The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

ILLUMINATING ENGINEERING PUBLISHING COMPANY, LTD.
PUBLISHING OFFICES:—ATHENÆUM PRESS, 13, BREAM'S BUILDINGS, LONDON, E.C.
Tel. No. 2120 Central.
EDITORIAL OFFICES:—32, VICTORIA STREET, LONDON, S.W.
Tel. No. 5215 Westminster.

EDITORIAL.

The second Annual Convention of the Illuminating Engineering Society.

The Second Annual Convention of this society was held in Philadelphia during the 5th and 6th of October. It is hardly necessary to state that the meeting has been very successful and that the enthusiasm of the members was evinced both by the exceptional character of the attendance and the standard of the papers read. Indeed, it is probable that few societies could boast of receiving a collection of papers covering such a wide area and containing the results of so much valuable original investigation at their annual meeting. The present years' success again proves, to quote a historic phrase of one of our contemporaries, that "the critics have turned out to be windbags."

Unfortunately, we still observe from time to time, instances, as exemplified by an editorial note in our esteemed contemporary *The Electrical Review* of October 16th, in which the writer proves to be unacquainted with the great work that is being done. In the case of the note to which we refer, he comments upon the attitude of the architect in the United States towards the illuminating engineer, and the tone of his remarks is such as to give the entirely erroneous impression that co-operation between the two professions is not desired.

We do not hesitate to say that no one in a position adequately to judge the conditions in the United States in this respect will endorse this suggestion, founded apparently upon one or two recent isolated utterances. There have been, it is true, many conferences between illuminating engineers and architects in which the views most intimately appealing to both have been put forward, but this frank discussion is desirable and does not in any sense indicate enmity. On the contrary, members of both professions who have taken part in the discussion of recent papers, though naturally differing on many points, have almost invariably agreed in this, that the architect and illuminating engineer could do very much to help one another, and that co-operation was both feasible and desirable. In this connexion the paper by Mr. Perot, read at the Second Annual Convention of the Illuminating Engineering Society, and abstracted in this number, furnishes one more example of the current feeling on this point, for he suggests that the Society should undertake the tabulation of data regarding new illuminants and the lighting of existing buildings for the benefit of the architectural profession.

We think that anyone who has studied our own remarks on this question in previous numbers will understand that we merely desire that architects and lighting engineers should learn as much as possible about the conditions by which both are guided, and needless to say we recognize the standpoints of those in both professions, and wish them to receive full expression.

But apart from the question we have been discussing we cannot help thinking that a comment of this kind, which ignores all but one aspect of illuminating engineering, is singularly inappropriate at the present moment.

The Illuminating Engineering Society have issued a series of papers of quite exceptional merit, and showing very clearly the wide scope of the subject.

We publish elsewhere a complete official list of the eighteen papers read on this occasion, and we are reproducing a selection that, though necessarily curtailed, may serve to indicate their value as a whole; we hope to proceed with the publication of others in our next number, accompanied by some account of the discussion.

The now recognized and valuable work of the Illuminating Engineering movement is supported by many of the greatest authorities on lighting in Europe and America, and therefore we, who are in a position to quote facts and figures in support of our views, are not likely to be discouraged by the mere reiteration of unworthy epithets. This trivial and flippant method of brushing aside pertinent inquiries is only a confession of weakness on the part of our critics.

We confess that we find it a little difficult to understand the present attitude of this particular journal, which in previous issues declared that "there is every reason to believe that the illuminating engineer has come to stay...," that "those who are in any way interested in the design of and manufacture of shades......may be advised to note very carefully what this new form of scientist has to say," and that "there is no doubt that the *science* of illuminating engineering is going to open up a new field of commercial exploitation," &c.

The New Illuminants and the Illuminating Engineer.

Turning to another of the remarks of our critic, we feel bound to protest against what appears to us his peculiarly narrow outlook when he suggests that illuminating engineering would deposit the station engineer in a "yawning gulf" caused by the introduction of the new lamps, and that the scope of the work of the illuminating engineer is therefore more curtailed than in the days when only carbon filament lamps were available!

In reality it is this very multiplication of different sources of light that supplies a very cogent argument for his existence. When only a choice between a few illuminants was possible, the assistance of an expert was relatively less vital. But at the present day it is literally impossible for any but an expert to keep in touch with the maze of modern developments.

Experience in the United States has shown that the illuminating engineer, so far from being a thorn in the flesh of the station engineer, is looked upon as one of the best friends he can possibly have, and so well is this recognized that, as stated in our last number, the Edison Electric Illuminating Co., of Boston, have organized a department of illuminating engineering for the benefit of their consumers. Bearing in mind the work already done by us and others in this country, we think it may at least be conceded that those who write on the subject of illuminating engineering should take reasonable pains to bring their point of view up to date.

Street-lighting.

There are probably few questions in illuminating engineering that are now receiving such continuous and concentrated attention as the subject of street-lighting. But a short time ago we were discussing the report of Mr. A. A. Voysey on the City lighting of London, and recording the visit of Dr. Bell, Mr. Wrightington, and others, who were touring the chief European cities with the object of studying the merits of existing systems.

Some fruits of these studies are given by these two gentlemen in their contribution to the Annual Convention of the Illuminating Engineering Society. Dr. Bell's Presidential Address deals broadly with the subject, and Mr. Wrightington describes his impressions of the lighting by gas in Europe, which are, on the whole, encouraging, especially as regards the use of high-pressure.

An interesting point to which he draws attention is the greater assistance that is derived by the street-lighting in the United States from the efforts of private enterprise in the shape of signs, shop-lighting, and local arc-lights and gaslights, &c. So far as it can be relied upon, assistance of this kind would appear to be very beneficial, for it leads naturally to convenient methods of diffusing the light and the use of small distributed units. This question of the size of units desirable in street-lighting and their distribution seems to be one on which much discussion may be expected in the near future, for the possibility of applying many different types of illuminants to street-lighting which have not previously been much utilized in this connexion is becoming generally realized.

At the same time the question has received considerable attention in Berlin, as will be seen from the recent contributions of Prof. Drehschmidt and Dr. L. Bloch, which we reproduce in abstract in this number. The existing methods in Berlin are of particular interest, and the development and relative merits of high-pressure inverted gaslighting and the new white flame arcs will be closely watched by engineers in other countries.

We are glad to notice that at a meeting of the City of London Corporation on October 22nd it was decided to send a deputation to investigate the street-lighting methods of some of the principal European towns, before extending the use of either high-pressure gas or flame arc lamps for street-lighting purposes in this city.

We trust that the result of this investigation will be of great value, and will contribute to improve the lighting of London so that it may become in time one of the best-lighted towns in existence, instead of, as at present, leaving very much to be desired in this respect.

The International Electrotechnical Commission.

The main point of interest to our readers in the proceedings of the Council of the International Electrotechnical Commission, which assembled in London on October 19th, has been the proposed international unit of light; to this reference was made in our September and October numbers.

The decision of the Council of the Commission, that the question be referred back for reconsideration by the electrotechnical committees of the different countries, in order that arrangements may be made for the needs of gas and electrical industries to be jointly considered, will we think, be regarded as a wise one.

A great deal of very excellent work in the direction of promoting an international unit has recently been done in the United States and elsewhere, and we do not think for a moment that this work will lose in value from the fact that no immediate final decision has been taken. We are particularly in sympathy with the expressed wish of the Council that this matter should be made the subject of discussion between those representing gas and electrical interests. For only by such co-operation it is reasonable to believe that a truly international unit can be arrived at.

Fortunately, we have abundant evidence available that such co-operation is possible. Dr. Humphreys, the President of the Institution of Gas Engineers in the United States, has just presented a very important report on this subject, which we reproduce elsewhere, and which describes the co-operation between the Institutions of Gas and Electrical Engineers in that country, and the Illuminating Engineering Society. In the same way it was interesting to observe from the recently issued report of the Deutscher Verein von Gas- und Wasserfachmännern, that gas engineers in Germany are considering the possibility of adopting or modifying the recommendations of the Verband Deutscher Elektrotechniker regarding the photometric comparison of arclamps.

It seems to us a pity that the recommendations of a body such as the International Commission of Photometry, which has done such exceedingly valuable work in defining photometric quantities and units, should fail to receive the general recognition among all classes of engineers that their importance demands, simply because the members of the commission are almost exclusively drawn from the gas profession, and the Commission has no truly official international character. It seems, by the way, to be a curious anomaly that the gas referees, who are the official testers of gas in this country, should not have been asked to appoint a representative on this commission.

The necessity for more complete co-operation between the representatives of different industries, therefore, may be said to furnish good ground for the council of the commission not having come to any premature conclusion as to international standards. Another reason for deprecating hasty action lies in the more or less incomplete state of the data connecting the values of the various units. The system of co-operation between the official laboratories of different countries has already accomplished valuable work, but yet there are still points to be settled, and therefore it is better not to commit ourselves to international decision. For instance, the recently raised question of the method of measuring the humidity of the air in which the pentane standard is burned in itself compels reconsideration of the proposal of the French national committee; we ourselves would like to see such questions thrashed out yet a little further, until there is no longer any room for doubt as to what the relations between the existing standards really are.

For the above reason we have supported the reconsideration of the proposal, and think that the decision of the Council of the Electrotechnical Commission will be regarded as a wise one; we feel confident that the perseverance in the present concerted efforts between the laboratories of different countries will shortly lead to more satisfactory conditions. Judging from the goodwill and friendly attitude shown by the different delegates towards genuine co-operation, much may be expected from this international gathering in the future. Science has shown once more that it knows no national boundaries, but is international in the true sense of the word.

LEON GASTER.

Review of Contents of this Issue.

Mr. A. P. Trotter (p. 887) continues his treatment of different photometrical instruments, describing, in the present section, the PHOTOMETERS designed by RUMFORD and FOUCOULT, and some of the methods of work of these investigators.

Dr. M. Corsepius (p. 895) completes his article dealing with the GLOBE PHOTOMETER. This article, it will be remembered, is mainly concerned with a NEW METHOD OF OBTAINING THE MEAN HEMISPHERICAL CANDLE-POWER of sources with this instrument. Among other investigations the author studies the effect of tilting the special vessel that serves to obstruct the light in one hemisphere, and arrives at the result that, for the determination of mean lower hemispherical candle-power, this source of error will not be of serious consequence under practical conditions.

Dr. C. V. Drysdale (p. 899) continues his series of articles on the LAWS AND MEASUREMENT OF RADIATION. In the present section he briefly explains Newton's Law of Cooling, and the experiments of Dulong and Petit, and gives some account of the work of Melloni on thermal radiation. Lastly, he gives a diagram illustrating the distribution of energy in the spectrum, as obtained by Tyndall with a rock-salt prism.

Mr. H. T. Harrison (p. 901) contributes an article on the COST OF STREET-LIGHTING. He discusses the general conditions to be observed in order to secure a uniform illumination by gas or electric lamps, and gives some tables showing the connexion between the number of posts and the cost per annum, &c., under various conditions.

The **Special Section** in the present number (p. 913) is given up to the series of papers recently delivered at the SECOND ANNUAL CONVENTION OF THE ILLUMINATING ENGINEERING SOCIETY. A complete official list of these papers is given, and several of them are dealt with in some detail.

The contribution of **Mr. L. B. Marks** (p. 921) deals with the ILLUMINATION OF THE CARNEGIE LIBRARIES in New York City in a very complete manner. The general conditions that must be respected in designing such an installation are discussed and full particulars are given of the exact fixtures used, and the method according to which they are distributed on the various floors of the building.

Dr. A. C. Humphreys (p. 917) gives an account of the work of the COMMITTEE ON NOMENCLATURE AND STANDARDS OF LIGHT, consisting of representatives of the Institutions of Gas and Electrical Engineers in the United States and the Illuminating Engineering Society. It is pointed out that the units of light in common use among those representing the gas and electrical interests differ by about 4 per cent, and the Committee therefore propose that a national unit, intermediate between these two values, should be adopted. This is the more to be desired, because it is expected that the international unit of light, when it is finally accepted, will approach the new American unit very closely.

Dr. A. H. Elliott (p. 921) gives an account of an exhaustive series of TESTS ON DIFFERENT VARIETIES OF PETROLEUM, from the point of view of obtaining a suitable photometric standard. The results are, on the whole, favourable; many of the lamps tested preserved a very constant value over a considerable interval of time, provided that certain conditions are complied with.

Mr. J. E. Woodwell (p. 938) discusses ILLUMINATION FROM THE PHYSIOLOGICAL STANDPOINT. He seems to think that the main danger to be avoided in illuminants is too bright intrinsic brilliancy, and describes the general effect of such sources on the pupil-aperture and the retina. He considers that the limits of permissible brightness that have been set by previous writers are none too low, and would himself prefer that the brightness should not exceed about 0·2 candle-power per square inch of radiating surface.

Mr. E. G. Perrot (p. 941) deals mainly with some of the aspects of illuminating engineering that appeal to the architect. In conclusion, he makes the suggestion that the Illuminating Engineering Society should prepare tables relating to existing illuminants and the conditions of illumination in certain buildings, &c., and other data, of which the architectural profession are in need.

Mr. L. J. Lewinson (p. 943) describes an exhaustive series of tests on daylight illumination carried out in the Electrical Testing Laboratories in New York. He gives some curves illustrating the variation of moonlight and of natural sunlight during different parts of the day, and discusses the effects of clouds and other climatic conditions.

Attention may be drawn to the OBITUARY NOTICE of **Sir George Livesey** on p. 890.

On p. 892 will be found an abstract of the REPORT OF THE ELECTROTECHNICAL COMMISSION, accompanied by a photograph of the various representatives of different countries who took part in the proceedings. The chief point of interest from the standpoint of illuminating engineering is the subject of an international unit of light; the Commission make no immediate decision on this matter, but refer the subject back to individual committees in order that some arrangement may be recommended that will be convenient both to the gas and electrical industries of different countries.

An article on p. 905 discusses the LIGHTING OF LIGHTHOUSES AND BUOYS BY ACETYLENE. Some account is given of the different methods by which beacons and buoys are lighted, the writer remarkng that it is mainly in this direction that acetylene has proved itself convenient. Special mention is made of the use of dissolved acetylene which, in conjunction with a special valve opening and shutting with the heat of the sun, has been widely employed in Sweden. This article is followed by an account of the MANCHESTER ELECTRICAL EXHIBITION, viewed from the standpoint of illuminating engineers (p. 909).

Among other papers dealt with in this number may be mentioned that by **MM. Laporte and Broca** (p. 947) dealing with the EFFECTS OF DIFFERENT ILLUMINANTS ON EYESIGHT. These experiments were carried out on electric incandescent glow-lamps and a mercury-vapour lamp, and included tests of visual acuity, speed of reading, effect on pupil-aperture and the production of retinal images. The authors' experiments suggest the conclusion that the difference in the colour of these sources is of little consequence, and that brightness is the important factor.

The recent papers by **Prof. Drehschmidt** and **Dr. L. Bloch,** abstracts of which appear on pp. 951 and 953 respectively, are of special interest, in that each deals with the STREET-ILLUMINATION OF BERLIN. Some particulars are given of the lighting by high-pressure inverted gas-lights and the new white flame arc-lamps using vertical carbons, the conclusion being, however, reached by DR. L. Bloch that it is not possible to state definitely that either method is invariably preferable; much depends on the local conditions and the improvements in both illuminants approximately balance each other.

Another article (p. 956) contains a résumé of the discussion that has recently been taking place in Germany on the subject of the MERITS OF HIGH-PRESSURE GAS AND HIGH-PRESSURE AIR, for the purpose of improving the efficiency of incandescent gas-lighting.

Mr. A. Denman Jones writes discussing the methods of studying the ABSORPTION OF ARC-LAMP GLOBES, recently proposed by Prof. J. T. Morris and Dr. E. W. Marchant.

At the end of the magazine will be found the usual **Review of Current Literature dealing with Illumination** (p. 961), and the **Patent List** (p. 965).

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.* 800.)

The Rumford Photometer.—Lieut.-General Sir Benjamin Thompson, Count of Rumford, who demolished the theory of caloric by proving that heat can be generated at the expense of mechanical work, wrote to Sir Joseph Banks on Dec. 20th, 1792, a short account of 'A Method of Measuring the comparative Intensities of the Light emitted by Luminous Bodies.' This consisted in observing the shadows cast by a rod on a sheet of white paper. He went into some detail, but on March 1st, 1793, he wrote a much longer letter, which, with the first, was communicated to the Royal Society.*

He described a carefully elaborated instrument, and proposed, if he might do so, "without being suspected of affectation," to "dignify it with a name, and call it a photometer."

The ordinary text-books, whether on physics or photometry, illustrate and describe the Rumford photometer as an arrangement by which two lamps on a table cast two widely separated shadows of a rod on a large screen. Writers of textbooks have a habit of endeavouring to simplify descriptions of apparatus, at the expense of accuracy. This primitive arrangement has the sole merit that it is an example of an arrangement where stray light reflected from the walls of the room or from the ceiling, has but little harmful effect, for it dilutes the two shadows equally. The textbook arrangement leaves out any consideration of the position of the observer, who apparently wanders round the table in the full glare of the lamps. Even so careful a writer as Palaz* says that "generally the two lights are moved along a divided scale perpendicular to the screen, but sometimes in any manner whatever; we then neglect the law of inclination.... In practice, if we wish to measure rapidly the intensity of a luminous source, say to within 10 or 15 per cent, the Rumford photometer is very valuable, in that it is easy to set up, but it makes no pretension to giving results which are rigorously exact." This is not fair to Rumford. He paid the greatest possible attention to the angles of incidence, and nowhere speaks of moving lights along a scale perpendicular to the screen. The Rumford photometer was an admirable instrument, and the inventor was a highly skilled observer.

The complete apparatus for which the term Rumford photometer should be reserved (using the expression the Rumford principle for the bald use of two lights and the shadow of a rod), consisted of two cylinders in a carefully blackened box at the meeting point of two tables. One table was 12 ft. long, the other 20 ft., and each was

* Thompson, *Roy. Soc. Phil. Trans.* 1794, and *Phil. Trans.* Abridged, Vol. xvii. The paper is also to be found in Rumford's Collected Works.

* Palaz, 'Traité de Photometrie Industrielle,' p. 24, or Patterson's translation, p. 26.

10 in. wide. The box had two short tubes through which the light passed on to a paper screen. The observer stood between the tables and examined the screen through a third opening between the two tubes. The apparatus is shown in plan in Fig. 48.

"Finding it very inconvenient to compare two shadows projected by the same cylinder, as these were either necessarily too far from each other to be compared with certainty, or when they were nearer they were in unnecessary objects, the two outside shadows are made to disappear.... they fall....upon a blackened surface, upon which they are not visible."

"As the diameters of the shadows of the cylinders vary in some small degree in proportion as the lights are.... brought nearer to or removed farther from the photometer....I have added to each a vertical wing;....by means of these wings....the widths of the shadows are augmented so as to fill the whole field of the photometer."*

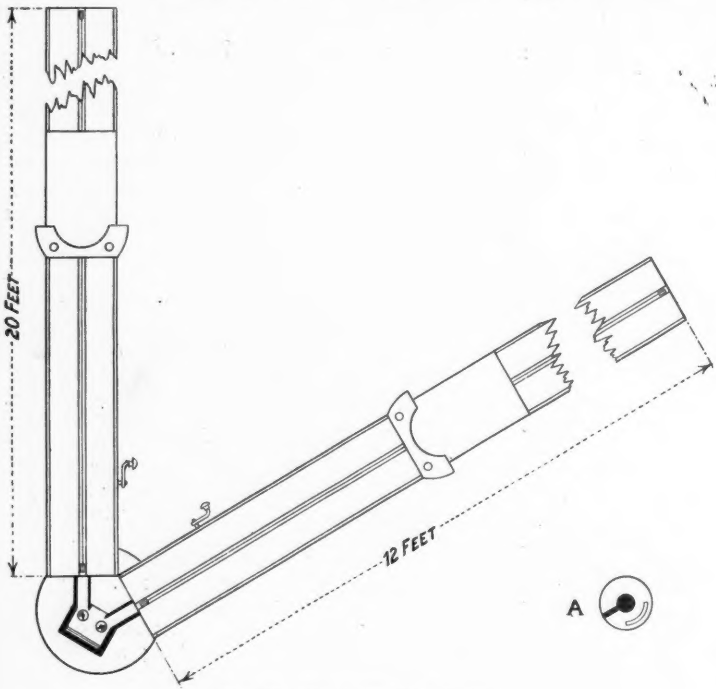


FIG. 48.—Rumford's Photometer.

part hid from the eye by the cylinder, to remedy this inconvenience I now make use of two cylinders....and when the two lights....are properly placed, these two cylinders project four shadows upon the white paper..... which I call the field of the instrument, two of which shadows are in contact precisely in the middle of that field, and it is these two alone that are to be attended to. To prevent the attention being distracted by the presence of

A cylinder with its wing is shown on a larger scale at A, Fig. 48. Count Rumford describes the apparatus in great detail. The lamps were moved by cords and winches, the handles are seen in the illustration. The sliding motion of the lights was "perfectly soft and gentle," an important matter, greatly neglected in many modern labora-

* Thompson, *Roy. Soc. Phil. Trans.* 1794, p. 73, and Abridged *Phil. Trans.*, Vol. lxxxiv. p. 362.

tories. The scales on the tables were graduated for direct reading.

Rumford's 'Experiments upon the Resistance of the Air to Light' appeared to yield no result, but they, indeed, reveal the remarkable accuracy of his work, seeing that he was using candles and oil lamps. These experiments, in fact, serve only to show the errors of the observations, for under the conditions of the experiments he was doing nothing more than testing the law of squares. The following figures are taken from the table of his fifth to his twelfth experiment :—

Distance of light in inches.	203	198·3	202·1	204	198	192·2	191·2	192·4.
Calculated distance.	202	200·4	201·6	203	200	191	190·2	192.

Lest it may be imagined that he was a man who could "fudge," the following extract will prove the contrary, and is worth quoting at length :—

"In order that in judging of the quality of the shadows my mind might be totally unbiassed by my expectations, or by any opinions I might previously have formed with respect to the probable issue of the various experiments, keeping my eye constantly fixed on the field of the photometer, and causing the light, whose corresponding shadow was to be brought to be of equal density with the standard, to move backwards and forwards, by means of the winch which I had constantly in my hand, as soon as the shadows appeared to me to be perfectly equal, I gave notice to an assistant to observe, and silently to write down, the distance of the lamp or candle, so that I did not even know what that distance was till the experiment was ended, and till it was too late to attempt to correct any supposed errors of my eyes by my wishes or by my expectations, had I been weak enough to have had a wish in a matter of this kind. I do not know that any predilection I might have had for any favourite theory would have been able to have operated so strongly upon my mind,....but this I know, that I was very glad to find means to avoid being *led into temptation*."*

The Foucault Photometer.—From the Bouguer to the Foucault photometer there was but a step. Foucault shielded the transparent screen from stray light with a box, and provided an adjustment by which the dividing partition, nearly but not quite touching the transparent screen, could be set so that the two illuminated halves could be made to meet with hardly any shadow or bright space. Fig. 49 is copied from Foucault's original illustration.† He found that two candles taken from the same packet varied at each instant, and gave the same light only accidentally, and almost always showed "a shocking inequality." He therefore used a bunch of seven.

