions the ultra-violet light in daylight can produce reddening and irritation of the skin, and may, in the case of unusually sensitive subjects, give rise to eruptions on the skin somewhat similar to those occurring in small-pox patients. In mountainous districts, where the ultra-violet constituent in daylight is exceptionally powerful, the so-called "glacier-burning" action on the skin is well-known.

These circumstances give rise to corresponding inflammatory conditions in the outer portions of the eyes that are well-known experiences on the part of those accustomed to work out-doors in the fields, &c. Also so-called "spring-catarrh" (*Frühjahrskatarrh*) of the *conjunctiva retina* has been shown by several authors to be, at least, partially due to the accentuation of the ultra-violet constituent in daylight at the beginning of the spring season. In polar regions the effect occurs in its most severe form as "snow-blindness" and "red-vision" (*Erythropsie*). These effects are ascribed to the reflection of strong ultra-violet radiation from the snow.

These considerations alone seem to invalidate Dr. Voege's argument by appeal to daylight-illumination. Moreover, as was urged in the course of the discussion at Erfurt this year (see *The Illuminating Engineer*, October, 1908, p. 855), the proportion of ultra-violet light in daylight is exceedingly variable, and that in all cases the illumination employed was of a diffused character from which almost all the ultra-violet light had been eliminated by successive reflection. Thus in cases in which the ultra-violet constituent in daylight is known to be exceptionally powerful, we take measures to protect ourselves, and when in the open avoid the exposure to the *direct* radiation of the sun; in cases in which such protection is impossible our eyes suffer.

The best means of protection available is our headgear, which has been so developed as to screen our eyes from the direct rays. When we are, however, obliged to subject ourselves to directly-reflected sunlight, *e.g.*, from snowfields or the surface of water, we have resource to the protection of spectacles. It has been demonstrated that blue glasses which allow ultra-violet rays to pass through them with special ease, are not so serviceable for this purpose as grey ones.

Now, corresponding protection from the *direct rays* is usually wanting in the case of artificial light. Indirect illumination, though preferable from this point of view, has been but little utilized, chiefly from considerations of cost. This distinction between natural and artificial conditions of illumination seems not sufficiently appreciated by Dr. Voege in his comparison of the respective conditions.

Attention must also be paid to another important consideration. What kind of daylight ought to be selected as our standard of comparison with artificial illumination? For this purpose a sky of a certain constant standard intensity should be selected; but what type of sky meets this condition? Dr. Voege himself admits that the blue sky is richer in ultra-violet light, but less bright than a clouded one; and he, like many others before him, records that the ratio of ultra-violet to the visible energy in daylight varies very greatly with the climatic conditions. It is clearly unsatisfactory when attempting to put forward a rigid physical proof to employ a source of comparison that is admittedly so variable. Moreover, optical brightness and photochemical intensity are two quite different factors, and even the ultra violet rays constitute only a fraction of the radiation that affects a photographic plate.

Moreover, according to Dr. Voege's researches the solution of nitrosodimethylaniline, which he employs with the object of eliminating the visible rays, absorbs rays between the limits of 0·5 μ and 0·37 μ, and yet allows light and wave-lengths lying between the H and K lines, and 0·2 μ to pass through unchecked. Yet the H line corresponds with a wave-length 0·4 μ, and the K line with a wavelength of 0·397 μ. According to the complete tabulation due to Listing,* the visible spectrum ends at 0·397 μ, and the normal eye cannot detect rays without assistance. By using the solution referred to above, Dr. Voege cuts out an intense ultra-violet band occurring in the spectrum of the arc-light, and of much greater consequence than the simultaneously absorbed ultra-violet region of the spectrum of daylight.

The comparison of a glow-lamp with the brightness of sunlight reflected from a polished metallic surface, critically regarded, can hardly be seriously endorsed as a basis of comparison.