Foucault attached great importance to the construction of the screen, and recommended a layer of starch on glass.

(*To be continued.*)

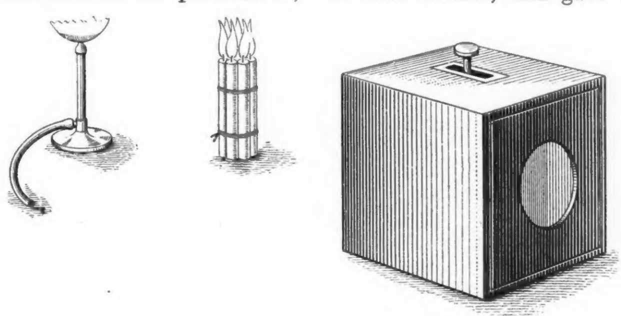


Fig. 49.—Foucault's Photometer.

* Thompson, *loc. cit.*, p. 90.

† L. Foucault, 'Recueil des Travaux Scientifiques,' 1878, p. 103.

SIR GEORGE LIVESEY.

It is with great regret that we record the death of Sir George Livesey, which occurred on Sunday morning, October 4th, at the age of seventy-four years.

It is impossible here to enter upon so vast a task as a detailed account of Sir George's life and work; they are bound up with the progress of the South Metropolitan Gas Company, whose service he entered in 1848.

But it is perhaps permissible to take this opportunity of referring to a few of the qualities which raised Sir George Livesey to his eminent position, and were so effectual in gaining the respect and affection of those who served under him.

His patient and thorough habit of mind led him to form conclusions cautiously; yet his decision once taken, nothing could shake his resolution in the pursuit of a course of policy which he believed to be correct.

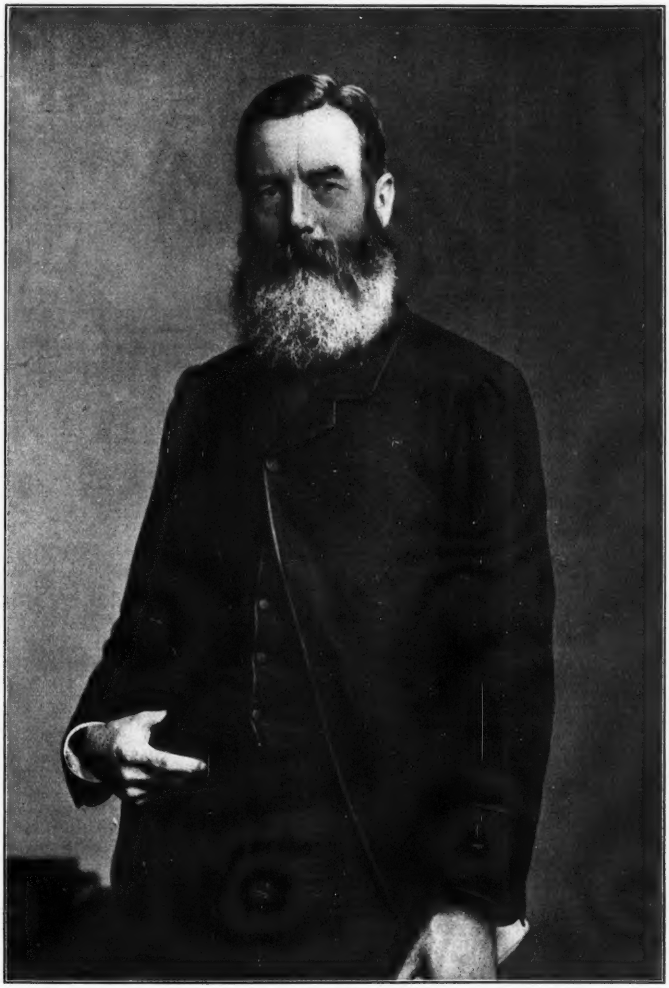
Sir George Livesey united with his scientific attainments a wide knowledge of human nature and rare administrative ability. His power of sympathy with those working under him led to a feeling between employer and employee such as it is given to few to inspire; the bearing of his unique work on social problems will be recognized and valued in the future perhaps even more than to-day. To all details of his business Sir George Livesey brought the same wide view, the same strong sense of justice, and the same broad sympathy with the needs of consumer and supplier alike.

When the writer, a few years ago, sought his advice on the prospects of illuminating engineering, Sir George Livesey found time amidst his unceasing duties to listen with ready patience and sympathy, and to give him the benefit of his great experience. With a characteristic wideness of view he explained that, although it was to him inconceivable that he could ever be other than a representative of gas interests, yet he believed in the need for greater facilities for an exhaustive study of the true merits of the different illuminants, and cordially agreed that the subject of illumination deserved fuller attention.

We desire to offer our respectful sympathy to Lady Livesey and the family in the great loss that they have sustained—a loss that is shared by the nation.

The foundations of Sir George Livesey's work were too truly laid in his lifetime to suffer now; but he himself is missed and regretted by all who ever knew him.

THE EDITOR.



[Reproduced by permission of the *Journal of Gas Lighting.*

Portrait taken after the South Metropolitan Gas Works Strike in 1889.

SIR GEORGE LIVESEY.

The International Electrotechnical Commission.

THE first meeting of the Council of the International Electrotechnical Commission was held on Monday, October 19th, 1908, in the Medical Hall on the Victoria Embankment, when an address of welcome was delivered by the Right Hon. A. J. Balfour, M.P., and Sir John Gavey, C.B., took the chair. Prof. Elihu Thomson was elected President of the Commission.

One of the main questions that came before the Commission was that of devising an improved system of electrical nomenclature and symbols, and their subsequent publication. It was proposed that a complete glossary of technical terms in different languages should also be prepared, indexed in alphabetical order.

On these questions the decision has been arrived at that, for the present, the attention of the different electrotechnical committees shall be concentrated on the definition of terms for subsequent compilation in the form of an official glossary, which should afterwards be duly authorized by the Council for publication. In so doing, however, each committee will, wherever possible, utilize the work already done by others, due credit being given in each case.

It was also decided that in cases in which the International Electrotechnical Commission has to make use of measurements in its work, the metric or Centimetre-Gramme-Second system shall be employed, but that, in order to meet the needs of those countries in which the metric system is not employed, individual committees shall have the right to add the equivalent value in brackets.

A very important proposal was submitted by the French Committee for discussion relating to the suggested international agreement upon a standard of light.

The exact terms of this proposition were as follows :—

The French Committee, recognizing the advantage which would be gained by the international agreement as to the standard of light, and seeing that the first investigations with regard to an absolute unit of white light have received official sanction by the decisions of the International Commission on Electrical Units of May 2nd, 1884, and of the International Congress of Electrical Engineers of August 31st, 1889, admitting that the present position of affairs in regard to the standard of light is similar to that which existed in 1884 with regard to the ohm, desires to put forward the following suggestions :—

"Whilst awaiting further investigations into the question of the absolute standard of light, that for practical requirements of standard of light be provisionally adopted under the name of "international candle," related in the following manner of the various standards at present in use, and which take cognisance of the decisions of the International Commission on Photometry, held at Zürich in 1907.

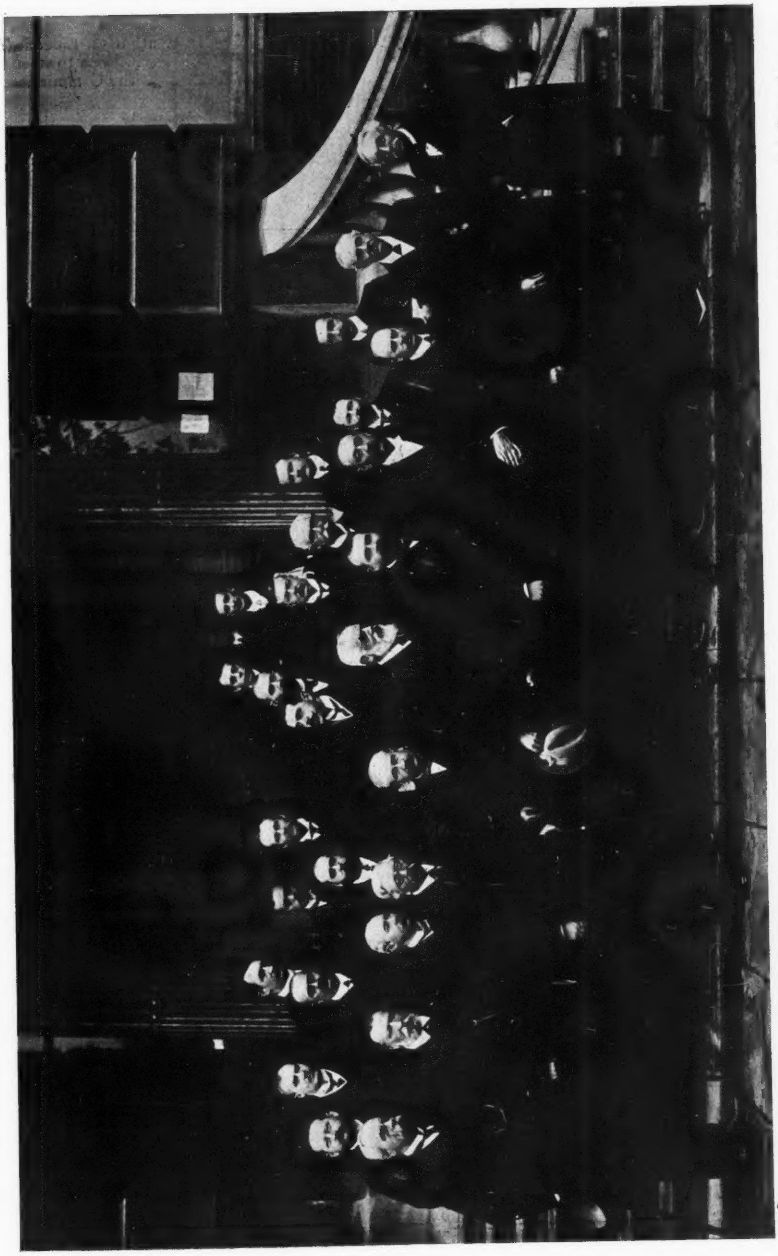
1 International Candle = 0·104 Carcel.
1 International Candle = 1·12 Hefner.
1 International Candle = 0·102 Vernon Harcourt.
1 International Candle = 0·98 Candle the Bureau of Standards.

The Council of the Commission, however, were wisely of opinion that this proposition should be adjourned in order to allow the different Electrotechnical Committees to be more completely informed on the subject, and also recommend that these committees should endeavour to arrange matters in such a manner as to satisfy the needs of both the gas and electrical industries in the different countries.

The following is an official list of the representatives of different countries taking part in the Commission :—

Argentine Republic	
Australia ...	... Mr. C. W. Darley.
Brazil ...	... Sr. H. Vascoucellor.
Canada ...	... Mr. Ormond Higman.
Denmark	... Mr. S. A. Faber, Prof. Abaslon Larsen.
France ...	... M. Paul Boucherot. M. Ch. David.
Germany	... Dr. E. Budde, Herr G. Dettmar.
Great Britain	... Sir John Gavey, C.B., Prof. Silvanus Thompson, F.R.S.
Holland ...	... Prof. Haga.
Hungary	... Mr. Joseph Vater.
Japan ...	... Dr. Osuke Osano, Mr. S. Kondo.

Mr. C. le Maistre, Acting Secretary.



Prof. S. P. Thompson, Official Delegate for Great Britain. | Sir John Gavey, Official Delegate for Great Britain. | Right Hon. A. J. Balfour. | Col. Crompton, Hon. Sec.

Members of the International Electrotechnical Commission.

Mexico ...	... General Don J. M. Perez, Sr. Alfonso Castello.
South Africa	... Mr. Lee Murray.
Spain ...	... Sr. Madariaga, Sr. Montenegro.
Sweden ...	... Prof. Svante Arrhenius.

Mr. Mailloux (U.S.A.), Mr. L. Gaster (Roumania), Mr. Maximo Croskey (Paraguay), Mr. Alex. Siemens, Mr. Robert Kaye Gray, Mr. Mordey (President of the Institution of Electrical Engineers), received special invitations to attend the meetings of the Council of the Commission, without vote.

The International Conference on Electrical Units.

THE Conference was opened on Monday, Oct. 12th, in the Rooms of the Royal Society, Burlington House, London, an address being delivered to the delegates by the Right Hon. W. S. Churchill.

At the first meeting a resolution was moved by Mr. A. P. Trotter to the effect that the fundamental electrical unit should be determined on the electro-magnetic system with reference to the C. G. S. units of length, mass, and time, and carried unanimously.

Prof. Warburg next proposed that the International ohm should be defined as the resistance of a specified column of mercury. This was agreed to after some discussion, but the question of the exact dimensions of the mercury standard was eventually referred to Committee.

At the second meeting of the Conference Dr. Glazebrook moved that the ampere be regarded as the second primary electrical unit. Dr. Glazebrook referred to the exactitude with which the ampere could be determined by electrochemical means, and pointed out that the determinations of the ohm and ampere were quite independent. This, of course, did not invalidate the use of standard cells and resistances for ordinary measurements.

Some discussion on the merits of the Clark and Weston cells as a means of defining the volt followed, but eventually the resolution that "the ampere is the second primary unit" was carried, and it was also agreed that specifications should be prepared by a committee relating to the mercury ohm, the deposition of silver for the purpose of determining the ampere, and the Weston cell.

Finally it was agreed that the international volt is to be a derived unit from the two primary units, the ampere and the ohm. The international volt is thus defined as the electrical pressure, which, when steadily applied to a conductor whose resistance is one international ohm, will produce a current of one international ampere.

At the third meeting the additional resolution "that the ohm is the first primary unit" was formally put to the Conference by Dr. Glazebrook and carried unanimously.

The Measurement of Mean Hemispherical Candle Power by the Aid of the Ulbricht Globe Photometer.

By Dr. M. Corsepius.

(*Continued from p.* 806.)

In the calculation on p. 806 it has been assumed that no upper screen is necessary. In the case of lamps provided with diffusing globes such a screen is still required, in spite of the use of the vessel, in order to cover the illuminating surfaces of the globe projecting from the vessel (see Figs. 4 to 6); but this constant of calibration is not affected thereby.

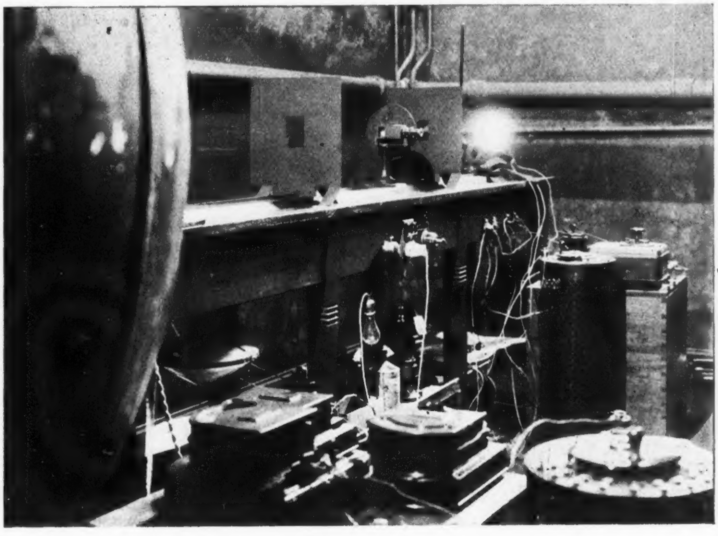


Fig. 3.—General View of Apparatus.

If, as explained above, we carry out two separate calibrations with and without the vessel respectively, the values of $I_{\circ}$ and $I_{\ominus}$ subsequently resulting from the use of the constants so obtained must ultimately be corrected by applying the corrections we have just worked out, and these, as we have seen, are extremely slight.

The effect of the introduction of foreign bodies on the integral brightness of the globe, and the difference between the two constants of calibration, can be calculated by the methods developed by Prof. Ulbricht. Thus in the case of small lamps the foreign body will consist of a hemisphere *h*, built out of copper sheet, and 30 centimetres in diameter; this consists of two separate portions, one a black circular disk, and the other a white hemispherical surface. In this case $a = a_1 = 0{\cdot}2$, and the difference amounts to about 3 per cent. But this quantity need not be taken into consideration, for its effect is eliminated by means of the double calibration with and without the vessel. On the other hand, when one has become acquainted with the difference between the two values by a long series of experiments upon different types of lamps one can calculate the second constant of calibration from the first, and need, therefore, only make one determination. In either case, however, we are enabled to make use of an unscreened standard lamp for the purpose.

The photometrical apparatus is shown in Fig. 3. The position of the vessel G in Fig. 6. As a result the value observed varied about 6½ and 17 per cent in the two cases. Such displacements of the vessel are, however, very obvious to the eye, and may easily be avoided without the help of any specially designed apparatus. One can, however, easily make assurance doubly sure by the aid of a plumb-line or level. In any case, however, a displacement, such as that shown in Fig. 5, would only give rise to an error of about 0·52 per cent in the final result.

For the purpose of determining the position of the radiant centre of illu-

FIG. 4.—Vessel truly Horizontal.

FIG. 5.—Vessel slightly Oblique.

within the globe may be seen in the photographs represented in Figs. 2 and 4; Fig. 2 shows the smallest, and Fig. 4 the largest of the forms adopted.

I have also considered the possibilities of errors introduced by not keeping the circle of section strictly horizontal, under practical conditions. The mean hemispherical intensity of the upper hemisphere was determined in the case of the lamps mentioned in Table I., first with the face of the vessel truly horizontal, as in Fig. 4; secondly, hung slightly oblique, as in Fig. 5; and lastly, still more crooked, as shown

minants I have availed myself of the variety of tester due to Ulbricht, and constructed by Stieberitz of Dresden; such an instrument, possessing two prisms and two view-holes, is shown in Fig. 7.

Fig. 8 shows an arc-lamp of the usual variety equipped with a highly transparent alabaster globe. The horizontal line indicates the position of the plane corresponding to the position of the radiant centre.

Although the glass is of such a transparent nature, it is worthy of note that the shadow of the carbons and the guide-rods is clearly visible, the plane indicated lying in reality not as suggested by the line in question, but much lower. Even comparatively transparent glass therefore exerts a certain diffusing action. This fact may be deduced from the last row of measurements in the table previously mentioned.

Finally, it is of interest to make some reference to the effect of diffusing globes on the value of the mean hemispherical candle-power. Although the few figures given in the table hardly suffice to enable us to trace a definite

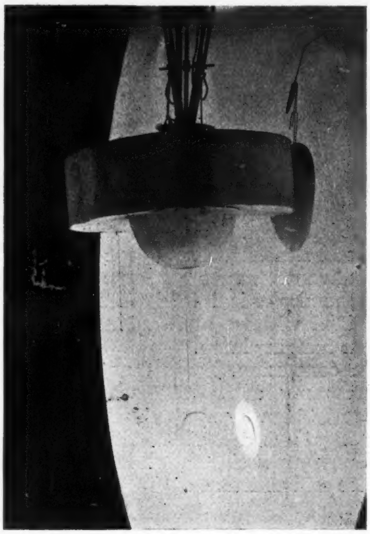


FIG. 6.—Vessel still more Oblique.

numerical connexion, there can be no question that the effect exists, and makes itself especially evident when hemispherical candle-power is considered.

Under the heading "k_g hem." are given the ratios between the mean hemispherical candle-powers, obtained without and with a diffusing glass globe respectively. We see at once that considerable differences are introduced between the ratios of the contributions in the two cases, and that, as Ulbricht has already shown, a determination of the mean hemispherical candle-power, using a clear glass globe, furnishes no indication as to what the same quantity, using a diffusing globe, will be. Under the heading "k_g spher." the corresponding ratios for the mean spherical candle-power are given. In this case the differences are distinctly lower.

We may conclude, therefore, that it is unwise to attempt the value of the mean hemispherical candle-power when a diffusing globe is used by the aid of a known coefficient of absorption of the glass, and a knowledge of the same quantity obtained for the naked source or for the source screened with clear glass. And it may be also remarked that the light from a naked arc-light is usually altered in two distinct ways when a diffusing glass globe is utilized, being affected not only by the absorp-

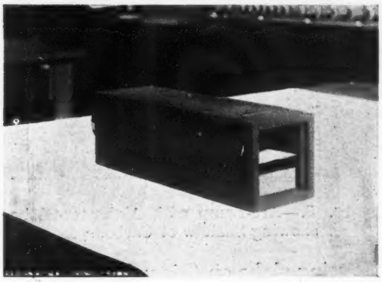


FIG. 7.—Apparatus for Determining Position of Radiant Centre.

tion of the glass, but also by the greater or less admission of air and the altered circulation, which often constitute quite as influential a factor as the former.

It must also be recognized that naked arc-lamps are now never used for practical purposes of illumination, and lamps with clear globes but very seldom. As we have seen, the effect of diffusing glass is such that measurements of the mean hemispherical intensity with clear globes afford no positive data as to the performances of the lamp in this direction. Even if we elect to measure the mean spherical intensity we do not actually avoid the same effects in practice, though the unknown effect of the globe on relation between the upper and lower hemispherical candle-power is eliminated.

On the other hand, the hemispherical candle-power in the lower hemisphere is in some cases the most important consideration, and such a measurement takes no account of the effect of the diffusing globe on this value. In other cases—for indoor illumination, for example—the intensity in the lower hemisphere is by no means the only value to be considered.

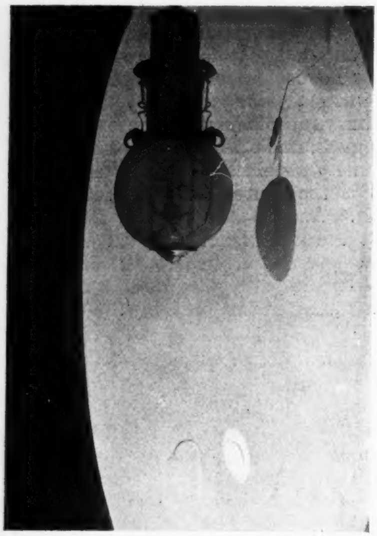


FIG. 8.—Arc-Lamp with Alabaster-Globe, showing Shadow of Carbons, &c.

In any case, whether we elect to measure the mean spherical or mean lower hemispherical intensity, we must take account of this diffusing action of the glass in a scientific manner, and cannot regard measurements using clear glass globes as effective for practical purposes.

On the whole it may justly be concluded from what has been said previously, that, as prescribed by the Verband Deutscher Elektrotechniker, *both* mean spherical and mean lower hemispherical candle-power should be measured, and the method of measurement described seems adapted to enable us to obtain both these quantities in a convenient and correct manner; measurements should also be carried out both with clear and diffusing globes.

It may be added that the vessel G may be placed above instead of below a source of light, its circle of section being maintained in the plane through the radiant centre as usual, thus enabling the lower hemispherical intensity to be obtained by means of a single measurement. This method has also the advantage that both the spherical and hemispherical intensities may be obtained without altering the position of the hanging lamp.

In conclusion, I must not omit to express my acknowledgment of the interest taken by Prof. Ulbricht in the investigations described in this article, and my appreciation of his valuable advice and assistance.

A CORRECTION.

We are requested to make a correction in the formulæ which appear in the article by Dr. M. Corsepius in *The Illuminating Engineer* for October on p. 806.

These formulæ should read as follows :—

$$f - f_1 = \frac{F.\ a}{\pi}\left\{\frac{\cos^7 a}{(2\cos^2 a - 1)^2\ (r - x)^2} + \frac{\cos^3 a}{4\,x^2}\right\} - \frac{F_1\ a}{\pi}\left\{\frac{\cos^7 a_1}{(2\cos^2 a_1 - 1)^2 (r - x_o)^2} + \frac{\cos^3 a_1}{4\,x_o^2}\right\}$$

$$f - f_1 = \frac{F.\ a}{\pi}\ \frac{\cos^7 a}{(2\cos^2 a - 1)^2 r^2} - \frac{F_1\ a}{\pi}\left\{\frac{\cos^7 a_1}{(2\cos^2 a_1 - 1)^2 (r - x_o)^2} + \frac{\cos^3 a_1}{4\,x_o^2}\right\}$$

The Production and Utilization of Light.

The Laws and Measurement of Radiation.

By Dr. C. V. Drysdale.

(Continued from p. 824.)

We may now pass from the methods of measurement to the results which have been obtained, and which are of such great importance. A brief résumé only of the earlier work will be given, as it is to be found at greater length in standard works such as Preston or Ganot.

Newton's Law of Cooling.—The first attempt to enunciate a law expressing the rate of loss of heat was made by Newton. He assumed that the rate of cooling of a body in a current of air was proportional to the difference of temperature between the body and the air. This law has been found very convenient, and sufficiently accurate to be employed when the difference of temperature is not more than a few degrees, but it breaks down utterly for large differences of temperature.

Experiments of Dulong and Petit.—An elaborate investigation was made in 1817 by the above two workers, into the cooling from large thermometer bulbs. By conducting experiments both in gases and in vacuo, they were able to separate convection from radiation, and to obtain empirical formluæ for each. Their conclusions were as follows :—

For radiation $R=k(a^t-a^{t_0})$ where R is the rate of radiation, k and a are constants, and t and t_0 the temperatures of the body and surrounding gas respectively. For convection

$$V=mp^c(t-t_0)^{1\cdot233},$$

where V is the velocity of cooling, m and c are constants, and p is the pressure of the gas.

The former of these two formulæ has been superseded by that of Stefan, described below; but the second still represents almost all that is known as to convection loss. By aid of these two formulæ, Thomson was able to separate the radiation from the convection losses in the case of his hollow sphere containing boiling water, which was used as a standard of radiation in his determination of the mechanical equivalent of light, described in the last chapter. MM. Provostaye and Dessains in 1846 carried out further experiments on the lines of those of Dulong and Petit, and somewhat modified their conclusions.

Work of Melloni.—Before passing to the more recent and accurate laws of radiation, some mention must be made of the work of other experimentalists. Melloni in 1833 carried out a vast number of experiments on the transmission of radiation, and the properties of various substances, using the thermopile as receiver. His conclusions may be briefly summarized as follows—

Radiation travels in straight lines in all directions from a hot body, and is propagated in a vacuum as well as in air. Its intensity or heat received per unit area is proportional to the temperature of the source, inversely proportional to the square of the distance from it, and is smaller the greater the obliquity of the path to the radiating surface. We have already seen, however, that the proportionality of radiation to temperature only holds over a very limited range.

Melloni also demonstrated that radiant heat could be reflected and refracted, with the same laws as those of light; and he, Leslie, and others investigated the radiating, absorbing, transmitting, and reflecting powers of various substances. The conclusions derived were as follows :—

Black surfaces possessed the highest radiating and absorbing power. A perfectly black surface, *e.g.*, lampblack absorbed practically the whole of any radiation that fell on it. A polished metal surface only radiated or absorbed about 10 per cent (or in the case of burnished silver only 2.25 per cent) of that radiated or absorbed by a black surface. The radiating and absorbing powers of a surface were always found to be equal.

The reflecting power was found to vary from 97 to 74 per cent for various metals down to zero for lampblack.

Lastly, the transmission or diathermancy varied very much. Glass and alum only transmitted about 10 per cent of the heat falling on them, while rock-salt transmitted 92 per cent, and fluorspar under some conditions as much as 78 per cent. As a rule, however (rock-salt excepted), the proportion transmitted is smaller for radiation from low temperature sources than from those at a higher temperature.

Tyndall in 1862 greatly extended the study of absorption, especially as regards gases. But his principal advance was in the investigation of the distribution of energy in the spectrum. Using a rock-salt prism to form a spectrum, and a line thermopile, by which the intensity of radiation could be measured in a very narrow portion of it, he found that the intensity in the luminous portion of the spectrum increased on passing from the violet to the red end, and that on going still further outside the spectrum the deflection still continued to increase for some little distance, after which it rapidly fell away.* The curve of distribution of intensity was, in fact, like that in Fig. 1. It was further noticed that the position of maximum intensity varied with the source, being considerably beyond the visible spectrum with a low temperature flame, and only slightly outside it with an arc.

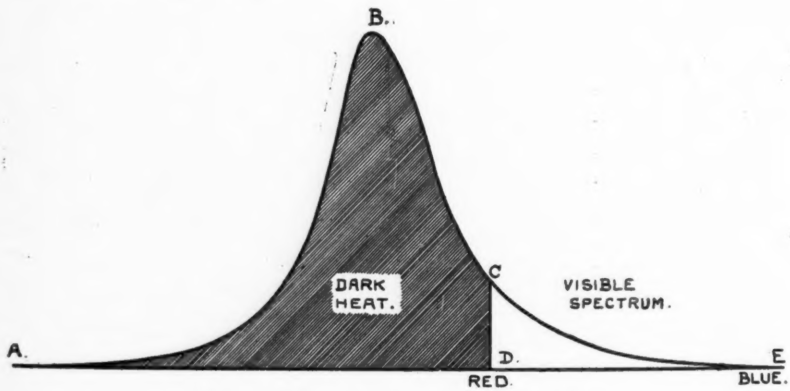


Fig. 1.—Thermal Spectrum of Electric Light.

Tyndall thus devised the spectrum integration method of determining luminous efficiency, by comparing the radiation within the spectrum with the total radiation from the source. He also devised the absorption method previously described.

* The greater intensity of heat outside the spectrum had indeed been noticed by Herschel as far back as 1800.

(To be continued.)

The Cost of Street Illumination.

BY HAYDN T. HARRISON, M.I.E.E.

STREET-ILLUMINATION is more often called street-lighting, probably because it generally refers to a number of lights erected in streets, which do little more than indicate the position of the road and pavements. The making of a street or road is in most cases in the hands of the local surveyor, who more often than not treats the whole thing as his father did before him, with the exception that he uses gas or electric lamps for the lighting of his streets in place of oil; but his method of obtaining what he considers suitable lamps for this purpose is to specify not the light these lamps should give, but the quantity of gas or electrical energy they should take. The result is that thousands of streets in this country are still lighted in the same way as they were twenty years ago; whereas if a little attention were paid to the correct arrangement and candle-power of the lamps, and the number of posts necessary to each street, far better illumination would be produced at a much lower cost.

The writer was asked to advise as to the best way of improving the illumination in the streets of a small town where both gas and electricity were available for the purpose; the latter being supplied through overhead mains attached to posts erected at the side of the road at about forty yards apart. The gas company had been asked to erect the lamp which they would recommend; and—though the reader possessing some knowledge of the elementary laws of illumination, may find it difficult to believe—they erected a post and lantern containing two inverted gas mantles. This appealed to a few members of the council on account of its brilliancy, but the majority at once noticed that, with the exception of the road and pavement close to the post, the illumination resulting was very poor. If the manager of the local gas company had had the slightest knowledge of the laws governing illumination he would have known that inverted mantles were quite unsuitable for street lighting in places where the posts are low and at long distances apart, and that ordinary mantles were well adapted for the purpose, owing to the relatively high candle-power of the rays approaching the horizontal.

The electrical engineer who consulted the writer followed his advice, and hung up, between the adjacent poles supporting his mains, eight 16-candle-power 25-volt osram lamps, connected in series. These came at distances of 15 yards apart, and the cost of erection and all materials was less than that of the one gas-post and fittings: the relative cost of lighting was the same. The interesting part, therefore, was the respective results as regards illumination. It requires very little calculation to see that the minimum illumination with the electric lamps—owing to their close proximity—was as high as it is even in Oxford Street; and, with the gas, lower than it would have been if a single ordinary gas mantle had been used.

I have put forward this as an example of the effect of a little intelligent use of the laws of illumination, which in this case resulted in ten times better illumination being obtained at the same cost. But as many readers will ask what was the opinion of the council or of the man in the street, I might mention that in the future the whole town will probably now be lighted by small candle-power lamps at short distances apart.

It is quite time that the method of simply putting up so many gas lamps or electric lamps in a street at conventional distances apart was abandoned in favour of some more scientific allotment of the various forms of light available for the purpose. The actual cost per thousand burning hours of the various types of lamps, and the candle-power to be obtained from each type, can now readily be ascertained by all surveyors or lighting committees. Therefore the type to use and the disposition of same for each individual case should not be difficult to decide, provided the matter is dealt with in a scientific or commonsense manner.

To take an example, let us suppose that various forms of lamps are obtainable at the following costs, including interest on capital charges :—

TABLE I.

Type o Lamp.	C.P. at 10° below horizontal.	Cost per annum of 4,000 hours (average).
(a) Electric flame arc lamp...	1,200	£20 0
(b) ,, ,,	800	18 0
(c) Electric open type arc lamp	600	18 0
(d) Gas high intensified lamp	600	17 0
(e) Electric enclosed arc lamp	400	14 0
(f) Gas, 2 mantle-burners ...	100	16 0
(g) Electric metal filament lamp	100	5 0
(h) Two electric metal filament lamps	100	6 0
(i) Gas, single mantle-burner	50	3 5
(j) Electric metal filament lamp	50	3 0
(k) Electric metal filament lamp	16 (Low voltage series)	1 0

This is a large choice, and is, of course, not always available; but it has been made as comprehensive as possible for the sake of an example, and any type not at his disposal can be struck out by the reader.

As it is now generally admitted that the minimum illumination at any part of the street is the correct factor on which to base street-lighting, it is necessary to see how many lamps of any type would be necessary to illuminate a mile of street up to a given standard, the average standards at present being as follows :—

TABLE II.

Class of Street.	Minimum Illumination.	Relative.
(a) Country roads	·005 c.f.	(1)
(b) Side streets	·01 c f.	(2)
(c) Main streets	·05 c.f.	(10)
(d) Important thoroughfares	·1 c.f.	(20)

Minimum illumination is at a point halfway between the posts, and is equal to the candle-power of the lamp divided by the slant distance squared, the slant distance being equal to the height of the lamp squared plus the distance to the centre of the post squared. This is given by the following formula :—

(1) $$i = \frac{CP}{\left(\frac{D^2}{2}\right) + H^2}$$

Where

i=Minimum illumination.

CP=Candle-power of rays approaching horizontal.

H=Height of lamp.

D=Distance between posts in feet.

But knowing the illumination and requiring to know the distance apart of the posts, the formula can be used as follows :—

(2) $$\left(\frac{D}{2}\right)^2 = \frac{CP}{i} - H^2$$

(3) $$D = 2\sqrt{\frac{CP}{i} - H^2}.$$

If the posts are erected alternately on either side of the road the number of posts for any given distance would not be represented by that distance divided by D, as D is the distance between two posts on opposite sides of the road, and is equal to a length of road represented by :—

(4) $$D = \sqrt{d^2 + a^2}.$$

Where :—

a=Width of road between the kerbs on which the posts are erected.

d=Length of kerb between each post.

Thus in order to find the number of posts to a given length of road if the posts are staggered, we have to find d as follows :—

(5) $$d = \sqrt{D^2 - a^2}.$$

Or in conjunction with the formula (2) :

(6) $$d = \sqrt{\left(2\sqrt{\frac{CP}{i} - H^2}\right)^2 - a^2}.$$

Applying this formula, for example, to a mile of street, 40 feet from kerb to kerb, to be lighted up to the standard of a main street, namely, with a minimum illumination of ·05 candle-feet, by lamps erected 20 feet high, and giving 1200 candle-power, erected on the kerb on alternate sides, by using formula (6) we find that the distance d between each post measured along the kerb equals :—

$$d = \sqrt{(2\sqrt{\frac{1,200}{\cdot 05}} - 20^2)^2 - 40^2}.$$

$$= \sqrt{(2 \times \sqrt{24,000} - 400)^2 - 1,600}.$$

$$= 303 \text{ ft. or } 101 \text{ yards.}$$

Thus, with the posts at distances of 101 yards the number of posts per mile will be 17·6.

From the same formula we can calculate the number of posts for each of the other units of light, and the result will be found to be as follows. The cost per mile is also given by multiplying the number of posts by the cost per annum given in Table I. :—

TABLE III.

Type of Lamp.	Number of posts per mile.	Cost per annum per mile.
a (20 feet high) ...	17·6	£352
b ,, ...	21 5	387
c ,, ...	25	450
d ,, ...	25	425
e ,, ...	31	434
f (12 feet high) ...	70	350
g ,, ...	70	350
h ,, ...	70	420

As any smaller unit would work out at less than 40 feet apart, it is obvious it could not be used for a road such as the example before us, which is 40 feet wide ; but in the case of country roads, where the minimum illumination permissible is ·005 candle-feet, a very different financial result occurs, as will be seen by examination of the next table, worked out from the same formula, for a road 30 feet wide between the kerbs :—

TABLE IV.
Minimum Illumination ·005 C.F.

Type of Lamp.	Number of posts per mile.	Cost per annum (40,000 hours) per mile.
a (20 feet high) ...	5·5	£110
b ,, ...	6·6	119
c ,, ...	7·6	137
d ,, ...	7·6	130
e ,, ...	9·4	132
f (12 feet high) ...	19	95
g ,, ...	19	95
h ,, ...	19	114
i ,, ...	27	88
j ,, ...	27	81
k ,, ...	52	52

On comparing the two foregoing tables it is obvious that for wide thoroughfares where high illumination is required large units of light can be used without increasing the cost, but for roads where a low degree of illumination is permissible small units will give the required result at a much lower cost.

It will thus be seen that, provided the total costs per annum of the various sources of light are known, it is only a matter of calculation to ascertain which is the most economical to use ; but it must be borne in mind that, owing to the fact that the candle-power of lamps is defined in so many different ways—such as spherical, hemispherical, or maximum—it is necessary to obtain guarantees not of any of these ratings, but of the candle-power between the horizontal and thirty degrees below the horizontal. This includes angles over which it is essential the candle-power should be high, as these rays have to illuminate objects in the distance.

The importance of this point is well illustrated by an open type electric arc-lamp, any maker of which will guarantee 1,000 candle-power for 500 watts. The maximum candle-power obtained with a clear glass globe would probably be 1,000 at the best angle, which is 50 degrees below the horizontal. But if asked for the candle-power at an angle of ten degrees below the horizontal, a conscientious maker would probably only guarantee 500 candle-power, which is the usual figure found in practice with opalescent globes.

As regards the cost of maintenance of various sources of light, this is generally undertaken by the department supplying the gas or electricity, and it will be found that where there is competition the sums estimated by the competitors are as low as they can possibly be; but this cost will obviously be much affected by local conditions and the length of the contract. For instance, if a contract is entered into of such duration that it would pay the electricity undertaking to lay a special street lighting network of mains—thus saving the cost of lamp-lighters' wages

—a considerable saving would be effected, and a low tender could be submitted. On the other hand, councils do not like entering into lengthy contracts, as improvements may come about by which they could obtain better illumination at a lower rate. Therefore the type of contract in which the consumption of gas or electricity per lantern is specified is found most satisfactory, provided a clause is inserted by which the supply undertaking agrees to periodically replace such lamps, if called upon, for any improved types which may be brought out, the cost of such replacements to be borne by the local authority.

In conclusion, it cannot be too strongly emphasized that all contracts relating to street lighting should insist upon the degree of illumination specified being maintained and, if possible, a heavy penalty be charged if the illumination is allowed to fall below the limit. It is true that this involves periodic testing by the surveyor or his assistant, but as illumination photometers for use in the street can now be obtained at a reasonable sum, and these instruments, after a little practice, can be relied upon to give accurate results within 5 per cent, no surveyor's department should hesitate to undertake this work.

A Deputation to Study Continental Street Lighting.

In a previous number attention was drawn to the action of the Boston Finance Commission in sending experts connected with gas and electric lighting to Europe to study the existing methods of lighting before deciding on a method of illumination for their own city.

It is therefore interesting to observe that at a meeting of the City of London Corporation on Thursday, Oct. 22nd, it was proposed to appoint a deputation for a similar purpose, the estimated cost being 200*l*.

Some of those present were disinclined even to spend this sum; but it was pointed out by others that thousands of pounds of the ratepayers' money might eventually be saved in this way. At the present moment the Committee were actually not in a position to decide what was the best existing method of lighting, and until this matter was thrashed out, the same uncertainty would prevail.

Ultimately the Committee's recommendation was accepted by a large majority.

Cantor Lectures on Illumination.

A series of four Cantor Lectures, dealing with the latest developments of the different illuminants, and the science and art of illuminating engineering, will be delivered before the Royal Society of Arts (St. John's Street, Adelphi) early next year by Mr. Leon Gaster, editor of *The Illuminating Engineer*; the dates at present determined upon are Feb. 15th, Feb. 22nd, March 1st, and March 8th respectively.

The Illumination of Lighthouses, Buoys, and Beacons by Means of Acetylene.

By an Engineering Correspondent.

The opening of the twentieth century was signalized by a marked progress in the existing methods of illuminating the various signals used in navigation. Acetylene enables certain advantageous conditions to be realized; it reduces the amount of personal attention that is necessary, and provides a brilliant light capable of piercing even the densest fogs.

The conditions of illumination in lighthouses, beacons, and buoys are very different. A lighthouse, as usually constituted, entails an optical projecting system embedded in masonry and mounted in a suitable tower. A beacon is usually an erection supported from below and carrying a suitable light which may be also provided with a lantern or projector; beacons are usually employed in shallow waters. Buoys, on the other hand, consist of floating bodies, and are not supported.

From the point of view of acetylene lighting we are mainly concerned with buoys and beacons; lighthouses are usually sufficiently important and complicated to require the presence of a keeper, and in such a case the advantages of acetylene-lighting, that render it particularly convenient in the case of buoys and beacons, do not weigh so heavily.

The use of acetylene results in a very bright flame, without the intermediary of fragile mantles. There is also the convenience of being able to enclose a large stock of illuminating material in a very small space. We may accomplish this by the use of dissolved acetylene, or by employing generators direct. Each of these methods has certain merits of its own.

Acetylene generators, like dissolved acetylene, may profitably be used in the case of lighthouses or very large buoys, which can be easily visited. The first lighthouse in France to be illuminated by acetylene was that at Chassiron, situated in the northern portion of the island of Oleron. This was originally lighted by petroleum, and a light of 70,000 bougies was obtained. This value was subsequently doubled by replacing petroleum by oil-gas, and again quadrupled when acetylene was installed.

To-day the illumination of this lighthouse is provided for by a group of

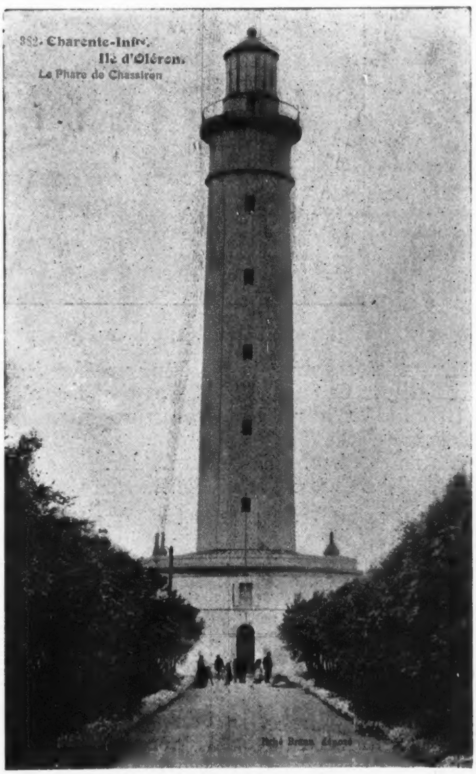


Fig. 1.—Chassiron Lighthouse.

generators and two gasometers feeding a "Sirius" burner, which consumes about 570 litres (approximately 20 cubic feet) per hour, corresponding to 2 kilograms of carbide, at a pressure of 1·25 m. During the long nights of winter the carbide consumed may amount to 30 kilos. The burner, equipped with an incandescent mantle 55 millimeters long yields 2130 bougies for 568 litres of gas, and therefore consumes roughly 0·27 litres per bougie (approximatly 105 candle-power per cubic foot).

Acetylene has been utilized for the illumination of buoys, mainly in the United States and in Canada. The first experiments were carried out in the United States in 1902, but the matter was subsequently taken up extensively in Canada in 1904, and the United States dispatched a representative to that country to report upon the system. As a result Mr. Fraser, of the United States Lighthouse Department advocates the use of acetylene on buoys.

Previous to the adoption of acetylene, he states, the buoys, lighted by gas, yielded but a feeble light, and were scarcely visible during fogs. Now, however, that acetylene has been introduced, the light is clearly distinguishable under all conditions.

There were, however, certain initial difficulties to be overcome. For instance, the burners were inclined to smoke, but greater attention to the purity of gas consumed removed this weakness.

Two main systems of acetylene illumination for buoys have hitherto been in use: (1) those using compressed acetylene, and (2) buoys using automatic generation. The second of these two systems has been generally considered preferable partly because less space is occupied, and also because it is often an advantage not to encumber buoys with much material, when they are easily accessible and can therefore be readily recharged. Moreover, a buoy that is only capable of containing 71 cubic metres of compressed acetylene, may contain as much as 280 cubic metres in the form of carbide if operated on the automatic system. In Canada, for instance, buoys so equipped will last throughout the season of navigation without recharging.