On the basis of the aforesaid assumptions† Dr. Voege comes to the conclusion that the spectrum of sunlight without the screening effect of glass indeed, even after the light has passed through a sheet of glass, extends further in the ultra-violet than the spectrum of all artificial illuminants.

Yet Cornu‡, even under the favourable circumstances, failed to detect wave-lengths further than 0·295 μ; while Rowland,§ again, placed the limit at 0·300 μ. On the other hand light of wave-lengths as small as 0·2 μ has been proved to exist in the spectrum of the arc-light. And even were our artificial illuminants invariably surrounded with a glass envelope, ultra-violet rays of 0·3 μ to 0·4 μ would be allowed to pass unhindered, only those below 0·3 μ being, in general, absorbed by glass of the ordinary variety.||

* Listing, *Pogg. Ann.*, 131, 564, 1868.

† *E.T.Z.* 1908, p. 781.

‡ Cornu. *Compt. Rend.*, 1878, p. 102.

§ Rowland, Photographic map of the solar spectrum, J. Hopkins Press, Baltimore, U.S.A.

|| *E.T.Z.* 1908, p. 778, Spectra 1 and 2 in Fig. 1., *Illuminating Engineer*, Sept. 1908, p. 772.

Dr. Voege would certainly have arrived at the same results had he adequately screened his plate from all stray light, and used a slit 1 to 2 mm. in length as is customary in spectrographic measurements, instead of one mm. long.

Dr. Voege has admitted that spectra of, at least, two existing sources, the Regina arc and the quartz mercury-vapour lamp, contain more ultra-light violet than daylight, and therefore a protecting screen would, in these cases, be necessary. Even supposing, however, that he succeeded in demonstrating, by methods to which no possible objection could be taken, that one surface, illuminated with a certain optical intensity, emitted more ultra-violet rays than another, even this would not decide whether or no the ultra-violet light present in artificial illuminants can be considered harmless.

This is emphatically a question for the physiologist to determine, rather than the illuminating engineer.

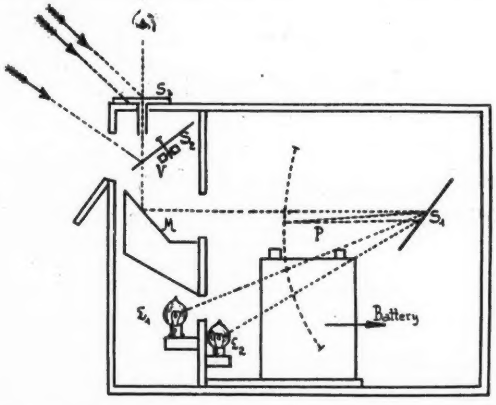
The Improved Harrison Photometer.

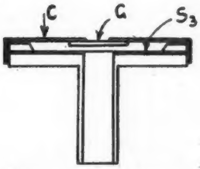
(We have received the following description of an improved form of Harrison Street Photometer, which, through the courtesy of the inventor, we have recently had an opportunity of inspecting. It may be of interest to recall that a description of this instrument has been previously published in *The Illuminating Engineer*, June, 1908, p. 504):—

THIS instrument is intended for measuring illumination on a screen at an angle of 45 degrees from the vertical, and also the candle-power of sources of light. For this purpose a flicker head is used, rotated by an air blast under the control of the operator, thus making it possible to obtain accurate results when measuring illumination derived from light sources of any nature.

of horizontal illumination to be made in the same way as is done in the Trotter Preece photometer, with the exception that the moving or adjustable screen is viewed by means of the mirror, which is used with the flicker head, the sector of which is set and fixed so as not to interrupt the view.

This means of fixing the moving sector also makes it possible to use the





Enlarged view of eye-piece

The addition lately made to the instrument consists of a horizontal screen which is covered, when making the measurements above referred to, by a cap having a hole through the centre, forming the eye-piece. This cap when removed exposes a white horizontal screen, thus permitting measurements

photometer as a direct comparison instrument, should it not be considered necessary to use the flicker, as the sector can be set in such a position as to be illuminated by the source of light to be measured and to be visible through the eye-piece, at the same time exposing to view the variable angle screen illuminated by the standard lamp, thus permitting a balance to be made.