The value of acetylene for buoys has been particularly recognized in Canada, because of the inconvenience previously experienced in continually recharging those illuminated by oil-gas, and in being obliged to maintain apparatus for compression in the neighbourhood. Under these conditions lighting by oil-gas is only tolerable when applied to a number of buoys collected together in the same locality, so that the same compressing apparatus was available for all. However, this condition can rarely be complied with, and therefore it was proposed to use acetylene, the apparatus for compress-

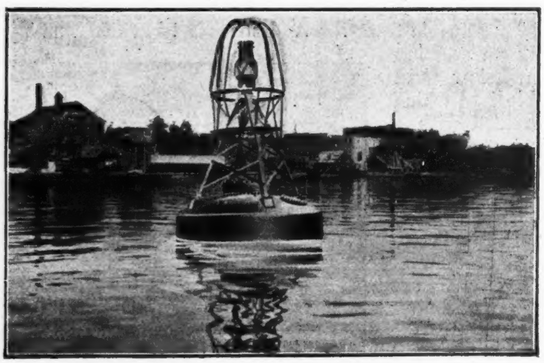


FIG. 2.—Buoy, lighted by Acetylene, on the St. Lawrence.

ing which could be installed on a small vessel. More recently, however, this system has largely given place to the use of automatic generating buoys.

Such buoys have been very much used in America, on the great rivers. In Europe, however, and notably in Sweden, where maritime illumination is of the greatest consequence, dissolved acetylene has been mainly employed.

Sweden, for instance, possesses a very fine system, involving the use of tubes of dissolved acetylene, having a capacity of about 50 litres. The flashing beacons distributed on the coast and equipped in this way, are able to act for seventy days in succession without it being necessary to attend to them. These results, however, have only been achieved by the use of an automatic apparatus enabling the beacons to be automatically lighted up when night falls, and, similarly, the supply of acetylene to be cut off at sunrise. For this purpose the special "Daten" arrangement of the Aktiebolaget Gas Accumulator Co. The working of the apparatus is based upon the action of two surfaces, one of which is black, and absorbs solar radiation, while the other reflects it. This gives rise to a difference in temperature of the two surfaces, and consequently an unequal expansion. During the day, therefore, the surfaces expand differently,

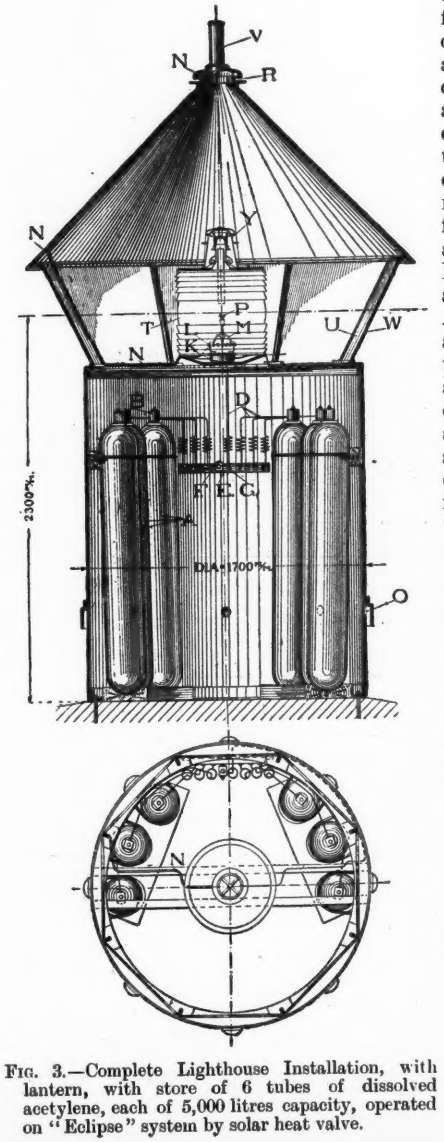


FIG. 3.—Complete Lighthouse Installation, with lantern, with store of 6 tubes of dissolved acetylene, each of 5,000 litres capacity, operated on "Eclipse" system by solar heat valve.

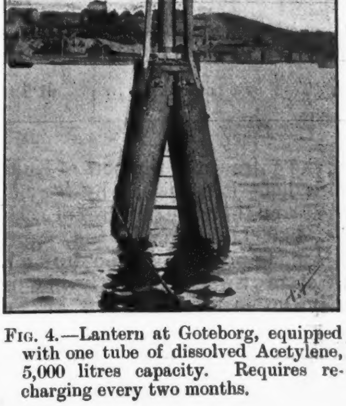


FIG. 4.—Lantern at Goteborg, equipped with one tube of dissolved Acetylene, 5,000 litres capacity. Requires recharging every two months.

and thus causes a valve to close. During the night, on the other hand, the effect does not take place, and the valve remains open.

With this apparatus ordinary steatite burners consuming 15, 20, or 25 litres per hour are employed, in place of the older type, consuming 12 litres per hour only; they are fed direct from the cylinders of dissolved acetylene.

Burners consuming 25 litres per hour. and run on a flashing system entailing alternate periods of 0·3 seconds brightness and 2 seconds of obscurity, only utilize about 70 litres of acetylene during a complete day. Consequently a tube of dissolved acetylene of 50 litres capacity, which will yield roughly 5,000 litres of acetylene, would serve to supply a 25 litre burner for about 70 days of 24 hours; if 12 litre burners, consuming about 46 litres per day in all, are used, a single tube will last for 108 days.

The costs for the different sizes of burners work out roughly as in Table I.

The first lighthouse lighted on the system just described is at Gasfeter at the entrance of the port of Kanneby. This light is furnished by 9 cylinders, each containing 5,000 litres of acetylene *i.e.*, 45,000 litres in all.

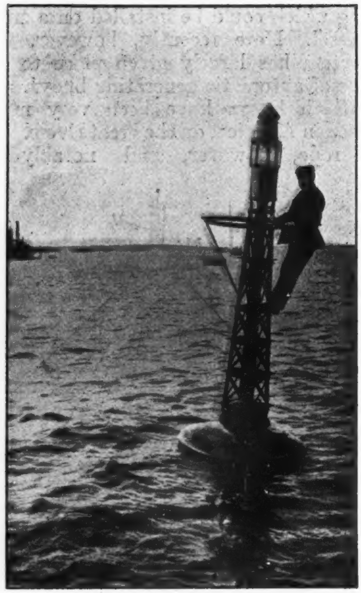


FIG. 5.—Illuminated Beacon, worked on eclipse-system, and capable of supplying light without recharging for one year.

TABLE I.

Nature of burner	15 litres	20 litres	25 litres
Intensity of Light	170 bougies	260 bougies	360 bougies
Consumption during 24 hours	46 litres	58 litres	70 litres
Consumption during 330 days	15,200 litres	19,200 litres	23,100 litres
Total cost per annum ...	61·5 francs	77·75 francs	80·85 francs

Among other lighthouses on the coast of Sweden similarly illuminated may be mentioned those at Vexley, Fors Halla, Fjordskar, and Bramskar. Numerous lightships, beacons, and buoys of all descriptions lining the coast employ the same system.

Dissolved acetylene is also used for maritime purposes by Norway, Russia, Finland, Denmark, Holland, and the Argentine Republic. It is also understood that the Austrian authorities are considering the utilization of the system in the Adriatic. R. G.

Notes on the Manchester Electrical Exhibition.

By an Engineering Correspondent.

October will long be remembered by all engaged in the various branches of the electrical engineering industry for at least three important events that took place during that month. Two of these, *i.e.*, the Conference on Electrical Units and Standards and the meetings of the Electro-Technical Commission, were of international interest, and their achievement in establishing a plain and intelligible medium of communication between the electrical manufacturer and the consumer, and in settling the terminology of electrical units, possesses a world-wide importance. The other event—the Manchester Electrical Exhibition—was not so universal in its claim upon the attention of scientific men and engineers as were the two events previously named. But its importance in this country cannot be questioned.

The twofold purpose of the Electrical Exhibition was to demonstrate the progress which had been made in the practical applications of electrical science, and to provide the fresh novelty and interest that are occasionally necessary for the encouragement of a trade revival. It may safely be said that never before in this country has the technical advance of any industry been so unmistakably demonstrated as has been that of the electrical industry by the Manchester Exhibition.

From the point of view of the illuminating engineer the exhibition deserved respectful attention on account of its being the first in which matters affecting illumination were so much in evidence. The display of electrical apparatus employed in almost every branch of illuminating engineering was exceedingly comprehensive, and showed that it is quite possible to harmonize adequate and efficient lighting with artistic effect.

A striking illustration of really effective artistic lighting, and of harmonization between the illumination and the general scheme of decoration of an interior, was to be had in the model house furnished by Messrs. Goodall, Lamb & Heighway, of Manchester. The painted ceilings and daintily tinted walls of the various rooms were shown to the best possible advantage under the nature of the illumination employed to display them.

In the spacious drawing-room a crystal electrolier and wall fittings shed an even light on furniture of quaint design, and showed to advantage the panelled walls painted in delicate tones of soft greens with enriched white mouldings surrounding them, and a ceiling painted in the harmonious tints of an evening sky. Messrs. Drake & Gorham were responsible for the lighting installation throughout the house and for all the fittings. All the energy required was obtained from a small petrol engine driving a dynamo and operating in conjunction with a battery of accumulators.

Before dealing with the illuminating apparatus displayed for utilizing electricity, it may be as well to say a word about the general illumination of the exhibition. The approaches were lighted by flame arc lamps and the road frontage was festooned with Robertson incandescent lamps. The interior of the building was illuminated by 28 "Oriflamme" arc lamps of the magazine pattern, each having a burning life of from 36 to 40 hours with each trim, and the magazines holding from six to nine pairs of carbons.

The Union Electric Co., Ltd., fitted eight "Excello" arcs in the roof of their stand. Four of these were burning on a direct current circuit, and four on an alternating current circuit, the object of this arrangement being to show that the "Excello" alternating current arc is equally as good as the

"Excello" direct current. Two sets of lamps were also suspended from the roof for shadowless illumination.

The General Electric Co., Ltd., showed the "Angold" flame arc-lamp, which attracted an amount of attention on account of its long burning life, and the "Flamgold" gravity feed arc-lamp, 1908 pattern, in which the most noteworthy improvements were the evenness of burning and absence of strain on the lamp mechanism. The "Jandus" regenerative flame arc-lamp, which is simple in construction, and has an effective life of 70 hours with one pair of carbons, was exhibited by Messrs. Drake & Gorham, Ltd. "Victor" arc-lamps were exhibited by the Electric and Ordnance Accessories Co., Ltd., in three types, viz., standard enclosed, having only one moving part, and made for d.c. circuits only; miniature enclosed arcs; and d.c. flame arcs.

The Gilbert Arc Lamp Co., Ltd., exhibited long burning flame lamps of street lighting, interior lighting types, and multiple carbon and enclosed lamps, while Messrs. Siemens Bros. Dynamo Works Co. also showed a number of arc lamps of various types. Messrs. J. & H. Grevener displayed their "Arco" flame lamp for d.c. and a.c. circuits.

The exhibits of incandescent lamps included many metallic filament lamps which are appearing this season for the first time, and all the well-known types were to be seen.

Messrs. Siemens Bros. Dynamo Works Co. had a show case of tantalum lamps and parts of the lamp illustrating the process of manufacture, and the tantalum lamp and holophane shade were to be seen on many other stands in the exhibition.

The General Electric Co., Ltd., showed a fine arrangement of osram lamps for high and low voltages. The "Metafil" of Messrs. The Edison & Swan United Electric Light Co., Ltd., practically made its début to the public. This lamp is manufactured in sizes suitable for most of the standard voltages. Messrs. G. M. Boddy & Co. exhibited the "Metalik" metallic filament lamp arranged to show tests for life and efficiency. The filament of this lamp is supported at the bottom, the loop being insulated by means of a special chemical process, which renders the filament very rigid, and enables the lamps to be run in any position.

The "Sunbeam" metal (tungsten) lamps from 25 volts up to 250 volts, and of various candle powers up to 100 c.p. were also exhibited. The Sunbeam Lamp Co. claim for these lamps an efficiency of 1¼ watts per c.-p., and immunity from breakage in transit, owing to the shortness of the bulb. Messrs. Falk Stadelmann & Co., Ltd., exhibited their "Sirius - Effesca" tungsten metallic filament lamps with artistic fittings illustrating their application, while the International Electric Co., Ltd., showed the "Orieco" metallic filament lamp. A wide range of carbon filament lamps was displayed, the Robertson Electric Lamp Co., Ltd., having an electric lamp making exhibit which closely resembled their display at Olympia.

The exhibits of fittings were chiefly confined to the latest designs suitable for residential use, examples being shown of the Adams, Sheraton, Louis XVI., Flemish, &c., schools. Nearly all the fittings shown were tasteful in conception, well finished, thoroughly modern. Two or three types of convertible fittings were shown, suitable for use in small houses, where the dining room is usually used as a drawing room, and the fittings exhibited were easily convertible for use in either case.

The show of meters and instruments formed a notable feature of the exhibition, many of the leading firms showing measuring instruments of quite modern design.

Among the special instruments exhibited was a 15 amp. time meter, suitable for purposes where current is charged by the time of consumption, such as, for instance, on arc lamp circuits where the central supply authority may be charged an inclusive figure to represent the cost of current, consumption of current, and the necessary amount of trimming.

Photometric apparatus was not shown to any great extent, but on the stand of Messrs. Siemens Bros. & Co., Ltd., were to be seen some interesting types. The new Siemens collapsible photometer, which was exhibited provides a very suitable instrument for measuring the efficiency of various lamps and permits making such measurements in the simplest and most convenient manner without a dark room, and with an accuracy sufficient for all practical requirements.

The measuring system is based on the angle mirror method. The apparatus consists essentially of three boxes connected together by collapsible bellows. The middle part of the apparatus contains a voltmeter and an ammeter; the photometer screen and two collapsible rails screwed on to the top are engraved with millimetre and candle-power scales. The instruments are connected to the circuit in such a manner that they indicate only the current and the pressure flowing through, and at the lamp terminals respectively, so that the actual watt consumption of the lamp is measured.

The Bunsen photometric disc. is employed, but the usual grease spot is replaced by a silver spot between the two plates of matt glass. The two other parts of the apparatus each contain two mirrors inclined at an angle of 120 deg. to one another, the standard lamp being in one part and the lamp to be tested in the other. The lamps hang vertically so that the apparatus is suitable for testing lamps which can only burn in this position. Tests can be made in full daylight. As the standard lamp and the lamp to be tested are connected in parallel and the former is in series with a resistance equal to the resistance of the ammeter in the circuit of the other lamp, both lamps have practically the same difference of potential at their terminals and can, therefore, readily be compared with one another.

In order to be able to determine candle-power in cases where the supply pressure is higher or lower than the rated pressure of the lamps, the standard lamp can be fixed at a different distance from the screen, so that the same amount of illumination is produced on the screen as at the rated voltage.

On the stand of Messrs. Venner & Co. were shown some interesting meters by Messrs. Chamberlain & Hookham, Ltd. The watt-hour meter attracted considerable attention; this type of meter having no brushes or commutator, and being unaffected by stray magnetic fields. Other types of interest were the slot electrolytic, cash register, and two-rate meters. The electrolytic meter shown was of the shunted type; only one fifty-thousandth of the current passing through the electrolyte of dilute sulphuric acid, which, together with the platinum electrodes was sealed up in a glass vessel. The two-rate meter exhibited was of the Hookham type, contained in the same size case, but fitted with a counting train, having two sets of dials, the upper registering the consumption during the high-rate period, and the lower the low-rate period, the change from lower to upper dial being effected by a time switch closing the circuit of a solenoid connected across the mains. Venner time switches were also much in evidence, some of the patterns exhibited being extremely ingenious.

A comprehensive collection of electrical instruments was on view on the stand of Messrs. Elliott Bros., a large number being shown under actual working condition with switchgear manufactured by Messrs. Eckstein, Heap & Co., in conjunction with whom Messrs. Elliott Bros. exhibited. The exhibit included ammeters, voltmeters, leakage indicators, testing sets, telegraph apparatus, &c. A feature of interest was the "Harrison" Universal Photometer. This consists of an instrument to measure the illumination derived from, or the candle-power of, a lamp of any nature under a large variety of conditions. The chief novelty of this instrument lies in the fact that it embodies a flicker disc, somewhat of the Whitman pattern, but rotated by a blast of air under the control of the operator.

Enclosed Arc-Lamps for Interior Shop-Lighting.

THE illustration shows an interesting example of interior illumination of a shop in Los Angeles, California, recently described by Mr. C. H. Stickney, by means of enclosed arc lamps mounted in a concentric diffusing reflector.

The method is specially applicable in cases in which the ceiling is high, and an even, diffused illumination is desired—a "spotty," uneven illumination being particularly undesirable for shops of this kind. The ceiling was in this case about 16 ft. high, and the floor area about 14,000 square ft.

It is claimed that this method is also specially applicable to shops devoted to the sale of clothing, because of the correct colour-definition afforded by enclosed arcs. The use of the reflectors also facilitates the production of a "soft" illumination coupled with an absence of sharp shadows. It is also stated that the annual cost of upkeep is exceedingly low. It will, however, be interesting to observe how enclosed arc-lamps of this type compare with high candle-power osram lamps, for which similar claims as regards colour and cheapness have been put forward (see *Illuminating Engineer*, October, p. 861).

Interior lighting, by enclosed arcs, of a clothing store, Los Angeles, California.

SPECIAL SECTION.

The Second Annual Convention of the Illuminating Engineering Society.

The second annual meeting of the Illuminating Engineering Society took place in Philadelphia on October 5th and 6th. The proceedings seem to have been characteristic of the vigour and enterprise of this body, and successful in every way. The membership of the society, since its inauguration nearly three years ago, has grown to over a thousand, and it is significant that over a quarter of the members enrolled were able to attend the convention, though in many cases this undoubtedly entailed making journeys of considerable length.

As an indication of the value of the work that is now being carried out, it is only necessary to point to the very varied and valuable collection of papers read on this occasion, a list of which will be found on the next page. Although we are devoting exceptional space to this important collection, it is naturally impossible to print even adequate extracts of all in this one number. We are, however, in a position to reproduce a few, selected so as to indicate the extent of the ground covered. We hope to deal with others in a subsequent number, and also to give some account of the discussion which followed.

Those papers which we at present deal with, however, by themselves serve to emphasize the scope of the work of the society. Among them we include a paper dealing very exhaustively with a practical illuminating engineering design by Mr. Marks, contributions dealing with the standpoints of the architect and the physiologist respectively, a paper on oil-lamps, and a paper dealing with daylight-illumination, and describing a number of original researches. At the present moment, too, when the question of an international standard of light is under discussion, the report presented by Dr. A. H. Humphreys, embodying as it does a record of valuable co-operation between those representing gas and electric lighting and illuminating engineering, is of special interest.

We also hope to deal in greater detail in our next number with Dr. Louis Bell's Presidential Address. Dr. Bell, who has recently been touring the chief cities of Europe with the object of studying different developments of street-lighting, naturally dealt largely with this subject. His remarks, coming from one who is familiar with the conditions on both sides of the Atlantic, are therefore of particular interest at the present moment, when the question of street-lighting is the subject of a considerable amount of discussion in Europe.

As Dr. Bell points out, the present conditions of civilization have called into play an entirely different set of conditions from those existing but a few generations ago. More and more business is now being transacted by night, and we can no longer be satisfied with installations merely intended to satisfy temporary and immediate needs. We now require permanent adequate illumination, and the exact intensity and location of the sources, &c., calls for a thorough and systematic study.

Dr. Bell seems to have found something to criticize in American methods, and to have expressed his belief in the method of measuring street-illumination on a horizontal plane. He likewise condemns the present "moonlight schedule," according to which an allowance is made for the order of illumination which the moon is believed to furnish, if unobscured. It is to be noted that

SECOND ANNUAL CONVENTION

OF THE

ILLUMINATING ENGINEERING SOCIETY

HELD IN

Philadelphia, October 5th and 6th, 1908.

PROGRAMME OF PAPERS.

MONDAY, OCTOBER 5th, 10.30 A.M. MORNING SESSION.

ADDRESS OF WELCOME. By Hon. John E. Reyburn, *Mayor of Philadelphia.*

1. PRESIDENTIAL ADDRESS. By Dr. Louis Bell.
A study of the problem of street-lighting in its broader aspects, especially with reference to the choice and placing of lamps in their relation to effective illumination.

2. REPORT OF COMMITTEE ON NOMENCLATURE AND STANDARDS. By Dr. A. C. Humphreys, *President Stevens Institute.*
An account of the conferences of committees of the Illuminating Engineering Society, the American Institute of Electrical Engineers, and the American Gas Institute on the subject of a National Candle Unit, which unit has been formally accepted by the two first-mentioned bodies, and will come up for action in October at the annual convention of the American Gas Institute.

MONDAY, OCTOBER 5th, 8 P.M. EVENING SESSION.

3. MODERN GAS-LIGHTING CONVENIENCES. By Mr. T. J. Litle, Jr.
Describes the various methods of gas-lighting ignition by electrical means, pilot flames, &c., with an account of some other special gas-lighting fittings and of a small candle-power gas unit.

4. ILLUMINATING VALUE OF PETROLEUM OILS. By Dr. A. H. Elliott.
An account of a number of experiments showing the value of petroleum oils as constant sources of light of great reliability, with data of experiments with oils of various densities used in a variety of commercial types of lamps.

5. STREET-LIGHTING FIXTURES: GAS AND ELECTRIC. By Mr. H. Thurston Owens.
Street-lighting is divided into five classes, and the methods discussed for securing the best illumination for each class.

6. STRUCTURAL DIFFICULTIES IN INSTALLATION WORK. By Mr. James R. Strong.
Advocates the laying out of outlets for an office building on the basis not of separate offices, but of each floor as a whole; and for residences on the basis of the darkest probable decoration of rooms, with outlets so located as to admit of any probable changes in arrangement of furniture.

7. ARCHITECTURE AND ILLUMINATION. By Mr. Emile G. Perrot.
The subject is treated under the heads of 'Necessary Illumination or Lighting' and 'Decorative Lighting,' with reference to an example of each case.

TUESDAY, OCTOBER 6th, 9.30 A.M. MORNING SESSION.

8. INTENSITY OF NATURAL ILLUMINATION THROUGHOUT THE DAY. By MR. LEONARD J. LEWINSON.

Gives the result of measurements of illumination from the sun and the moon, the determinations covering the entire range of the twenty-four-hour period and different conditions of weather.

9. THE INTEGRATING SPHERE IN INDUSTRIAL PHOTOMETRY. By DR. CLAYTON H. SHARP and MR. PRESTON S. MILLAR.

Treats of the theory of the integrating sphere and gives experimental data on the test and performance of large and small spheres in the photometry of arc and incandescent lamps.

10. THE IVES COLORIMETER IN ILLUMINATING ENGINEERING. By DR. HERBERT E. IVES.

Describes an instrument for the measurement of all kinds of light in terms of the three primary spectral colours, with a table of readings for all the various sources of illumination.

11. CALCULATING AND COMPARING LIGHTS FROM VARIOUS SOURCES. By MR. CARL HERING.

The physical meaning of the various quantities involved by lighting calculations and the laws applying to them are explained, the formulas put in shape for direct practical application, with numerical examples to illustrate their use in calculating and comparing light from different kinds of sources.

12. THE CALCULATION OF ILLUMINATION BY THE FLUX OF LIGHT METHOD. By MR. J. R. CRAVATH and MR. V. R. LANSINGH.

Practical application of a method suggested by Dr. Clayton H. Sharp whereby the total flux of light is calculated in lumens, and the average illumination of a given plane determined from the number of lumens falling on that plane.

TUESDAY, OCTOBER 6th, 2 P.M. AFTERNOON SESSION.

13. STREET-LIGHTING WITH GAS IN EUROPE. By MR. E. N. WRIGHTINGTON.

Describes the various methods of street-lighting with gas employed in London, Paris, Berlin, Vienna, &c.

14. DESIGN OF THE ILLUMINATION OF THE NEW YORK CITY CARNEGIE LIBRARIES. By MR. L. B. MARKS.

A preliminary paper treating of the lighting problems involved in the design of the illumination of public libraries, and including details of the design of the illumination of the Carnegie libraries in New York City.

15. ENGINEERING PROBLEMS IN ILLUMINATION. By MR. ALFRED A. WOHLAUER.

A number of engineering problems in illumination are presented and their solution indicated.

16. INTRINSIC BRIGHTNESS OF LIGHTING SOURCES. By MR. J. E. WOODWELL.

Treats of the intrinsic brightness of lighting sources from the hygienic standpoint, and discusses the practical application of this factor in the design of illumination.

17. SOME EXPERIMENTS ON REFLECTION FROM CEILING, WALLS, AND FLOOR. By MR. V. R. LANSINGH and MR. T. W. ROLPH.

An analysis of the effect of reflected light from ceiling, walls, and floor—separately and in various combinations—upon the intensity and uniformity of illumination, the analysis being based upon illumination tests of a room equipped with the eight possible combinations of light and dark ceiling, walls, and floor.

18. THE RELATION BETWEEN CANDLE-POWER AND VOLTAGE OF DIFFERENT TYPES OF INCANDESCENT LAMPS. By MR. FRANCIS E. CADY.

The paper establishes that the exponent expressing the rate of change of candle-power with change of voltage is not a constant, but a function of the watts per candle; that this exponent is different for different types of filaments, and that its value decreases as the watts per candle decrease.

Mr. Lewinson, in his paper dealing with daylight-illumination, comments upon the same subject.

Dr. Bell also pleads for consideration of the exact use for which certain streets are intended, and criticizes the attempt of some American cities to illuminate the whole town-area with uniform intensity, irrespective of which streets are most important. He considers that the illumination in a main thoroughfare should suffice to enable a pedestrian to read ordinary print with comfort.

Another paper with which we hope to deal subsequently is that by Dr. Clayton Sharp and Mr. Preston S. Millar on the use of the integrating sphere. This paper consists of a well-illustrated description of the practical working and advantages of the globe, which should be of great interest after the recent articles in our columns on the subject; it is also satisfactory to observe that the study of the use of this globe, which has received so much attention in Germany, is now being taken up in the United States.

Hitherto the integrating globe has been mainly employed in the determination of the mean spherical candle-power of large sources, arc-lights, and the like. The authors, however, comment upon its value for the same purpose in connexion with the photometry of glow-lamps, the flicker and other inconvenient results of the rotating method being avoided.

Among other papers with which we have still to deal we may mention that of Mr. Ives, who describes a form of instrument for comparing the colour-values of various illuminants. The paper by Mr. Karl Hering is a useful compilation of the various symbols and formulæ used in illuminating engineering. Two papers by Messrs. Cravath and Lansingh and Lansingh and Rolph deal with the calculation and use of the conception of flux of light in illuminating engineering, and the effects of reflection from various types of walls and ceilings respectively. Mr. A. A. Wohlauer discusses a series of practical problems in illumination, including the study of methods of producing a uniform illumination and the design of reflectors to serve this end.

A very important practcal aspect is touched by Mr. J. R. Strong, who discusses the placing of outlets in an office-building and methods of arranging them so as to provide for possible alterations in the disposition of the furniture. The whole subject of illuminating engineering is intimately bound up with the positions of outlets and sources, and papers on this subject are much to be desired.

We have also to mention a contribution by Mr. H. Thurston Owens on 'Street-Lighting Fixtures,' and another by Mr. T. J. Litle, Jun., dealing with modern gas-lighting conveniences, with special reference to electrical ignition.

It is interesting to observe that the first autumn meeting of the New York section of the Illuminating Engineering Society was arranged for the 15th of last month, and was devoted to a review of the various papers presented at the Convention. Certainly they provide ample food for discussion.

The New Physical Laboratory of the National Electric Lamp Association, U.S.A.

A RESEARCH laboratory has been organized by the National Electric Lamp Association for the purpose of undertaking physical and chemical investigations into problems relating to electric lamp manufacture, &c.

The laboratory is to be placed under the direction of Dr. E. P. Hyde, formerly of the National Bureau of Standards. Dr. Hyde's connexion with the laboratory augurs well for the valuable work which will doubtless be undertaken.

Report of Committee on Nomenclature and Standards.

By Dr. A. C. Humphreys.

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

The Committee on Nomenclature and Standards, while not ready to make a final report, reports the progress already made in the direction of establishing a common national and international unit of candle-power.

The special work referred to was assigned to a sub-committee, and the report of this sub-committee, through its secretary, Dr. E. P. Hyde, will best serve to indicate the progress already made, and is as follows :—

REPORT OF SUB-COMMITTEE ON NOMENCLATURE AND STANDARDS OF THE ILLUMINATING ENGINEERING SOCIETY.

At the first annual convention of the Illuminating Engineering Society held in Boston, July 30th–31st, 1907, the question of a possible agreement upon a common national and international unit of candle-power was presented* for consideration. As a result of the interest in this subject manifested by the members of the society in the discussion which followed the reading of the paper, the question was further presented for consideration at a meeting of the American members of the Committee on Nomenclature and Standards, which was held in Boston July 30, 1907, during the convention. At this meeting the following resolution was unanimously adopted :

Resolved :—" That a sub-committee on nomenclature and standards be appointed by the Chairman to confer with similar committees of the American Institute of Electrical Engineers and the American Gas Institute, with a view to the consideration of the adoption of a unit of light, and with the request that it report to the main committee at the earliest possible date."

In accordance with this resolution the Chairman appointed the following as members of the sub-committee on Nomenclature and Standards : Dr. Louis Bell, Mr. J. B. Klumpp, Dr. C. H. Sharp, and Dr. E. P. Hyde. The sub-committee held a meeting in New York on September 20th, at which Dr. Bell and Dr. Hyde were elected chairman and secretary respectively, and plans were made for interesting the American Institute of Electrical Engineers and the American Gas Institute in the movement for a common national and international unit of candle-power. To this end the following communication was drawn up and presented to the American Gas Institute at its annual convention held at Washington, October 16th–18th, 1907.

Walton Clark, *President.*

Dear Sir : About one year ago, the Illuminating Engineering Society created a committee, representing the varied interests in this country and abroad, to consider the question of establishing suitable, and, if possible, universal nomenclature and standards for the science of illuminating engineering.

The question of a common national and international unit of candle-power was taken into consideration by the American members of this International Committee, and upon motion, Dr. A. C. Humphreys, the chairman of this committee, appointed a sub-committee to confer with similar committees from the American Gas Institute and the American Institute of Electrical Engineers.

As a result of numerous recent investigations it has been established that the value of the candle unit defined as 1/10 of the intensity of the Harcourt 10 candle-power pentane lamp is different from that obtained through the Hefner, by the use of the ratio, one Hefner candle = 0·88 British Parliamentary candle. The amount of the difference is not definitely known, but is probably about 4 per cent, the unit obtained through the Harcourt 10 candle power pentane lamp being

* Primary, secondary and working standards of Light; *Transactions* Illuminating Engineering Society, Vol. 2, No. 7, pp. 426-439; October, 1907. See also *The Illuminating Engineer*, (London), January and March, 1908.

smaller. Whether this difference is due to a change in the value of either of the two units (the candle unit in England or the Hefner unit in Germany), or whether it is due to errors in the earlier comparisons between the two units which gave the ratio of 0·88 is immaterial for our present purpose. The important fact which we desire to present for your consideration is that although in the photometry of both gas and electric lamps in the United States the unit has nominally been the British Parliamentary candle, it has been obtained in different ways in the two industries.

In the photometry of gas the English example has been followed, and the candle unit in use in this country is probably not very different from that in use in England. On the other hand, the unit used in the photometry of electric lamps, following the recommendation of the American Institute of Electrical Engineers, has been obtained through the Hefner by the use of the ratio, one Hefner candle = 0·88 British Parliamentary candle. We are, therefore, confronted at present with the existence of two different units of candle-power in the United States, differing from each other by about 4 per cent. It is evident that such a condition is not only unfortunate but extremely disadvantageous to the better interests of either industry, and any action that would tend to bring the two units into agreement should be welcomed by all concerned, provided such action does not work hardship upon any of the interests involved.

With the establishment of State commissions for gas and electricity, which will look more and more to the Federal Bureau of Standards for standards of candle-power, complications will certainly result if the unit recognized in any industry is not in agreement with that maintained at the Bureau of Standards and it is obviously impossible for the Federal government to maintain and legalize two different units for use in the photometry of gas and electric lamps. In a recent paper published by the National Bureau of Standards at Washington, attention was called to the discrepancy between the candle unit obtained through the Harcourt 10 candle-power pentane lamp and that obtained from the Hefner by the use of the ratio 0·88.

In this same paper attention was also directed to the question of possible international action looking toward the establishment of a common unit of candle-power for England, France, and the United States. The units in use in these three countries are so nearly alike that, with the accuracy at present obtainable in industrial photometry, no serious results would follow a compromise by which all three countries would agree upon a common unit of candle-power. If the value of this common unit were taken as the average of the values of the units maintained at the national laboratories in the three countries, it would be very close to the mean between the two units in use in the United States in the photometry of gas and electric lamps. Therefore a compromise in the interest of international unity would require no greater changes of unit than a compromise in the interest of national unity. Moreover, the change in unit would in no case be greater than about two per cent, and the effect of such a change would not be seriously felt, even in the photometry of incandescent lamps where the highest accuracy in commercial testing is attainable.

Since the German unit of candle-power differs by 10 or 15 per cent from the average value of the units in England, France, and the United States, it would not seem desirable to include the German unit in taking the mean value. Either Germany could elect to adopt the international candle unit, or else the ratio of the Hefner candle to the international unit could be determined.

In consideration of the facts stated above, we, the undersigned, on behalf of the Sub-Committee of the Committee on Nomenclature and Standards of the Illuminating Engineering Society respectfully request, therefore, that the American Gas Institute appoint a committee to confer with the sub-committee of the Illuminating Engineering Society on the question of the possible adoption of a common national and international unit of candle-power.

A similar request is being made to the American Institute of Electrical Engineers, and it is hoped, through the co-operation of these two representative bodies, that some definite action will be taken.

Yours respectfully,
(Signed) EDW. P. HYDE.
J. B. KLUMPP.

This communication was referred to the Technical Committee of the Gas Institute for action, with the result that subsequently the following members were appointed to form a sub-committee of the Institute to confer with similar committees of the American Institute of Electrical Engineers and the Illuminating Engineering Society: Mr. W. H. Gartley, M. A. E. Forstall, Dr. A. H. Elliott, and Mr. C. O. Bond.

In a similar way an invitation to the American Institute of Electrical Engineers to appoint a sub-committee to unite in conference with sub-committees of the other two bodies to consider the question of the adoption of a common national and international unit of candle-power was presented to the Standardization Committee, at its meeting in New York Nov. 7th, 1907. The invitation was received favourably by the Standardization Committee, and the following sub-committee was appointed: Dr. A. E. Kennelly, Dr, Samuel Sheldon, Dr. C. P. Steinmetz. and Dr. S. W. Stratton.

The two sub-committees of the American Institute of Electrical Engineers and American Gas Institute held separate preliminary meetings, and passed resolutions expressing the attitudes of the respective sub-committees on the question of the adoption of a common unit of luminous intensity. In addition to the formal committee meetings, several informal joint conferences of representatives of gas and electric lighting interests were held, as the result of which a more thorough understanding of the present situation and of the necessity and probable effects of an agreement upon a common unit of candle-power was reached.

Finally on February 14th, 1908, in the Engineering Societies Building in New York the three sub-committees representing the American Institute of Electrical Engineers, the American Gas Institute, and the Illuminating Engineering Society, met in joint conference, and organized themselves into a joint committee with Dr. S. W. Stratton, permanent chairman, and Mr. C. O. Bond, permanent secretary. In the absence of Dr. Stratton, Dr. E. P. Hyde was elected chairman *pro tem* of the meeting. After a lively discussion the following preamble and resolutions were unanimously adopted:

"The joint Committee composed of sub-committees of the American Institute of Electrical Engineers, the American Gas Institute, and the Illuminating Engineering Society, recognizes that although the differences among the units of candle-power in use in the United States at the present time are not greater than a few per cent, nevertheless in view of the increasing accuracy that is being demanded in industrial photometry, there is a growing need of a common unit of candle-power which shall be established and maintained at the United States Bureau of Standards at Washington, D.C., and in terms of which secondary and working standards for use in the photometry of all kinds of illuminants can be measured. The Committee further realizes the importance and desirability of international agreement upon a common international unit of luminous intensity to be used throughout the civilized world. It so happens that the common unit which would be adopted in the United States as a compromise between the candle units used in the photometry of gas and electric lamps would approximate very closely to the mean value of the candle units maintained at the National laboratories of the United States, England and France. The unit of light maintained at the National laboratory in Germany (the Hefner) differs from the candle units maintained at the national laboratories of the other three countries by so great an amount that no benefit would accrue either to Germany or to the other countries by including the Hefner in taking the mean of the various units:

And Whereas the three sub-committees in joint conference deem that the above statements embody the consensus of opinion of said committees : therefore, be it—

Resolved: (1). That the joint committee, composed of sub-committees of the American Institute of Electrical Engineers, the American Gas Institute, and the Illuminating Engineering Society, approves the adoption of a common national candle unit which shall be maintained at the United States Bureau of Standards, and in terms of which secondary and working standards for use in the various industries can be standardized, and recommends to each of the three societies here represented through the respective sub-committees the adoption of such a plan.

Resolved: (2). That this committee will support the Bureau of Standards in any action which it may take to bring about international agreement upon a common candle unit, and will recommend to each of the three societies here represented the endorsement of such action, provided the unit agreed upon shall represent approximately the average value of the candle units maintained at present at the national laboratories of the United States, England, and France, or, specifically that it shall be lower than the unit at present maintained at the Bureau of Standards at Washington, D.C., by an amount not less than one (1) per cent, nor more than three (3) per cent, the exact value to be agreed upon as the result of an international conference.

Resolved: (3). That inasmuch as the adoption at this time of a definite value for the common national candle unit for the United States would embarrass the Bureau of Standards in bringing about international action, this Committee refrains at this time from recommending the adoption of a definite value for the common national candle unit, but recommends, in the interest of the various industries involved, that during the interval required for the consummation of international action a common candle unit be used which shall be two (2) per cent. less than that now maintained at the Bureau of Standards, since there can be no doubt but that such a candle unit would differ by less than one (1) per cent from the proposed international candle; and further resolved that the Secretary of this joint committee is instructed, after the concurrence of the three societies here repreesnted, to address a letter to the Director of the Bureau of Standards enclosing a copy of these resolutions, and requesting that the Bureau of Standards, which has taken the initiative in the present movement toward a common national and international candle unit, maintain as its working candle from this time on until definite international action shall have been taken, a candle unit two (2) per cent lower than that which it is maintaining at the present time.

Resolved: (4). That this Committee recommends that each society here represented, acting through its own proper channels, shall address to such similar foreign societies as may be interested a statement of the movement in the United Sates toward a common international candle unit (enclosing a copy of these resolutions), and shall request the cooperation of the said foreign societies in advancing the movement."

In pursuance of these resolutions the sub-committee of the American Institute of Electrical Engineers reported the action of the joint Committee to the Board of Directors of the Institute for approval. The action of the sub-committee was endorsed, and the latter was authorized to notify the Secretary of the joint Committee to that effect, in accordance with Resolution 3.

In the Illuminating Engineering Society the resolutions of the joint Committee were endorsed by the Committee on Nomenclature and Standards, and referred by this committee to the Council of the Society. At a meeting of the Council, held June 12th, 1908, the action of the sub-committee was approved. Since authority in such matters is vested in the Council of the Illuminating Engineering Society and in the Board of Directors of the American Institute of Electrical Engineers, the final action by these two bodies has already been obtained.

Before the resolutions of the joint Committee can be approved finally by the American Gas Institute they must be presented to the society for action, at its annual convention, which is to be held in New York in October. It is encouraging to report, however, that the resolutions of the joint Committee have already been endorsed, both by the Technical Committee and subsequently, on March 17th, by the Board of Directors of the Institute. Should the Institute at its convention act favourably on the resolutions of the joint Committee, the Secretary of this committee will address a letter to the Director of the Bureau of Standards in accordance with Resolution 3, requesting that the Bureau "maintain as its working candle from this time on until definite international action shall have been taken, a candle unit two (2) per cent lower than that which it is maintaining at the present time."

The sub-committee on Nomenclature and Standards is authorized to report further that the Bureau of Standards has already entered into negotiations with the foreign laboratories in regard to the possible agreement upon an international unit of luminous intensity and that the hope is expressed that final agreement may be reached very shortly.

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.)

The design of the illumination of a public library involves considerations which are quite unlike those that ordinarily confront the illuminating engineer, and are in many respects more difficult to meet than in almost any other class of building. The design must secure :—

1. Sufficient illumination on the reading tables and book-shelves to meet the demands of a wide class of readers of various ages and conditions of eyesight, taking into account the fine print in some of the books and the difficulty of reading titles of books in position on the shelves. Some of the books are worn by frequent handling, and the titles become more or less obscured.

2. Low intrinsic brightness of light sources and freedom from glare, and, so far as possible, removal of lights from the ordinary field of vision.

3. Sufficient illumination for the library staff to oversee the entire floor.

4. Sufficient illumination to provide a moderate reading light in all parts of the room, to admit of the relocation or addition of furniture, such as portable magazine filing racks, &c.

5. Moderate cost of installation.

Fig. 1.—First Floor, Carnegie Library.

6. Economy of operation. This must take into account not only the system of illumination and type of lamps used, but also the switching arrangements.

7. Simplicity in construction and convenience in operation. This must take into account the character of the help from those in local charge of the equipment.

8. Æsthetic design of fixtures, and

attractive appearance of the reading-rooms at night.

The present paper is a preliminary one, and deals with the design of illumination of the new Carnegie branches of the New York Public Library, and in particular with the St. Gabriel's Park branch, which is representative of seven other Carnegie Library buildings which are now under construction in New York City. The St. Gabriel's Park branch of which Messrs. McKim,

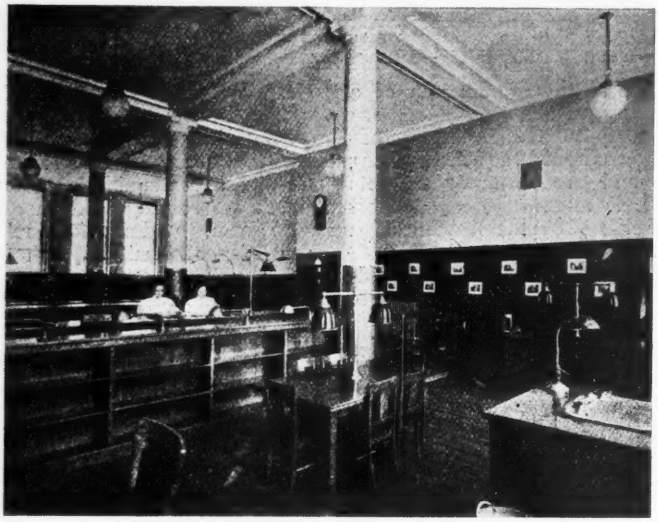


FIG. 2.—Second Floor, Carnegie Library.

FIG. 3.—Third Floor, Carnegie Library.

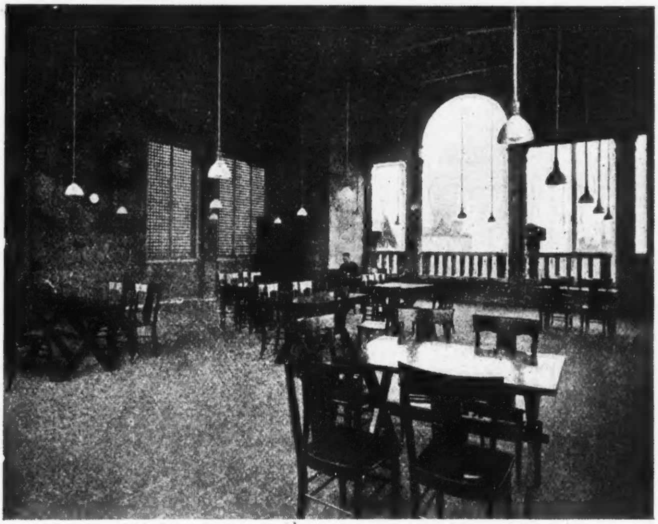


Fig. 4.—Roof Reading Room, Carnegie Library.

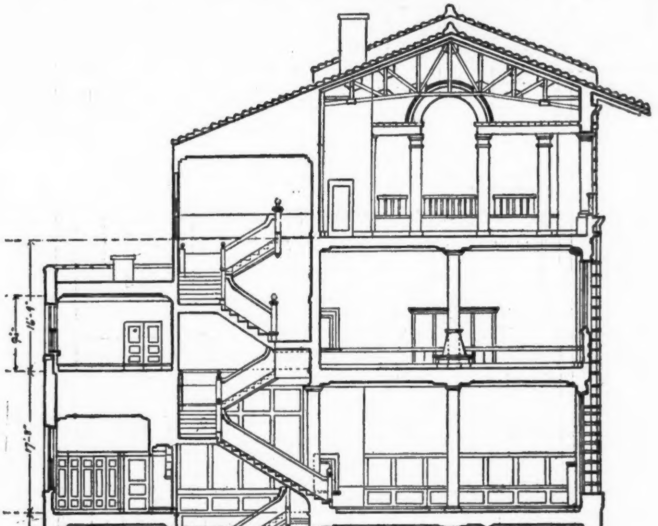


Fig. 5.—Longitudinal Section of Library Building.

Mead & White were the architects, was opened to the public a few months ago.

Drawings of floor plans—showing location of light outlets, switches, &c., units. Fixture drawings by Mr. W. S. Kellogg, supervising architect of the works, schedule of lamps, and photographs of the four main floors of the building, are also given.