It will be seen that any of the following measurements can now be made by means of this instrument :—

1. Candle-power with a flicker head.
2. Candle-power by the direct comparison method.
3. Illumination on screen at an angle of 45 degrees with flicker head.
4. Illumination on screen at an angle of 45 degrees by direct comparison.
5. Horizontal illumination by direct comparison.

The other advantages of this instrument have all been retained in the new model, namely :—

1. Light weight and portability.
2. Long range with two different standards.
3. Permanent connexions between cells and standard lamps, which need never be disconnected.
4. Ease of removal from case of battery, standard lamps, and flicker head for inspection and charging without disconnecting.
5. Easy and accurate manipulation due to method of rotating flicker head.

The figure shown illustrates how these objects are attained and the general simplicity of the apparatus.

Light Tinted Symbols on Dark Backgrounds.

We have received a letter from Mr. A. J. Marshall, of the Bureau of Illuminating Engineering, New York, commenting upon our reference to the above subject in the September number of *The Illuminating Engineer*, p. 778.

Mr. Marshall wishes to point out that what he advocates is the use of *light-tinted* symbols on *dark* grounds, but not necessarily white on black. On the contrary, he considers this combination undesirable, and prefers a yellow tint on a dark-green background, as being restful to the eyes, though his experiments are not yet sufficiently complete to justify this being regarded as the ideal arrangement.

The too sudden adoption of the plan recommended, would admittedly be confusing and possibly injurious to the eyes ; therefore Mr. Marshall advocates that the process of alteration should take place gradually, and that, in the meanwhile, amber-tinted paper with a rough matt surface ought to be used in books, especially those used in school work.

The Absorption of Arc-Lamp Globes.

Dear Sir,—I do not think Mr. Denman Jones has quite appreciated the test I suggested. The method I proposed for determining the absorption of a globe by measuring illumination from an arc-lamp first through the globe and then through a hole in it, is, I believe, quite a good one. These measurements make a comparison between the illumination from the globe, plus that due to the bare arc, with the illumination from the globe plus that due to the arc when it is obscured by the globe. It is obvious that the comparison between these illuminations does not give the absorption of the globe directly. To determine the actual absorption a small portion of the globe close to the hole might be covered with an opaque card, and a third measurement of the illumination (from the globe alone) made on the darkened patch. By subtracting the illumination due to the globe alone from each of the other two the ratio between the light from the arc with the globe to the light from the arc without the globe is at once found. The actual source of light with which the globe has to be used is employed, and all the other conditions to which I referred in my last letter are similar.

The difference in the absorption-coefficent found by Prof. Morris and myself is, I believe, largely one of definition. When I spoke of absorption I meant the absorption as measured by a comparison between the intensity of a beam of light passing through the globe to the intensity of the same beam had the globe not been there. An average value of the absorption may be found by determining the mean hemispherical candle-power for the two cases. If the absorption is measured as the ratio of the total light in a given direction, with the globe in place, to the light there would otherwise have been, the result is very different. A large proportion of the total light so measured is that scattered from the surface of the globe. The ratio of light absorbed to total light measured in this way can, I think, hardly be called the coefficient of absorption for the globe, though it is coefficient of great practical importance. As an example of the difference between these two quantities I may mention the following test: With a large opal arc-lamp globe tried with a Tantalum lamp, the true absorption of the globe was found to be 82 per cent, while the apparent absorption was 36 per cent.

In determining the total light from a lamp it is, of course, the latter coefficient that is important, and which, no doubt, Prof. Morris measured in the tests I have ventured to criticize.

Yours very truly,
E. W. Marchant.

REVIEWS OF BOOKS.

Annuaire International de l'Acetylene.

Edited by MM. R. Granjon and P. Rosenberg.

Bibliothèque de l'Office Central de l'Acetylene, 104, *Boulevard de Clichy, Paris*, 2 *francs.*

The second number of the 'Annuaire International de l'Acétylène' fills nearly 300 pages, which contain a considerable amount of useful information on the production and uses of acetylene, arranged in a concise and readable form.

The eighteen chapters comprised in the volume cover a great variety of subjects, and some of them are of exceptional interest, notably those dealing with acetylene burners, incandescent acetylene lighting, and different applications of acetylene for lighting purposes. Chaps. i. to iv. also contain a summary of methods of generating and purifying the gas, which will doubtless be found useful by those anxious to gain a rapid survey of the technicalities of this subject. The volume, as a whole, undoubtedly achieves its evident object of illustrating the extent of the subject of acetylene lighting at the present day and the other extremely varied directions in which acetylene seems to be finding application.

The last portion of the book contains some useful statistics relating to the development of acetylene in different countries and the existing institutions and societies devoted to the discussion of the subject, followed by the subject-index, and a list of addresses of dealers in carbide and acetylene apparatus in different countries.

Le Nuove Lampade Elettriche ad Incandescenza.

By G. Mantica.

Biblioteca dell' Associazione Utenti Energia Ellettrica d'Italia, Via Cernaia, 11, *Milan.*

This book contains a general and up-to-date survey of the metallic filament and other incandescent lamps of the present day. The first two chapters are devoted to a historical summary of the subject and some remarks on the incandescent lamps in general, and the third discusses the carbon filament lamp; the Edison, Bernstein, Cruto, and other early lamps are briefly mentioned, and the metallized filament also receiving attention.

The fifth—the most important chapter in the book—contains a more detailed study of the various tungsten lamps, the osram, zircon-wolfram, colloidal, &c., and is illustrated by a number of charts of tests carried out in the photometrical laboratory of the Associazone Utenti Energia Elletrica, to the members of whom this book is dedicated.

Other chapters in the book deal briefly with the problems of radiation underlying incandescent lamps, and the standard specifications applying to their sale in Italy.

PATENT LIST.

PATENTS APPLIED FOR, 1908.

I.—ELECTRIC LIGHTING.

22,003. Anti-vibration device for pendants, &c. Oct. 17. A. Newall, 73, Approach Road, Victoria Park, London.
22,454. Arc lamps. Oct. 22. S. C. Mount and Beck Flame Lamp, Ltd., 27, Chancery Lane, London.
23,053. Fixings for electric fittings. Oct. 29. J. J. Rawlings, 34, High Holborn, London.
23,069. Supports for incandescence filaments (C.S.). Oct. 29. The British Thomson-Houston Co., Ltd., 83, Cannon Street, London. (From General Electric Co., U.S.A.) (Addition to 16,531/07.)
23,070. Supply and regulation of electric energy for searchlight arc lamps. Oct. 29. The British Thomson-Houston Co., Ltd., and A. A. Pollock, 83, Cannon Street, London. (Addition to 4,379/05.)
23,726. Filaments for incandescent lamps. Nov. 5. The British Thomson-Houston Co., Ltd., and H. H. Needham, 83, Cannon Street, London.
24,760. Regulating arc lamps for theatres, &c. Nov. 18. H. Powell, 4, Clayton Square, Liverpool.

II.—GAS LIGHTING.