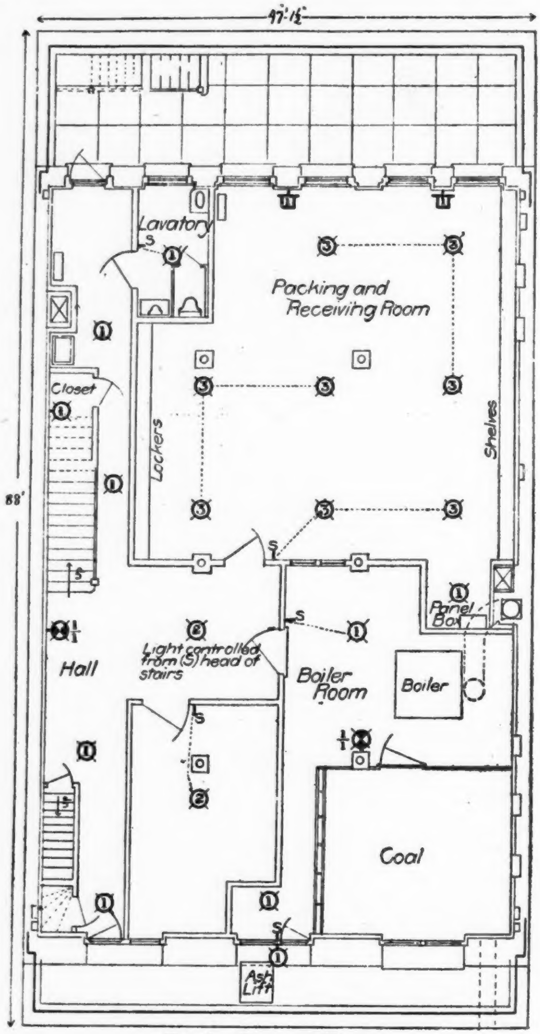


Fig. 6.—Basement Plan.

as well as dimensions of rooms in the building and position of furniture—are given herewith. The light units are designated at each outlet and shown on the plans on the basis of 50 watt

The lighting service is taken from the direct current three wire mains of the New York Edison Co., and enters the building in the basement, from which it is distributed throughout the

CARNEGIE LIBRARY, ST. GABRIEL'S PARK BRANCH.

FIXTURE AND LAMP SCHEDULE.

Basement. Height, 9'-6".

No. of pieces	Drawing No.	No. of lamps.		Description of Lamps.		Height of Globe Holder.	Name of Room Location of Lamp.	Remarks.
		Gas.	Elec.	Special.	Regular.			
1	4 A		1		16-c.p. Edison		Front area	Bracket lamp weather proof socket
2	15 A		2		16-c p. Edison Frosted	7'-0"	Boiler room Coal and ash	Ceiling pendant
1	3 A	1	1		8-c.p. Edison			Combination bracket
1	1 A		1		8-c.p. Edison			Electric bracket
4	15 G		4		16-c.p. Edison	7'-6"	Halls	1-lamp pendant 6" ball R.O. 3-¼" holder
1	15 H		1		32-c.p. Edison	7'-8"	Halls	1-lamp pendant 8" x 4" C.R.O. 6" ball
1	3 F	1	1		8-c.p. Edison		Hall at foot of stairs	1 combination bracket chain pull
1	1 F		1		8-c.p. Edison		Closet under stairs	Electric bracket lamp up, chain pull
1			1		16-c.p. Edison Frosted	At ceiling	Toilet	Electric ceiling outlet prismatic
1	17 B		1		16-c.p. Edison Frosted tip	7'-6"	Work room by B. L.	1-lamp pendant ch. pull
8	6 B		24		16-c.p. Edison Frosted tip	7'-6"	Work room ceiling	Ceil. pendant distance x on draw = 1'-0" each 3 electric
1	15 A		1		32 c.p. Edison	9'-0"	Store room	1-lamp pendant
2			1		16-c.p. Edison Frosted			2 flexible portables with fluted glass shades

First Story. Height, 15'-3".

No. of pieces	Drawing No.	No. of Lamps.		Description of Lamps.		Height of Globe Holder.	Name of Room Location of Lamp.	Remarks.
		Gas.	Elec.	Special.	Regular			
1	18		1		187-watt Gem	12'-6"	Ent. vest.	1-lamp pendant 16" C. R. O.
1	2	1					Ent. vest.	Gas wall bracket
1	3 F	1	1		8-c.p. Edison		Top of stairs by ent. vest.	1-lamp bracket, smoke bell over, chain pull
2	19		12		8-c.p. Edison Frosted tip	7'-3½"	On west wall over swinging frames	
1	3 F	1	1		8-c.p. Edison		Foot of stairs up	1 combination bracket chain pull
1	1 F		1		8-c.p. Edison		Under main stairs on the landing to basement	1 electric bracket, lamp up, chain pull
2	5 B		4		16-c.p. Edison Frosted tip		Office	2-lamp brackets, chain pull
4	5 B		8		16-c.p. Edison Frosted tip		Reference Room	2-lamp brackets Proj. 15" from wall to centre of lamp, lamps down, chain pull
1	1 B		1		16-c.p. Edison Frosted tip		Book lift	1-lamp bracket, lamp down, chain pull
9	18		9		16-c.p. Edison	12'-6"	Main room	Ceiling pendant 16-in C. R. O. ball
2	10		4		16-c.p. Edison Frosted		Shelves in office	2 mirror reflectors
10	10		20		16-c p. Edison		7 shelf cases in main rm.	Mirror reflectors
20	9		20		8-c.p. Edison		3 shelf cases in main rm.	Revolving fixtures
9	R 7 D		18		20 c.p. 50-watt Gem	7'-2"	4 shelf free standing cases	Exact spread of arms given later (about 5'-0")
3	8 E		3		16-c.p. Edison Frosted		Delivery desks	Adjustable revolving standard
3	14		3	40-watt Tantalum Frosted			Circulation room	On round tables
1	14		1	40-watt Tantalum Frosted			Reference room	On round tables
4	L 7 C		8		16-c.p. Edison Frosted		Reference room	Rectangular tables, distance x = 1'-6" for 6'-0" table and 1'-3" for 5'-0" table
2			2	16-c.p. Edison Frosted				2 flexible portables with fluted glass shades.

Second Story. Height, 15′-6″

No. of pieces	Drawing No.	No. of Lamps. Gas.	Elec.	Description of Lamps. Special.	Regular.	Height of Globe Holder.	Name of Room Location of Lamp.	Remarks.
1	3 F	1	1		8-c.p. Edison		Stair landing 1st to 2nd	Combination bracket chain pull
1	3 F	1	1		8-c.p. Edison		Foot of stairs up	Combination bracket, chain pull
1	1 B		1		16-c.p. Edison Frosted tip		Book lift	Bracket, lamp down, chain pull
2	5 B		4		16-c.p. Edison Frosted tip		Rear of circulation room	2-lamp bracket, lamps down, lamps 15″ from wall, chain pull
4	1 B		4		16-c.p. Edison Frosted tip		Column over seat	1-lamp bracket, lamps down
1	1		1		8-c.p. Edison		Slop sink	Lamp down, no shade, chain pull
1			1		16-c.p. Edison Frosted tip		Toilet	Electric ceiling outlet, prismatic
1	6 B		6		16-c.p. Edison Frosted tip	7′-6″ (ceil. 12′-0″)	Librarian's Room	6-lamp ceiling pendant x=1′-3″
2	1 B		2		16-c.p. Edison Frosted tip		Librarian's room	brackets, lamp down, chain pull
16	9		16		8-c.p. Edison		3 shelf cases	Revolving bracket
11	11		22		16-c.p. Edison		5 shelf cases	Mirror reflector
4	11		8		16-c.p. Edison		Bulletin board	Mirror reflector
2	14		2	40-watt Tantalum Frosted			Circulating room	Round tables
4	L 7 C		8		16-c.p. Edison Frosted tip		Reference room	Rectahgular tables, Dist. x=1′-6″ for 6′-″ tables and 1′-3″for 5′-0″ tables
3	8 E		3		16.c.p. Edison Frosted tip		Delivery desk	Revolving Adj. Standard
9	18		9		187-watt gem	12′-6″	Ceiling, main room	16″ C. R. O. Pendant balls

Third Story. Height, 15′-0″.

Janitor's Apartments. Height, 9′-0″.

No. of pieces	Drawing No.	No. of Lamps. Gas.	Elec.	Description of Lamps. Special.	Regular.	Height of Globe Holder.	Name of Room. Location of Lamp.	Remarks.
6	18		6		187-watt Gem	12′-6″	Ceil. main room (reading)	16″ C. R. O. Pend. balls
3	3 F	3	3		8-c.p. Edison		Comb. brackets on stairs, Ch. p.	
2	3 F	2	2		8-c.p. Edison		Janitor's Hall	Comb. brackets, Smoke bells, Ch. p.
4	3 F	4	4		16-c.p. Edison		Janitor's bed rooms	Comb. brackets, Smoke bells, Ch. p.
1	3 F	1	1		16-c.p. Edison		Janitor's bath	Comb. brackets, Smoke bells, Ch. p.
1	6 G	4	4		16-c.p. Edison	6′-6″	Janitor's living room	Comb. ceiling pendant, x=1′-0″
1			4		16-c.p. Edison Frosted	8′-0″	Kitchen ceiling	Cluster porcelain reflector
1	3 F	1	1		16-c.p. Edison Frosted		Kitchen wall	Comb. bracket over tubs Ch. p.
1	1 A		1		8-c.p. Edison		Janitor's stairs to roof	Lamp up
10	13		10	Straight filament lamps			Reading room, ex. cases	Johns-Manville Co. "Linolite"
2	1 B		2		16-c.p. Edison Frosted		Reading room over folio cases	Lamp down 15″ from wall Ch. p.
8	1 B		8		16-c.p. Edison Frosted		Reading room, Cols. over seats	Lamp down 15″ from wall Ch. p.
1	1 B		1		16-c.p. Edison Frosted		Book lift	Lamp down Ch. p.
9	L 7 C		18		16-c.p. Edison Frosted		Reading room tables	x=1′-6-″ for 6′-″ table and 1′-3″ for 5′-0″ table
2			2		16-c.p. Edison Frosted			2 flexible portables with fluted glass shades

Roof. Height, 20'-0" to truss.

No. of pieces	Drawing No.	No. of Lamps. Gas.	Elec.	Description of Lamps. Special.	Regular.	Height of Globe Holder.	Name of Room, Location of Lamp.	Remarks.
3			3		32-c.p. Edison Frosted	8'-0"	Hall	1-lamp, electric pendants Prismatic enamelled
2	2	2					N. wall	Gas brackets
2	1 A		2		16-c.p. Edison		Book lift and motor room	Ch. p.
23	16		16		125-watt Gem with frosted tip	7'-0"	From stair platform to shade holder	Enamelled reflectors

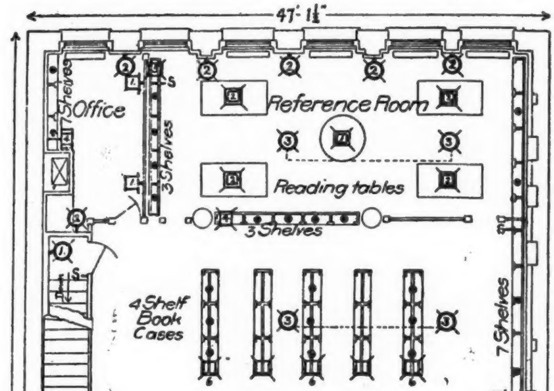


FIG. 7. - First Floor Plan.

building through panel boxes located on each floor. These panel boxes contain the switches which control the individual circuits.

DESCRIPTION OF ROOMS.

Basement.—The basement contains the packing and receiving room, boiler room, coal vault, store-room, and lavatory. The walls and ceilings of this room are white in colour.

First Floor.—The main entrance to the building is on the first floor. With the exception of the vestibule and small office, which are separated from the rest of the room by glazed partitions, this floor constitutes one large room. In the front of the room is the circulating department, in the middle the application and delivery desk, and in the rear portion the free standing book stacks and the reference room. These departments are separated from each other by low rails or low book shelves. Along the walls of the room are book-cases about 7 ft. high. The walls are cream coloured and the ceiling white. The public has access to all of the bookshelves. In the entrance hall are located two exhibition racks of the swing frame type. The switches for controlling the lights are in charge of the librarian.

Second Floor.—This floor contains the children's reference-room and circulating department, and the librarian's room. The conditions are very much the same as on the floor below.

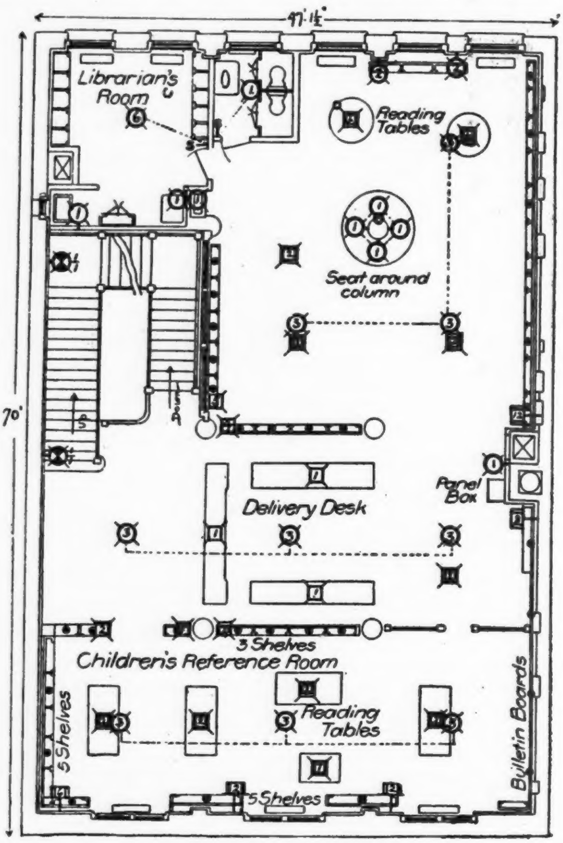


Fig. 8.—Second Floor Plan.

Third Floor.—The main reading-room and the janitor's apartments are on the third floor. In addition to the reading-tables in the main room, there are two circular seats for readers around the columns; also two exhibition cases for the display of photographs, prints, &c. The room contains portable magazine and newspaper racks, but has no bookshelves.

Roof.—The roof is used as an open-air reading-room. The floor of this room is of dark coloured tile, the walls red brick, and the ceiling formed by a roof of dark coloured tile, supported on trusses.

ILLUMINATING TESTS.

Tests of illumination were made under my direction by the Electrical

vided by 10, 187 watt ceiling pendant lamps each equipped with a prismatic reflector, both lamp and reflector being enclosed in a 16 in. crystal globe roughed on the outside. The height of the lamps above the floor is 12 ft. 6 in. The localized illumination is provided on the reading-tables, stacks, book shelves, &c., and may be used in whole or in part depending upon the requirements, permitting lamps in the reading-tables or on the bookshelves, to be extinguished when not required.

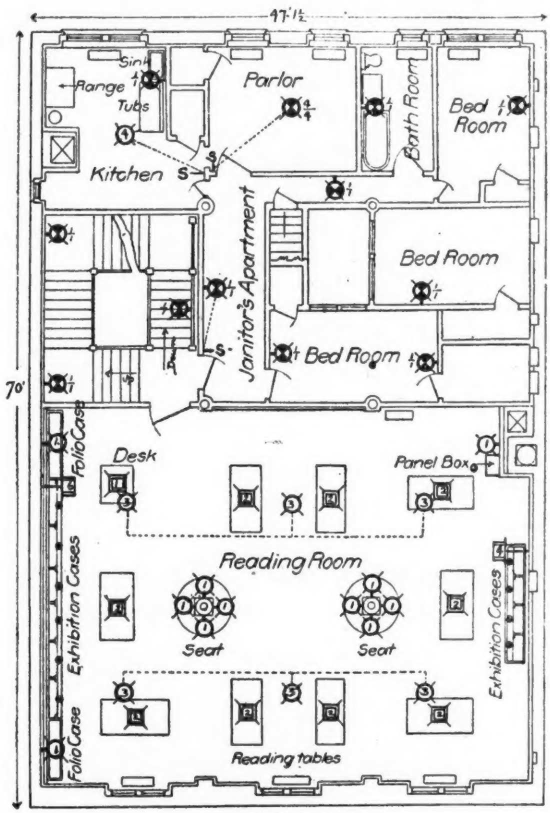


FIG. 9.—Third Floor Plan.

Testing Laboratories, on the first floor and in the roof reading-room.

The first floor dimensions are approximately 67 ft. by 44 ft., and the height of the ceiling is 15 ft. 3 in. in the clear. General illumination is pro-

The free standing bookcases located near the rear of the room are 52 in. high and 9 ft. 6 in. long, divided into four shelves 9 in. apart. These are illuminated by 50 watt Gem lamps, backed by prismatic reflectors which are covered by opal shades, green on the outside, shown in elevation in the illustration. These are located 6 ft. 6 in. above the floor, and immediately over the centre of the aisles between stacks as illustrated on the diagram.

The seven shelf bookcases upon which tests were made are illuminated by 3 candle-power carbon filament incandescent lamps on swing brackets, which, when in use, extend 9 in. beyond the edge of the case, but when out of use are swung over the top of the rack in order to leave maximum aisle space. These lamps are 44 in. above the floor and 6 in. above the top of the case. They are backed by opaque metal reflectors.

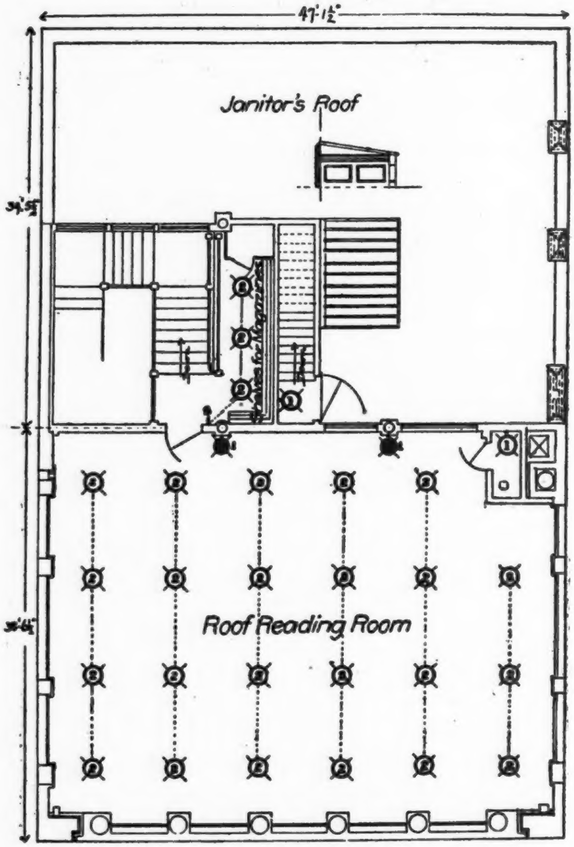


FIG. 10.—Roof Reading Room Plan.

special two-socket mirror trough wall reflectors holding the lamps in a horizontal position, and equipped with 50 watt Gem lamps, The location of these reflectors is illustrated in the diagram.

Tests were made upon the low bookcases along the aisles. These cases are provided with local illumination from

The round reading-tables shown on the drawings are provided with local illumination from 40 watt frosted tantalum lamps in single lamp fixtures, having 14 in. opal dome shades, green on the outside. Immediately over the lamps and inside the dome shades are placed prismatic reflectors. These fixtures are placed at the centres of the tables, with the tantalum lamps 20 in. above the table top.

The rectangular tables, 3 ft. ×5 ft., in the rear of the room are illuminated by frosted 16 candle-power Edison lamps, equipped with reflectors of the same type as those used on the round reading tables. The test was made on one of the tables, which was equipped by mistake with 40 watt tantalum lamps instead of 16 candle-power Edison lamps, and the error was not discovered until it was too late to complete further measurements with lower candle-power lamps in time for presentation in this paper.

A plan of the roof reading-room is given, showing the approximate location of tables and light sources. In this case 125 watt tip-frosted Gem lamps are used in conjunction with a temporary installation of prismatic reflectors sand blasted inside. The tables are not fixed as in the floors below.

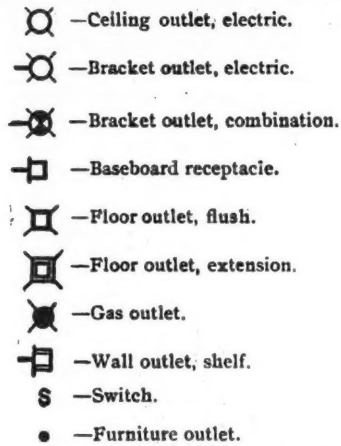


FIG. 11.—Key to Wiring Symbols.

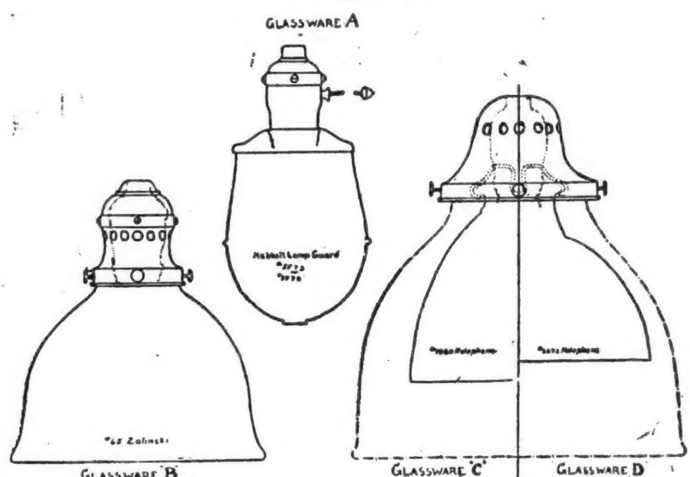


FIG. 12.—Glasswares A, B, C and D.

CONDITIONS OF TEST.

Most of the lamps in this installation were installed over two months ago, and have experienced a normal amount of service since installation. As slight fluctuations in voltage were to be anticipated, and as it was desired to obtain results which would be free from the influence of such fluctuations, it was decided to make the photometric comparisons with a standard lamp operated from the lighting system, and subject to the same fluctuations in voltage as were the lamps which were under test. Under these conditions accurate results are secured, which are intercomparable.

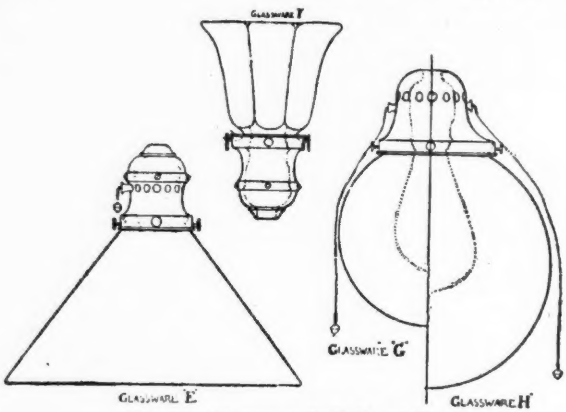


FIG. 13.—Glasswares E, F, G and H.

On the first floor tests were made to show the amount of general illumination, and also to show illumination produced by both the ceiling lamps provided for general illumination and the lamps provided for local illumination.

METHODS OF TEST.