21,887. Lighting and extinguishing. Oct. 16. H. L. Doun and Telephos, Ltd., 115, Cannon Street, London.
21,961. Burners for lighting and heating. Oct. 17. G. Wardle, 60, Lever Street, London.
22,520. Mantle rods. Oct. 23. J. R. Hoyland, 3, Brown Street, Market Street, Manchester.
23,122. Incandescent mantles (C.S.). Oct. 30. L. Severin, 231, Strand, London.
23,315. Mantle preserver for upright burners. Nov. 2. G. A. Walker, 25, Clifford Gardens, Willesden, London.
23,555. Inverted incandescent burner. Nov. 4. B. G. Hutchinson, Falcon Works, Eastgate, Barnsley, Yorks.
23,741. Lighting with compressed gas. Nov. 6. T. D. Kelly, 11, Kitchener Road, Upton Lane, Forest Gate, London.
23,830. Inverted incandescent pressure lamps (C.S.). Nov. 6. M. Graetz, 77, Chancery Lane, London.
23,923. Incandescent mantles. Nov. 9. A. Cruickshank, 18, Burstock, Road, Putney, London.
24,303. Incandescent mantles. Nov. 12. E. Swann, 55, Dollis Park, Church End, Finchley, London.
24,385. Intermittent lights for advertising. Nov. 13. A. T. Gilbert, 16, Dundas Road, Peckham, London.
24,493. Inverted incandescent lamps. Nov. 14. J. Keith and G. Keith, 65, Chancery Lane, London.
24,630. Mantles for inverted incandescent burners. Nov. 16. L. Friedeberger, 323, High Holborn, London.
24,689. Incandescent lighting. Nov. 17. H. Reeser and H. E. Bray, 20, Copthall Avenue, London.
24,793. Automatic igniters and extinguishers (C.S.). Nov. 18. (I.C. June 16, 1908, Germany.) M. W. Bröndun, 345, St. John Street, London. (Addition to 10,715/08.)
24,819. Igniting lamps at a distance. Nov. 18. W. Walsham and E. A. Holloway, 55, Greenford Avenue, Hanwell.
24,849. Controller for lighting and extinguishing (C.S.). Nov. 18. J. M. Tourtel and W. R. Mealing, 33, Cannon Street, London.
24,925. Lighting and extinguishing lamps at a distance (C.S.). Nov. 19. A. Grossmann, 173, Fleet Street, London.

III.—MISCELLANEOUS
(including lighting by unspecified means, and inventions of general applicability).

22,004. Control of oil, gas and other lamps. Oct. 17. D. A. Symons, 39, Victoria Street, Westminster.
22,274. Acetylite lamp. Oct. 21. M. E. Eggert, 17, Richmond Road, London.
22,401. Igniting apparatus (for gas or oil lamps) (C.S.). Oct. 22. E. Bérnardy, Sunbridge Chambers, Bradford, Yorks.
22,428. Automatically extinguishing lamps when upset (C.S.). Oct. 22. A. O. Stopes, 306, High Holborn, London.
22,481. Lenses for vehical lamps. Oct. 23. R. Whitehouse, A. E. Mitton, H. Mayhew and L. Nichols, Snow Hill Mills, Birmingham.
22,516. Incandescent vapour lamps. Oct. 23. J. H. Miess, Birkbeck Bank Chambers, London. (D.A. Nov. 22, 1907.)
22,621. Anti-vibration device for pendants (gas or electric). Oct. 24. A. Newall, 73, Approach Road, Victoria Park. London.
22,645. Lamps. Oct. 24. S. O. Cowper-Coles, 4, South Street, Finsbury, London.
22,657. Lamps. Oct. 26. C. E. Baxter, 32. Martineau Street, Birmingham.
22,748. Photometer. Oct. 27. H. Chapman, Ryecroft Villas, Meersbrook Road, Sheffield.
22,814. Illumination of railway stations, signs, name-boards, &c. Oct. 27. W. H. Bagley and F. J. B. Collis, 18, Southampton Buildings, London.
23,243. Lamps. Oct. 31. H. Cole, 77, Colmore Row, Birmingham.
23,456. Electric torches, gaslighters, lamps, &c. Nov. 3. Co-operative Wholesale Soc., Ltd., and J. Clarke, 111, Hatton Garden, London.
23,468. Illuminating and heating. Nov. 3. G. Epstein, 54, Willow Road, Hampstead, London.