The intensity of vertical illumination was measured at points on the fronts of sticks and bookshelves where it is desired to read titles on the backs of books. Tests were also made of horizontal illumination in aisles immediately in front of stacks to show illumination on books opened and held in such positions for casual inspection Other tests of horizontal illumination were made upon reading tables.

In conducting these tests a Sharp-Millar portable photometer was used. In tests of vertical illumination at the book-stacks the photometer was placed on the shelves with the illumination test plate vertical, and in the position occupied by the title of a book. An observation under these conditions is equivalent to viewing the title from a point directly in front or to viewing the test plate from a point in a line normal to its surface. Other tests of the same values were made by placing a piece of blotting paper (used as a test plate) vertically over the backs of the books, and observing it through the photometer located at the point from which one would naturally view the titles of the books in practice. This constitutes a determination of the illumination intensity through observation of the test surface at angles varying from 45 degrees above to 40 degrees below the normal, depending upon the height of the shelf.

In all cases the illumination is stated in terms of that produced by a standard lamp placed at a known distance from the test-plate, which was viewed as in the test.

(*To be continued.*)

The Illuminating Value of Petroleum Oils.

By Dr. Arthur H. Elliott.

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

The author describes a number of tests on oil-lamps, the object being to secure some lamp or flame that would serve as a secondary standard for photometric work; these comprise experiments made with a number of lamps and also with various petroleum oils of high and low density.

The small lamps used are found in commerce with glass reservoirs and 0·5 in. and 1·0 in. cotton wicks. Use was made also of lamps with two wicks, where in one case both wicks go through the same burner slot, and in the other case, each wick has a separate slot in the top of the burner. Two lamps with round wicks were also used.

The oils used have been the best grade kerosene oils of 48° to 50° Beaumé, and 150° flash; heavy burning oil, 40° Beaumé, 300° flash; gas oil, distilled to eliminate residuum, of 35° Beaumé; and a mixture of kerosene oil with heavy 300° flash oil, the mixture having a density of 45° Beaumé. The burners used are what are termed in commerce "Queen Anne," "Climax," "Dual," "Duplex," "Rochester," and "Belgian."

In starting these investigations, the work done by others was naturally looked over and very little of this kind of work was found on record, with the exception of some work done by Stevenson Macadam, F.R.S.E., who about the year 1870 conducted some experiments on the illuminating value of mineral oils and compared them with sperm oil, rape oil (colza), and whale oil. Table A gives a résumé of his results and a comparison of the mineral oils, with others mentioned.

Table A.—Illuminating Value of Oils. Macadam.

Lamp used	Small flat flame		Medium flat flame		Large flat flame	
Oil used	Grains per hour	Candle-power	Grains per hour	Candle-power	Grains per hour	Candle-power
Paraffine (Shale) ... Uphall & Young ...	328	6·0	492	9·0	656	12·0
Value of 120 grns. of paraffine oil per hour	120	2·195	120	2·195	120	2·195
Sperm	180	1·306	—	—	—	—
Rape (Colza) ...	170·6	1·05	—	—	—	—
Whale	153	0·90	—	—	—	—

TABLE A (continued).

Lamp used	¾-in. Argand		1-in. Argand	
Oil used	Grains per hr.	Candle power	Grains per hr.	Candle power
Paraffine (Shale) Uphall & Young.	494	9·0	975	19·83
Value of 120 grns of paraffine oil per hour ...	120	2·195	120	2·719
Sperm	—	—	1006	13·0
Rape (Colza) ...	—	—	933·2	11·33
Whale	—	—	853	9·8

In the investigations tabulated in Tables B, C, &c., two methods of procedure have been used.

Each lamp was tested against a pair of standard sperm candles, burning within the regulation limits of 120 grains of sperm for each candle per hour. The relative variation in the illuminating power was then calculated, designating the maximum illuminating power as 100, and the others as percentages.

Each of the readings across the table indicates hourly observations, and it will be seen that in many cases these observations run over a large number of hours. Moreover, the quantity of oil, in grains, burning one hour, to give one candle-power, was calculated, in order to compare it with the standard sperm candle—the light obtained from sperm burned at the rate of 120 grains per hour. This gives a direct comparison between sperm and the same weight of any oil used. Some of these figures are extremely interesting, as indicating the high value of petroleum oils of good quality, as compared with sperm oil.

TABLE C.

Queen Anne Burner. One ½-in. wick. 6 hours. Burning 308·64 grains of oil per hour.

Candle-power.	Variation of Illuminating Value.
4·90	98·00
5·00	100·00
5·01	100·00
5·01	100·00
5·00	100·00
5·00	100·00
Average 4·987	99·70

1 c.p.-hour requires 61·98 grains of oil.
120 grains of oil per hour = 1·936 candle-power.
Variation of standard during test, 10·25 to 10·21 c.p.

TABLE B.—EXPERIMENTS WITH VARIOUS LAMPS, USING KEROSENE OIL.

Oil not measured.

Burner used	Time	Candle-power	Illumination
Queen Anne, ⅝-in.	10 minutes	5·59	90·7
" " "	2½ hours	6·16	100·0
" " "	4 hours	6·16	100·0
Queen Anne, 1-in.	15 minutes	8·64	98 5
" " "	1¾ hours	8·77	100 0
" " "	3¾ hours	8·56	97 6
Climax, 1·5-in., with height gauge	10 minutes	6·88	98·00
" " " " "	1 hour	6·79	96·7
" " " " "	2 hours	7·02	100·00
Climax, 1·5-in. wick, 1-in. height gauge. Student feed ...	10 minutes	11·67	93·5
Climax, 1·5-in. wick, 1-in. height gauge. Student feed ...	1½ hours	12·51	99 5
Climax, 1·5-in. wick, 1-in. height gauge. Student feed ...	3 hours	12·60	100 0

TABLE B (continued).

Burner used; Climax, 1.5-in. wick, 1-in. height gauge. Student feed.

Time.	Candle-power.	Illumination.
5 hours	11·67	92·6
30 minutes	15·09	100·0
3½ hours	14·96	99·1
5½ hours	14·83	98·3
7 hours	14·52	96·2
10 minutes	14·92	99·1
2 hours	14·73	97·9
5 hours	14·97	99·5
7 hours	15 05	100·0

TABLE D.

Kerosene, Queen Anne burner. One 1-in. wick 6 hours. Burning 618·98 grains of oil per hour

Candle-power.	Variation of Illuminating Values
10·83	98·71
10·87	99·08
10·87	99·08
10.97	100·00
10·97	100·00
10·97	100·00
Average 10·913	99·48

1 c.p.-hour requires 55·71 grains of oil.
120 grains of oil per hour = 2·114 candle-power.
Variation of standard during test, 10·18 to 10·14 c.p.

The tables serve to indicate the steadiness and reliability of the flat-flame lamps, even when burned with common reservoirs where the level of the oil varies as the lamp burns; it will be noted that the rate of consumption and the candle-power are extremely constant. Many of the lamps used gave nearly twice the candle-power of sperm candles for the same weight of oil, while the round-wick lamps gave fully three times as much.

In the early experiments the lamps were adjusted by the eye; that is to say, the height of the flame was determined, and not changed during the experiment, attention being paid only to obtaining the best light. In later experiments, a wire gauge above the flame served to determine its height in the case of flat-flame burners; this arrangement was found impracticable with the round burners. Under these circumstances, it was found that a flat-flame burner would operate several hours with a loss of less than 5 per cent in its candle-power, and in many cases only 2 or 3 per cent. The form and height of the flame, of course, determine its candle-power, but this condition was not considered of so much import-

TABLE E.

Kerosene, Dual Burner. Two 1-in. wicks. 6 hours. Burning 540·12 grains of oil per hour.

Candle-power.	Variation of Illuminating Value.
8·83	200·00
8·72	98·75
8·72	98·75
8·80	99·66
8·80	99·66
8·80	99·66
Average 8·78	99·413

1 c.p.-hour requires 61·51 grains of oil.
120 grains of oil per hour=1·951 candle-power.
Standard unchanged during test.

TABLE F.

Kerosene, Duplex Burner. Two 1·5-in. wicks. 6 hours. Burning 1208·32 grains of oil per hour.

Candle-power.	Variation of Illuminating Value.
22·60	98·70
22·70	99·13
22·70	99·13
22·80	99·56
22·80	99·56
22·90	100·00
22·75	90·35

1 c.p.-hour requires 53·11 grains of oil.
120 grains of oil per hour=2·259 candle-power.
Variation of standard during test, 10·00 to 10·07 c.p,

TABLE G.

Kerosene, Rochester Burner. One round wick 1·5-in. diameter. 6 hours. Burning 1898·17 grains per hour.

Candle-power.	Variation of Illuminating Value.
34·4	99·71
34·2	99·13
34·5	100·00
34·1	98·84
34·2	99·13
34·2	99·13
34·66	99·32

1 c.p.-hour requires 55·40 grains of oil.
120 grains of oil per hour=2·166 candle-power.
Variation of standard during test, 10·12 to 10·00 c.p.

TABLE H.

Kerosene, Belgian Burner. One round wick, 1⅛-in. in diameter. 6 hours. Burning 1539·11 grains of oil per hour.

Candle power	Variation of illuminating value
39·5	99.49
39·6	99·d5
39·6	99·75
39·6	99·75
39·7	100·00
39.6	99·75
Average 39·6	99·75

1 c.p.-hour requires 38·86 grains of oil.
120 grains of oil per hour=3·08 candle-power.
Variation of standard during test, 10·08 to 10·01 c.-p.

TABLE I.

Summary of Six Hour Tests. Kerosene.

Burner used	Queen Anne	Queen Anne	Dual	Duplex	Rochester	Belgian
Size of wick	½-in.	one 1-in.	two 1 in.	two 1·5-in.	1·5-in.	1⅛-in.
Grains oil per hour ...	308·64	618·98	540·12	1208·32	1898·17	1539·11
Average candle-power	4·987	10·913	8·78	22·75	34·26	39.60
Average per cent illumination	99·70	99·48	99·41	99·35	99 32	99 75
One c.-p. hour requires grains of oil ...	61·98	56·71	61·51	53·11	55·40	38·86
120 grains of oil per hour=candles ...	1·936	2·114	1·951	2·259	2·166	3·080

ance as obtaining a steady flame burning at a uniform rate and giving a constant candle-power. The trimming of the wick determines the shape and height of the flame and also its freedom from smoke. Many of the lamps of flat-flame without any adjustment of level in the reservoir, were used for as long as seven hours with a change of less than 5 per cent in the candle-power.

TABLE J.

300° Flash Oil, 40·4° Beaumé, Dual Burner. Two 1-in. wicks. 4 hours.
Burning 459·87 grains of oil per hour.

Candle-power	Variation of illuminating value
6·34	100·00
5·73	90·3
5·93	93·5
5·56	87·7
Average 5·890	92·9

1 c.p.-hour requires 77·7 grains of oil.
120 grains of oil per hour = 1·544 candle-power.
Standard unchanged during test.

As will be seen from the tables, the heavy oils cannot be burned in small, single-wick, flat-flame lamps, since the burning temperature of the cotton wick is lower than the burning temperature of the oil. Furthermore, the density of the oil prevents its rising sufficiently rapidly in such wicks. The experiments were therefore conducted with double wicks. These remarks are true of both the 300° flash oil and also the distilled gas oil.

TABLE K.

Oil Mixture (Half Kerosene, Half 300° Flash). Dual Burner. Mixture = 44·5° Beaumé at 60° F. Two 1-in. wicks. 4 hours.
Burning 544·75 grains of oil per hour.

Candle-power	Variation of illuminating value
9·01	100·0
8·93	99·1
9·01	100·0
8·91	98·9
Average 8·965	99·5

1 c.p.-hour requires 60·8 grains of oil.
120 grains of oil per hour = 1·975 candle-power.
Standard unchanged during test,

In later experiments, a reservoir with a student lamp feed was used for the flat-flame burners; in this case the light was constant over six or seven hours with a variation of less than 1 per cent in the candle-power, tested by both standard sperm candles, and also secondary standards and electric units. Even an oil as low in density as 44° Beaumé in seven hours lost only 5·5 per cent of its photometric value. It was even found possible to place two lamps of the same photometric value opposed to one another on a photometric bench, and obtain only 0·02 candle-power variation in five hours.

TABLE L.

Oil Mixture (Half Kerosene, Half 300° Flash). Queen Anne Burner. One 1-in. wick. 4 hours. Mixture = 44·5° Beaumé at 60° F.
Burning 542·69 grains of oil per hour.

Candle-power	Variation of illuminating value
7.70	100·0
7·65	99·3
7·15	93·0
7·00	91·0
Average 7·375	95·8

1 c.p.-hour requires 73·6 grains of oil.
120 grains of oil per hour = 1·630 candle-power.
Standard unchanged during test.

TABLE M.

Oil Mixture (Half Kerosene, Half 300° Flash).
Climax Burner. Student feed.
One 1·5-in. wick. 7 hours. Oil mixture, 44·5° Beaumé. Tested for variations of candle-power with time.

Time	Candle-power
9.30 A.M.	15·05
10.30 "	14·85
11·30 "	14·43
12.30 P.M.	14·43
1.30 "	14·33
2.30 "	14·33
3.30 "	14·23
4.30 "	14·23
7 hours	14·485 Average c.p.

Maximum candle-power	15·05
Minimum candle-power	14·23
Variation of candle-power ...	·82

Variation 100 to 94·55.
Standard unchanged during test.

It will be seen from Table P that the oil used in a lamp replenished from day to day during one week, is of practically the same character at the end of the week as it is at the beginning. This fact demonstrates that the wicks carry the oil uniformly, and do not separate the various constituents of the oil, and fully accounts for the uniformity of burning and constant candle-power.

TABLE N.

Gas Oil (Distilled), 35·3° Beaumé, 0·847 Specific Gravity, Dual Burner. Two 1-in. wicks. 6 hours. Burning 578 70 grains of oil per hour.

Candle-power	Variation of illuminating value
8·18	100·0
8·18	100·0
8 18	100·0
8·18	100·0
8·12	99·26
8·12	99·26
8·12	99 26
Average 8·16	99·68

1 c.p.-hour requires 70.9 grains of oil.
120 grains of oil per hour = 1·692 candle-power.
Variation of standard during test, 10·32 to 10.30 c.p.

In conclusion the author acknowledges the service rendered by the Consolidated Gas Company of New York and also that of his three assistants, Messrs. Ihart, Regan, and Morhous.

TABLE O.

Gas Oil (distilled), 35·3° Beaumé, 0·847 specific gravity, Duplex Burner. Two 1·5-in. wicks. 6 hours. Burning 657·4 grains of oil per hour.

Candle-power.	Variation of Illuminating Value.
14·40	100·0
14·30	99·3
14·10	98·0
13·70	95·1
13·40	93·0
13·20	91·6
13·10	91·0
Average 13·74	95·4

1 c.p.-hour requires 45·9 grains of oil.
120 grains of oil per hour = 2·614 candle-power.
Variation of standard during test, 10·00 to 10·06 c.p.

TABLE P.

Climax Burner, lamp one week burning, using Kerosene. Test of variation of oil.
Oil at start, 49·1° Beaumé, 60° Fahr.
Oil at finish, 49·0° Beaumé, 60° Fahr.

DISTILLATION.

	320°-400° F.	500°-600° F.	500°-600° F.	Residuum. 600°-660° F.
Start	47·2 p. cent. 52° Bé.	42·8 p. cent. 47° Bé.	9·8 p. cent. 41·0° Bé.	3·2 p. cent.
Finish	46·0 p. cent. 52° Bé.	42·0 p. cent. 47° Bé.	10·0 p. cent. 41·5° Bé.	2·0 p. cent.

Standard Conditions for Testing Oil-Lamps.

In connexion with Dr. A. H. Elliott's exhaustive series of tests on this subject, it may be of interest to recall the papers read by M. Pihan and Herr Curt Proesdorf, at the International Petroleum Congress at Bucharest in 1907 (see *The Illuminating Engineer*, Jan., 1908, p. 79). On this occasion M. Pihan described the use of the Carcel lamp for making standard tests on oil-lamps and Herr Proesdorf described some experiences with 150 different types of lamps.

Subsequently, some further interesting particulars of tests on these lines were described by M. Guiselin in the *Journal du Pétrole* (see *The Illuminating Engineer*, March, 1908, p. 244).

The Intrinsic Brightness of Lighting Sources.

By J. E. Woodwell.

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

The author commences his paper by commenting upon the importance of intrinsic brilliancy of illuminants, especially at the present day, when brighter sources are being introduced; and this brightness can be intensified by the use of reflectors. He mentions some other recent papers dealing with the subject.*

Briefly, any brilliant source of light in the field of view, however small, causes a contraction of the pupil of the eye, and reduces the effect of illumination received from other parts of the visible field. A contraction of the pupil also takes place, even if the bright spot is viewed only occasionally. Furthermore, the continuous or occasional presence of a bright light source in the field of view impairs, temporarily at least, the sensitiveness of the eye itself, thus again reducing the effectiveness of illumination. Moreover, the contraction of the iris in the presence of bright light sources soon reaches the limit of its protective faculty, beyond which it responds feebly to an increase in brightness. The control of the pupillary aperture appears to be designed to strengthen the vision under comparatively weak illumination, rather than to protect against excessive intensity or brightness.

Recent researches of André Broca and F. Laporte† indicate that the pupillary contraction caused by bright light sources within the peripheral vision reduces visibility in proportion to the decrease in working illumination, and produces the greatest eye fatigue in comparatively weak illumination. The exhaustion and injurious effect was greatly reduced, on the other hand, under an illumination of from 1·86 to 3·72 foot-candles.

The *intrinsic brightness* of the luminous source rather than the *distance* of the source from the eye was shown to be the principal cause for pupillary constraction. The different light sources could be classed—with reference to their action in producing pupillary contraction and residual images—in the order of their respective intrinsic brightness. These researches also suggest that the protective faculty of the eye is not susceptible to the energy effect or to light rays of different colour.

Ultra-violet rays have been regarded by some authorities as harmful, but it has been shown that these rays in the light from various forms of incandescent illuminants of high intrinsic brightness are, with few exceptions, much less than in direct or even reflected sunlight. Other invisible radiation of much more harmful character may accompany not only the newer light sources of high incandescence, but those of lower temperature as well.

The more important hygienic effects of light sources of high intrinsic brilliancy within the field of vision may then be summarized as follows:—

1. Contraction of the pupil is caused, thereby reducing the amount of light entering the eye and the consequent visibility.

2. The sensibility of the visual organs is temporarily impaired by residual images and retinal fatigue.

3. The effects of (1) and (2) are also produced by the occasional view of

* 'Some Physiological Factors in Illumination and Photometry,' Dr. Louis Bell; 'Light and Illumination,' Charles P. Steinmetz; 'Matters of Illumination which Affect the Eye,' Dr. Wendell Reber; 'Effect of Light upon the Eye,' Dr. H. H. Seabrook; 'Eyesight and Artificial Illumination,' Dr. John T. Krall; 'Artificial Illumination from a Physiological Point of View,' Dr. Myles Standish.

† Étude des principales sources de lumière au point de vue de l'hygiène de l'oeil. MM. André Broca et F. Laporte. *Bulletin* of the Société Internationale des Électriciens, Vol. VIII. (2nd series), No. 76.

bright sources or by subjecting the eye to sudden fluctuations of light.

4. *Intrinsic brightness* rather than the *distance* of the source from the eye is the principal cause for pupillary contraction.

5. The harmful effects are greatest in proportion to the decrease in the working illumination, and are considerably reduced under an illumination exceeding 2 foot-candles.

6. The different luminous sources may be classed with reference to producing pupillary contraction and after-images in the same order as their respective intensities.

In applying the knowledge to the laws of hygiene of the eye to the design of artificial illumination, the best criterion of the proper values of intrinsic brightness of the light source, as well as of other essential factors, is daylight.

From this point of view *diffusion* is the most important quality. Diffusion may be obtained in artificial illumination by enlarging the area or surface of the light source, by shading the source with diffusing globes or screens, or by concealing the source and utilizing the diffuse reflection of the surfaces which receive the direct light.

Whatever method may be applied in practice to secure improved diffusion and reduced intrinsic brightness of the artificial sources, it is most important to determine the values of intrinsic brightness which are both safe and advantageous to apply to the design of illumination.

The intrinsic brightness of a light source is the candle-power or *intensity of* the source divided by the *area* of the luminous surface. The intrinsic brightness of a small surface is the candle-power perpendicular to the surface divided by the area of the surface. Intrinsic brightness is stated, therefore, in candle-power per square inch, or in Hefners per square centimeter when metric units are employed.

Measurements of daylight-illumination taken by Basquin show a mean annual brightness for zenith sky in Chicago of 500 candles per square foot, or about 3·47 candles per square inch, with a range from 200 to 1,100 candles per square foot, according to the month and other conditions.

Under ordinary conditions the vertical brightness of the flux of light from the sky, direct sunlight excluded, though varying widely under different conditions, is not often more than one candle-power per square inch. Even such a comparatively low degree of brightness exposed to view affords discomfort to the eye. Shades and screens are depended upon to modify all but the most moderate natural brilliancy, so that with a satisfactory interior illumination the virtual intrinsic brightness of the flux of daylight through windows may be as low as 0·1 or even 0·01 candle-power per square inch.

Even an abnormally high illumination of 10 foot-candles on a white diffusing surface, such as white blotting paper, gives an intrinsic brightness of the surface very little more than 0·005 candle-power per square inch, neglecting absorption which would reduce the apparent brightness to 0·004 candle-power or less.

Compared with such figures the intrinsic brightness of all of the naked artificial luminous sources is enormously high, while the values secured in actual practice by the use of shades and diffuse reflecting surfaces are generally more than ten times as great.

A number of authorities regard 4 or 5 candle-power per square inch as safe and admissible and 1 or 2 candle-power good practice. While the use of even the lower of these values in artificial illuminations is questioned, it would result in a most pronounced improvement from the hygienic standpoint, and alleviate one of the principal causes of eye strain and fatigue.

Ordinary acid-frosted or sand-blasted incandescent carbon or metallized filament lamps have an intrinsic surface brightness of from 0·75 to 1·0 candle-power her square inch, and, when in the field of vision, such frosted lamps frequently produce a distressing effect, and considerably reduce the value of the effective illumination.

The author, therefore, considers that from 0·2 to 0·1 candle-power per square inch is none too low for the safest and best practice where artificial sources must necessarily be placed in the constant or even occasional field of vision.

In the presence of a highly-illuminated field of view the iris diaphragm of the eye is "stopped" down almost to a minimum, and the direct effect of any light sources within the field of vision is correspondingly lessened. These conditions occur in practice where a room or space is almost uniformly illuminated by exposed lighting sources of high brilliancy, and there are neither dark surfaces, sharp contrasts, nor shadows which would require the eye to work with a larger pupillary aperture. Such conditions, while tending to reduce the deleterious effect of brilliant light sources, are not the most favourable for best vision. Working in such an environment it is not strange that a comparatively high intensity of illumination in foot-candles is frequently demanded, and the eye appears insatiable. From the standpoint of efficiency, therefore, as well as of hygiene, the conditions must favour a pupillary aperture which is sufficiently large to work the eye at its maximum sensibility. To accomplish this result the intensity of illumination should not only be moderate, in general from 1·5 to 4 foot-candles, but the intrinsic brightness of the sources should be reduced to 0·2 or a 0·1 candle-power per square inch; or else the sources must be completely excluded from the field of vision.