23,552. Acetylene lamp. Nov. 4. L. J. Maas, 92, Antrobus Road, Handsworth, Birmingham.
23,710. Acetylene lamps. Nov. 5. H. Lucas and W. H. Egginton, 18, Southampton Buildings, London.
24,246. Controlling devices for lighting systems. Nov. 11. D. Anderson, 18, Southampton Buildings, London.
24,365. Automatic ignition device for oil or spirit incandescent lamps (C.S.). Nov. 12. C. Hannemann, 18, Southampton Buildings, London.
24,677. Oxyhydrogen search lights. Nov. 17. L. Kamm, 27, Powell Street, Goswell Road, London.
24,929. Acetylene lamps. Nov. 19. A. Barnett, 9, Warwick Court, Gray's Inn, London.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

20,223. Incandescent filaments. Sept. 10, 1907. Accepted Nov. 18, 1908. "Z" Electric Lamp Syndicate Ltd., 111, Hatton Garden, London.
22,756. Lighting of railway carriages. Oct. 15, 1907. Accepted Oct. 21, 1908. E. M. Preston and A. E. Kennard, 77, Chancery Lane, London.
23,148. Arc Lamps (C.S.). Oct. 19, 1907. Accepted Oct. 21, 1908. Johnson & Phillips, Ltd., and C. F. Tubbs, Birkbank Bank Chambers, London.
23,215. Arc lamp electrodes (C.S.). I.C. Oct. 20, 1906, Germany. Accepted Oct. 28, 1908. Deutsche Beck-Bogenlampen-Ges. m. b. H., 27, Chancery Lane, London.
23,429. Electrodes for arc lamps (C.S.). Oct. 23, 1907. Accepted Oct. 28, 1908. E. R. Grote and The Foster Arc Lamp and Engineering Co., Ltd., 40, Chancery Lane, London.
23,781. Arc lamps (C.S.). I.C. Oct. 26, 1906, Germany. Accepted Nov. 4, 1908. Deutsche Beck-Bogenlampen-Ges. m. b. H., 27, Chancery Lane, London.
23,950. Electroliers. Oct. 30, 1907. Accepted Nov. 4, 1908. G. F. Woods, 4, St. Ann's Square, Manchester.
23,991. Incandescent lamps. Oct. 30, 1907. Accepted Nov. 4, 1908. H. E. Theobald, 52, Chancery Lane, London.
24,343. Signal lamps. Nov. 4, 1907. Accepted Nov. 11, 1908. C. W. Cox and The Edison and Swan United Electric Light Co., Ltd., 34, Castle Street, Liverpool.
25,398. Arc lamps. Nov. 15, 1907. Accepted Oct. 21, 1908. A. Wunderlich and G. A. Hughes, 18, Southampton Buildings, London.
25,815. Incandescent lamps. Nov. 21, 1907. Accepted Nov. 18, 1908. J. H. Collings and H. Hirst, 33, Cannon Street, London.
26,135. Enclosed arc lamps. Nov. 26, 1907. Accepted Nov. 4, 1908. G. W. Farthing and T. K. Steanes, 77, Chancery Lane, London.
26,179. Hollow metal filaments for incandescent lamps. Nov. 26, 1907. Accepted Oct. 28, 1908. F. W. le Tall, 2, Norfolk Street, Strand, London. (From A. Lederer, Austria.)
880. Lamp sockets (C.S.). Jan. 14, 1908. Accepted Oct. 28, 1908. A. J. Boult, 111, Hatton Garden, London. (From Benjamin Electric Manufacturing Co., U.S.A.)
2,103. Incandescent lamps. Jan. 30, 1908. Accepted Nov. 18, 1908. Cutler, Wardle & Co., Ltd., and W. Wardle, 55, Market Street, Manchester.
3,076. Incandescent lamps. Feb. 11. 1908. Accepted Nov. 4, 1908. J. A. Leon, 60, Queen Victoria Street, London.
3,266. Arc lamps. Feb. 13, 1908. Accepted Oct. 21, 1908. Johnson & Phillips, Ltd., and S. Paterson, Birkbeck Bank Chambers, London.
4,608. Holders for electric lamps. Feb. 29, 1908. Accepted Nov. 18, 1908. F. W. Suter, Chancery Lane Station Chambers, London.
5,040. Metallic filaments or rods for incandescent lamps (C.S.). I.C. Nov. 9, 1907, France. F. J. Planchon, 40, Chancery Lane, London,
5,387. Incandescent lamps (C.S.). Mar. 10, 1907. Accepted Oct. 21, 1908. A. G. Bloxam, Birkbeck Bank Chambers, London. (From Siemens and Halske, Akt.-Ges., Germany.)
5,416. Filaments for incandescent lamps. Mar. 10, 1907. Accepted Nov. 18, 1908. The British Thomson-Houston Co., Ltd., 83, Cannon Street, London. (From General Electric Co., U.S.A.)
8,416. Incandescent filaments (C.S.). I.C. April 26, 1907, Germany. Accepted Nov. 4, 1908. Wolfram-Lampen, Akt.-Ges., 7, Southampton Buildings, London.
9,620. Hand-fed Arc-lamps. May 4, 1908. Accepted Nov. 11, 1908. J. Bonn and A. E. Jones, 97, Oxford Street, London.
10,098. Filament for glow lamps. May 9, 1908. Accepted Nov. 11, 1908. J. W. Ward and R. H. Stevens, 11, Southampton Buildings, London.
11,600. Filaments of Chinese ink for incandescent lamps (C.S.). I.C. Oct. 30, 1907, Germany. Accepted October 28, 1908. K. Rittersberg and H. Rubert, 67, Knesebeckstrasse, Charlottenburg, Germany.
11,603. Tungsten incandescence filaments (C.S.). I.C. June 8, 1907, Germany. Accepted Oct. 21, 1908, Siemens and Halske Akt.-Ges., Birkbeck Bank Chambers, London. Addition to 16,489/07.
12,644. Arc lamps (C.S.). June 12, 1908. Accepted Nov. 18, 1908. J. O. Girdlestone and C. F. G. Thorkelin, 37, Warwick Road, Ealing.
15,079. Decarbonizing metallic filaments (C.S.). July 16, 1908. Accepted Oct. 28, 1908. H. Aron and A. Geiger, 77, Colmore Row, Birmingham.
15,994. Shade devices (C.S.). July 28, 1908. Accepted Nov. 18, 1908. C. W. Frauenlob, 4, Corporation Street, Manchester.
16,534. Refractory conductors (C.S.). I.C. Aug. 7, 1907, U.S.A. Accepted Oct. 28, 1908. W. D. Coolidge, 83, Cannon Street, London.
17,419. Arc-lamp electrodes (C.S.). I.C. Sept. 3, 1907, U.S.A. Accepted Oct. 21, 1908. G. M. Little, Westinghouse Buildings, Norfolk Street, Strand.

24,211, } Incandescent filaments (C.S.). I.C. Nov. 12, 1907, France. Soc. Fr. d'Incandescence par
24,212. } le Gaz (Système Auer), 24, Southampton Buildings, London. (Additions to 12,720/08).

II.—GAS LIGHTING.

26,373. Upright incandescent mantles. Nov. 29, 1907. Accepted Nov. 11, 1908. F. H. Mitchell, Corrie-Jones, and A. Millward, trading as Lomax & Co., 41, Corporation Street, Manchester.

27,679. Inverted incandescent burner. Dec. 16, 1907. Accepted Nov. 4, 1908. H. Pullen, 27, Listerhills Road, Bradford.

2,606. Street lamps for incandescent lighting. Feb. 5, 1908. Accepted Nov. 4, 1908. T. Glover, 173, Fleet Street, London.

2,951. Automatic gas governor and street pressure changer (C.S.). I.C. Feb. 9, 1907, U.S.A. Accepted Oct. 21, 1908. A. A. Yankee, 118. Holborn, London.

10,223. Regulating nozzles for inverted incandescent lamps (C.S.). May 11, 1908. Accepted Nov. 18, 1908. M. Graetz, 1, Broad Street Buildings, Liverpool Street, London.

13,204. Burning-off gas mantles (C.S.). I.C. Nov. 8, 1907, Germany. H. Drehschmidt, 77, Chancery Lane, London.

13,852. Incandescent lamps with electric ignition (C.S.). I.C. Dec. 31, 1907, France. Accepted Nov. 11, 1908. M. Delage and P. Woog, 25, Southampton Buildings, London.

15,845. Converting pendant with upright incandescent burner into one with inverted burner (C.S.). I.C. Feb. 11, 1908, Germany. Accepted Nov. 4, 1908. F. Heuer, 19, Holborn Viaduct, London.

III.—MISCELLANEOUS

(including lighting by unspecified means, and inventions of general applicability).)

2,492. Turning on and off gas or electric lamps from a distance (C.S.). Feb. 4, 1908. Accepted Nov. 11, 1908. J. V. Wengelin, 111, Hatton Garden, London.

3,060. Systems for the projection of rays (for searchlights, &c.). Feb. 11, 1908. Accepted Nov. 4, 1908. M. Barr and R. A. Bell, 116, Worple Road, Wimbledon, Surrey.

8,104. Filaments for illuminating and heating (C.S.). April 11, 1908. Accepted Nov. 4. 1908. G. Michaud and E. Delasson, 7, Southampton Buildings, London. (Addition to 4,461/08.)

10,662. Burners of reading lamps (C.S.). May 16, 1908. Accepted Oct. 28, 1908. G. Baker, King Edward Street, Whitland, Carmarthenshire.

11,054. Lenses, glasses, or reflectors for motor and other lamps (C.S.). May 21, 1908. Accepted Oct. 28, 1908. A. R. Cosgrove, 19, Holborn Viaduct, London.

15,746. Long distance lighting (C.S.). I.C. July 25, 1907, Germany. Accepted Nov. 11, 1908. J. Lafitte, 111, Hatton Garden, London.

16,602. Incandescent petroleum lamps (C.S.). I.C. Nov. 8, 1907, Italy. G. Bas, 33, Cannon Street, London.

EXPLANATORY NOTES.

(C.S.) Application accompanied by a Complete Specification.

(I.C.) Date applied for under the International Convention, being the date of application in the country mentioned.

(D.A.) Divided application; date applied for under Rule 13.

Accepted.—Date of advertisement of acceptance.

In the case of inventions communicated from abroad, the name of the communicator is given after that of the applicant.

Printed copies of accepted Specifications may be obtained at the Patent Office, price 8*d*.

Specifications filed under the International Convention may be inspected at the Patent Office at the expiration of twelve months from the date applied for, whether accepted or not, on payment of the prescribed fee of 1*s*.

N.B.—The titles are abbreviated. This list is not exhaustive, but comprises those Patents which appear to be most closely connected with illumination.

TRADE NOTES.

Messrs. Siemens Bros. draw our attention to the fact that they are now issuing a coloured label in stamp form, which is a reproduction of their well-known "Satisfied Consumer" poster. Perforated sheets of these labels to be obtained by application, enclosing trade card, to Messrs. Siemens Bros. & Co., 6, Bath Street, City Road, E.C.

Messrs. The British Thomson-Houston Co. Ltd., send us an illustrated card descriptive of the B. T.-H. Edison and Tungsten lamps; also a pamphlet describing the electrical heating and cooking devices by the same firm.

We have also to acknowledge the receipt of the excellently bound and got up 'Verity's Electric Supplies' in three volumes, which constitutes a new departure in catalogues, and presents its contents in an exceptionally complete and handy form.

Among other catalogues of electric, gas, and other fittings received, mention must be made of the publications of *Messrs. The General Electric Co., Ltd.*, and *Messrs. The British Westinghouse Co. Ltd.*, *Messrs. Falk & Stadelman*, *Messrs. Strode & Co.*, and *Messrs. Julius Sax & Co.*