With a weak illumination, however, requiring the eye to work at or near the limit of opening of the pupillary aperture, the eye is extraordinarily sensitive to the direct light from sources of even moderate intrinsic brightness, and under such circumstances the actual apparent surface brightness of the source cannot be kept too low for safety.

The distance of the luminous source from the eye within the limits ordinarily found in interior illumination does not appear to be material, except in its relation to the position of the source and its inclusion or exclusion of the field of vision.

The preceding discussion has been confined to the direct effects and modification of the intrinsic brightness of luminous source, but it is evident that the same conditions will apply equally well to the reduction of the intrinsic brightness of all illuminated surfaces which become secondary sources of illuminations. Even with indirect illumination the ratio of brightness of the reflecting surfaces to that of the illuminated field may be excessive.

The foregoing data will have their principal application, however, in the design of globes and shades which are commonly employed to reduce the intrinsic brightness of exposed lighting sources. In arriving at the resultant intrinsic brightness it is necessary to refer to the spherical candle-power of the source, and to make allowance for the absorption by the glass which may vary between from 15 to 25 per cent for alabaster to 60 per cent or more for opal or porcelain glass. The absorption by ground glass will vary according to the process employed in roughing or sand blasting, but it will generally be between 20 and 40 per cent. The thickness as well as the quality of the glass will also have a marked influence upon the absorption. Moreover, the distribution of the light from this source will be modified by surrounding the lamp with an inclosing globe. The most perfect diffusion will be received by a ground opal glass, but at a sacrifice of from 40 to 60 per cent of the total light. The more transparent glasses, on the other hand, do not sufficiently diffuse the light from the source. In any event, however, it is important that the size of the diffusing globe or shade should be proportioned to the candle-power of the source, so that the reduction of intrinsic brightness will be approximately uniform.

Finally, the author points out that it is difficult to lay down hard and fast rules, and that much depends on the local conditions. However, the most essential point is to reduce the intrinsic brightness of all sources within the field of vision to not over 0·2 candle-power per square inch of diffusing surface.

Architecture and Illumination.

By Emile G. Perrot.

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

The author remarks that the primary function of a building is to serve the practical uses of man.

If, however, architecture is considered in its real significance as being ornamental construction, one of the fine arts, and possessing in addition to its technical value, æsthetic and phonetic values—that is, beauty and power to tell a story—then illumination becomes only the handmaid of architecture, as are painting and sculpture.

Thus the relation of illumination and architecture presents a twofold aspect. According to Ruskin's view of architecture " we may live without her and worship without her, but we cannot remember without her," and we must recognize the ability of our architecture to transmit to posterity the true life and history of our time. Only thus will the highest function in the practice of the art have been fulfilled.

The architect's method of expression is by the use of the materials of construction, which must be so moulded and shaped as to give the appearance of solidity; the building must be solid and substantial in addition to being a thing of beauty. This effect is produced largely by means of shades and shadows; hence the knowledge of the " third dimension," as it is called, is necessary to the proper expression of a building. It is here that light plays a most important part in the bringing out of the details which characterize the work of the master architect. It was the understanding of the contour of details that made the Greeks surpass the Romans as artists, and is indicative of the perfection to which the Greek mind was developed as compared with that of the Roman. The study of the play of light and shade on the exterior of a building requires the highest kind of training for the successful outcome of an architectural composition; the effect of the building in strong sunlight being usually considered.

With the interior of the building, however, it is different. The effect of the strong sunlight no longer exists; a diffused or subdued light takes its place. Hence, the design of details for the interior of a building should not possess the same characteristics as are found on the exterior of buildings. Here again the skillful architect seizes his opportunity to display his talent by so modifying the details that they may be best brought out under the different light conditions.

The aspect of a building when viewed in daytime will be different from that at night with artificial illumination. Therefore, the architect should study the method of lighting in relation to its effect on the aspect of the design, in just the same manner as he does the effect of sunlight. This phase of the art of lighting, it must be confessed, has been very much neglected by the architect. It is to be hoped that greater care will be used, and more study put into the illumination of buildings, by our architects so that the result, when the building is completed, will be one in which no shortcoming from this cause will be visible.

Illumination may be divided into two parts—" necessary lighting," and " decorative lighting." Under the first head is included all methods of lighting which are used in buildings irrespective of the effect upon the architecture; in other words, the scientific application of the sources of light for the purposes of rendering possible the use of the building at night time.

The second division comprises that use of artificial lighting for the purposes of display, without any reference to the scientific or economic aspect. Of course the latter method of lighting also performs the function of the former.

The method of lighting outlined under the first heading is the one that has been employed in the majority of cases; in many instances it seriously counteracts the effects of the architecture by compelling the use of large and unsightly fixtures in locations ill adapted for them. This result is very noticeable in large buildings whose prototypes are the monuments of ancient Rome and Greece, in which the use of elaborate chandeliers are unknown. However, lighting fixtures, if properly placed, and designed for the location, are one of the best means of adding to the furnishings of an apartment. The architect should design the fixtures for a building just as he designs the carving for a column capital or the bas-relief enrichment of a frieze, for the use of stock patterns for any feature of a building is reprehensible. On the other hand nothing is more striking in a building than a lighting fixture when in use at night time.

As a rule, the general practice heretofore has been for the architect either to make a selection from fixtures that are in stock or to entrust the designing of the fixtures to specialists in this line.

In many cases the architect is not consulted at all, the owner or committee arrogating this right to themselves, very frequently to save the architect's commission. However, in more important work the architect's influence on the selection of fixtures is felt more than ever, to the extent thus far that the architect even designs the hardware for the building, just as he would a stair-rail or iron-grille.

A very successful combination of architecture and illumination exists in the new Singer Building, New York. The lighting of the main entrance lobby is particularly striking by reason of the absence of electroliers, while the architect has made use of concealed lamps over a diffusing glass forming the centre of each vault; thus a flood of light emanates from the centre of each vault, bringing out very effectively the details of the building. The decorative or display lighting of the exterior of the building is effectively accomplished in the combined use of lamps to outline the architecture of the roof, and search lanterns to illumine the shafts of the high tower, bringing out, even in night time, the effect of the colour scheme. While the wisdom of the display on a building of this type, from an architectural standpoint, may be questioned, the author considers the scheme appropriate in the case of the lighting of pleasure buildings, such as are seen in the summer parks, such as the towers in Coney Island. The kaleidoscopic treatment of the designs in electric lamps is in keeping with the latter type of building, and the general use of lamps to outline the architecture and form part of the general treatment of the design is to be commended.

The author mentions the use of decorative lighting on a large scale in connexion with the Buffalo Exposition of 1901. On account of the nearness of the Exposition to Niagara Falls, he states, it was possible to produce effects on a large scale hardly possible when the cost of production is so much greater, and in this Exposition illumination served as the handmaid of architecture. The author considers, indeed, that for the perfect union of architecture and illumination the Buffalo Exposition has never been surpassed.

Mr. Perrot recommends that the Illuminating Engineering Society should materially help architects, by the publication of tables embodying results of tests and by giving data and formulas for the lighting of all types of buildings by various illuminants. Such pamphlets should contain examples of lighting schemes in existing buildings. The publication of such data would involve considerable labour and cost, but a committee of the Society could be appointed which would be able to accomplish this end, if the members consisted of those who had previously performed this service for the large manufacturing and lighting companies.

If buildings are to be properly lighted and made to embody the latest improvements, the architects should be kept in touch with all that is new and desirable for the purpose of effectively and economically lighting the buildings he designs, with the view of wedding together architecture and illumination, and thus leave to posterity the fullness of what has hitherto been but a faint effort of the proper union of the noblest of the fine arts, and the most useful of the sciences. This result, the author concludes, can be better accomplished through this Society than by any other means.

The Intensity of Natural Illumination Throughout the Day.

By Leonard J. Lewinson.

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

This paper deals primarily with the intensity of illumination produced by natural sources of light, such as the sun, moon, and stars, modified by the earth's atmosphere, and describes a series of experiments undertaken at different periods during the day.

A number of papers treating of daylight-illumination have appeared, but in all of them there is an almost entire absence of intensity-determinations—"foot-candle" values, which are of chief interest to illuminating engineers.

To the establishment of the best artificial conditions, a knowledge of natural conditions is essential. Men who deal with lighting problems are in need of data that can be applied in the design of artificial illumination. They should know the order of magnitude of the natural illumination intensity during the day, for which they endeavour to provide a substitute at night, or a reinforcement on dark days. They should appreciate the fluctuations in intensity to which natural illumination is subject—variations of greater extent than are met with in any artificial illumination.

A problem which is open to discussion, and which is of much importance, can be summed up in the question, "Why does the human eye, which is satisfied with an illumination of 2 foot-candles produced at night by an artificial source, require at least 20 foot-candles of daylight for ordinary reading purposes?" It is believed that studies of the kind considered in this paper will shed some light on this interesting question.

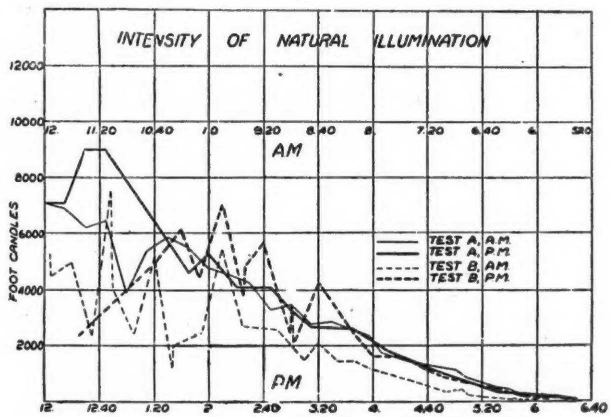


Fig. 1.—Intensity of Natural Illumination in Day Time.

Moonlight intensity is of particular interest in connexion with street-lighting. It has been the chief criterion, particularly in this country, and will probably remain so for years to come. In many towns, lighting plants are operated on a "moonlight schedule," the lamps being operated only when natural illumination is considered insufficient. "What is the illuminating value of moonlight?" "How does this intensity vary?" These are questions which have long remained unanswered. Now, however, that engineers are approaching the problems of street-lighting from a scientific view-point, it is essential to know the foot-candle intensity of moonlight and skylight at night.

In these experiments two Sharp-Millar photometers,* equipped with miniature tungsten lamps were used, the experiments being conducted on the roof of the Electrical Testing Laboratories in New York City. There is practically no obstruction to sky-light. The roof of the adjoining building toward the west is only a few feet higher than the roof of the Laboratories. On the north side there are no buildings within 100 ft., and toward the east and south the space is practically open. When two photometers were used, the test plate of one was horizontal, and that of the second was turned so as to be normal to the direct light from the sun or moon. In certain tests, one photometer was used in making both sets of measurements.

With unvarying intensity and good colour value, a precision of approximately 1 per cent can be obtained with the photometers used in these tests. On account of the great colour differences and large variations in intensity which were encountered, the precision of the determinations was necessarily somewhat lower. For the purposes of this paper, however, the results attained may be considered as substantially correct.

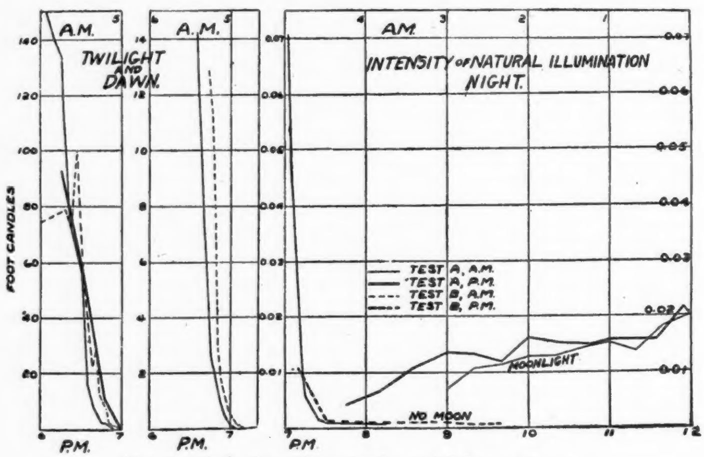


FIG. 2.—Intensity of Illumination at Night, no Moon.

TEST A.

24 HOURS' CONTINUOUS OBSERVATION.

Date: Sept. 9th and 10th, 1908.
Sun rises, Sept. 9th, 5.33 A.M.
Sun sets, Sept. 9th, 6.19 P.M.
Moon full, Sept. 10th, 7.45 A.M.

The sky during this test was clear, and practically cloudless throughout the entire twenty-four hours. There was a slight haze all day, except during the hours immediately preceding and following noon. This haze was slightly heavier in the early afternoon than during the morning. The temperature was about 61 degrees F. during the early morning hours, increasing to 73 degrees F. at noon, and steadily decreasing to 64 degrees F. at 9 P.M., after which it remained about constant until 3 A.M., Sept. 10th.

The results are expressed graphically in Figs. 1 and 2. Noon is taken as the starting point; the heavy, continuous line shows the illumination during the afternoon and evening of Sept. 9th, the scale of hours being shown

* For description, see *Electrical World* and *Electrical Review*, Jan. 25, 1908.

at the bottom of the diagram. The thin, continuous line shows the illumination during the mornings of Sept. 9th and 10th, the scale of hours at the top of the diagram applying. It will be seen that the P.M. curves read from left to right, and the A.M. curves from right to left. Horizontal illumination intensities are shown in these diagrams, because the normal illumination values are available only during the periods when the sun and moon are visible.

Considering first the night illumination, one notes that the skylight value approximates 0·001 foot-candle, when the moon is not visible.

The rate of increase of illumination during the hour preceding sunrise is enormous, the intensity at 5.25 A.M., about seven minutes before sunrise,

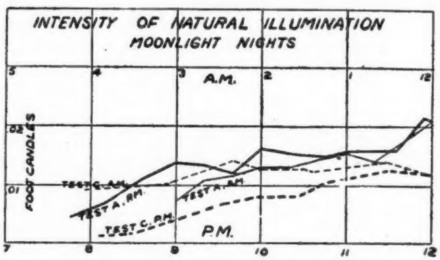


FIG. 3.—Intensity of Natural Illumination on Moonlight Night.

being approximately 10,000 times that at 4.25. During the hour after sunrise, the rate of increase is relatively small, the intensity at 6.38 A.M. being about eleven times that at 5.37 A.M.

A fair average figure for horizontal illumination produced by moonlight and skylight on this particular night is about 0·014 foot-candle, between 8.35 P.M. and 2.20 A.M. The "normal" illumination is about double the horizontal. The moonlight illumination is very much more constant during the night than is the sunlight during the day, probably due to the fact that on this occasion the moon did not rise as high in the sky as did the sun.

With noon as a starting point, working forward towards 6 o'clock in the afternoon, and backward toward 6 o'clock in the morning, the illumination curves correspond very closely, except during the hour immediately preceding and immediately following noon, where large fluctuations were noted, due to varying atmospheric conditions.

TEST B.

17 HOURS' CONTINUOUS OBSERVATION.

Date: Sept. 1, 1908,
Sun rises, 5.24 A.M.
Sun sets, 6.35 P.M.
No moon.

During the early morning there was a very heavy mist and the relative humidity was very high, decreasing from 98 per cent at 4.51 A.M. to 80 per cent at 10.20 A.M. From 10 o'clock to noon the per cent of relative humidity decreased more rapidly to about 48 per cent. The mist gradually disappeared, but the sky became overcast with irregular clouds.

Figs. 1 and 2 continue a graphical representation of the above results. Here, again, the rapid changes during the hour immediately preceding sunrise and the hour following sunset are noted. The fluctuations in intensity during the day are very marked, the ever-shifting mists during the morning and the heavy clouds which obscured the sun at times during the afternoon causing these variations. The average intensity during the afternoon, particularly after 1 o'clock, is higher than that in the morning, due to the disappearance of the heavy mists. Some of the intensities observed are considerably higher than the values at corresponding periods during the first test, probably due to the fact that the cloud formation at certain times caused an increase in the horizontal illumination intensity. This phenomenon has already been pointed out by Dr. Edward L. Nichols, in his paper on 'Daylight and Artificial Light,'* in which he shows a four-fold increase of illumination during eight minutes

* *Transactions* of the Illuminating Engineering Society, Vol. III., No. 5 (May, 1908). See also *Illuminating Engineer* (London), August.

preceding the obscuring of direct sunlight by the formation of a storm cloud.

Referring to Fig. 2, it will be seen that the skylight approximates 0.001 foot-candle after 7.30 P.M. There are slight variations from this value incident to the breaking up of the clouds after 9 o'clock.

It is of interest to note that at a few minutes before dawn and a few minutes after sunset the illumination is about 2 foot-candles; such an intensity produced by an artificial source, as stated before, is considered sufficient for reading purposes. In making the tests, however, it was found that when the natural illumination was 2 foot-candles, it was impossible to read the instruments without the aid of artificial light. On the clear day (Test A) the illumination was found to be 2 foot-candles at about 25 minutes before sunrise and 25 minutes after sunset. In Test B, when the sky was clouded or obscured by a heavy mist, this value was obtained at about 15 minutes before sunrise and 15 minutes after sunset.

TEST C.

10 HOURS' CONTINUOUS OBSERVATION.

Sun sets, 7.03 P.M., August 12th.
Sun rises, 5.04 A.M., August 13th.
Full moon, 12.15 A.M., August 12th.

During this test the percentage of relative humidity was very high, averaging about 90 during the night. Up to 9 o'clock there were light clouds in the sky. Between 9 and 10 P.M. the sky was cloudless. Subsequently a haze formed, causing the appearance of rings around the moon.

In Fig. 3 are shown the moonlight curves derived from the results of Tests A and C. The continuous line represents the intensity of the full moon during a clear September night. The broken line represents the intensity of the full moon during a night in August, the sky being almost cloudless, but somewhat hazy. During the August test, the intensity averages are somewhat lower than the September test, due probably to the haziness encountered during the earlier test.

Conclusions regarding natural illumination under conditions described are as follows:—

Certain cloud formations have the effect of increasing the intensity of illumination by diffusion. Other clouds act as absorbing media, and decrease the illumination intensity. Variations in intensity due to clouds, are often of a large order, and sometimes occur suddenly.

In the absence of clouds the rate of change of intensity between the hours of 8 A.M. and 4 P.M. is regular.

The rate of change of intensity during the hours of dawn and twilight is very high.

The skylight value at night, when there is no moon, is approximately .001 foot-candle.

The intensity of moonlight is about .014 foot-candle.

Daylight illumination varies in intensity from 2,000 to 8,000 foot-candles between the hours of 8 A.M. and 4 P.M.

It is hoped that the data herein presented may serve as an acceptable first step towards the establishment, on a quantitative basis, of the facts in regard to natural illumination. The author wishes to acknowledge his indebtedness to various persons, in particular Messrs. H. E. Allen and S. Ulmar, for valuable assistance in making the tests outlined in this paper.

REVIEWS, ABSTRACTS, AND REPRODUCTIONS.

A Study of the Chief Sources of Light from the Standpoint of their Effect upon the Eye.

By MM. André Broca and F. Laporte.

(Abstracted from the *Bull. de la Soc. Int. des Électriciens,* June, 1908.)

In order to study illuminants differing in colour as widely as possible, the authors select for examination incandescent glow-lamps, arc-lamps, and mercury vapour-lamps; while it is almost impossible, theoretically, to compare the effect of hetero-chromatic lights, a similar study of the sources actually in use, may, from the practical standpoint, be considered feasible.

One well-known difficulty in hetero-chromatic photometry is the Purkinje effect, which, however, according to the work of Macé de Lepinay and Nicati, only becomes marked for wave-lengths below 0·517 μ, and for illumination below 0·7 lux. Again, it is recognized that visual acuity may be affected by wave-length irrespective of the intensity of illumination, and the authors therefore decided to investigate how far this and other effects influence the action of modern illuminants. Apart from this question of visual acuity, however, there are other problems, such as the production of fatigue in the eye, that also deserve consideration.

The investigations described by the authors fall into two sections:—

1. Those involving a comparison of visual acuity and speed of reading in the case of different illuminants; for this purpose the electric glow-lamp and the mercury-vapour lamp were selected as representing the widest range of colour likely to occur.

2. The study of the effect of receiving images of various bright sources on the retina; for this purpose it was deemed preferable to utilize also sources of great brilliancy, such as arc-lamps with or without globes.

Study of Visual Acuity.—In these experiments the authors employed a type of wedge photometer, the two sides of which were illuminated by an incandescent glow-lamp and mercury lamp respectively, and were brought, as nearly as could be, to equal brightness. A chart having type of various sizes, calculated to test visual acuity, was then inserted between the eye of the wedge, and the observer could thus compare the effect of both illuminants for equal brightness. Four observers were tested in this way.

As a result the authors find that, at all events when the range of illumination employed in practice is considered, no sensible difference between the two illuminants exist. The collected results are shown in Table I.

Probably if the illumination had been very much further reduced the introduction of the Purkinje effect would have led to an apparent greater visual acuity on

TABLE I.

Source employed.	F.L.		R.J.		L.S.		A.G.	
	Illumination in Lux.	Visual Acuity.	Illumination in Lux.	Visual Acuity.	Illumination in Lux.	Visual Acuity.	Illumination in Lux.	Visual Acuity.
Mercury lamp	0·66	0·19	0·65	0·32	0·84	0·53	0·62	0·40
Glow lamp	**0·59**	**0·16**	**0·61**	**0·29**	**0·64**	**0·42**	**0·62**	**0·34**
Mercury lamp	1·87	0·45	1·63	0·55	2·40	0·84	1·85	0·76
Glow lamp	**1·57**	**0·42**	**1·63**	**0·51**	**1·71**	**0·76**	**1·44**	**0·69**
Mercury lamp	14·5	0·67	—	—	13·1	0·95	18·6	0·78
Glow lamp	**13·2**	**0·63**	—	—	**12·1**	**0·96**	**12·4**	**0·84**
Mercury lamp	16·6	0·71	19·1	0·85	19·7	1·27	20·5	0·84
Glow lamp	**19·2**	**0·625**	**20·15**	**0·95**	**20·2**	**1·40**	**19·8**	**0·88**
Mercury lamp	141	0·81	141	1·05	107	1·32	—	—
Glow lamp	**125·8**	**0·84**	**122**	**1·13**	**117**	**1·20**	—	—

the part of one of the illuminants; but such orders of illumination hardly come within the scope of practical conditions.

Effect of Quality of Light on Speed of Reading.—In this experiment the same apparatus as that previously described was employed, but some running text displaced the acuteness of vision chart. For this purpose the type used in printing the *Bulletin* of the Bureau of Standards consisting of English words was employed. The distance at which it was found to be just possible to read the text was noted, and the type was set at a distance from the eye equal to 0·75 of this distance. In addition to the visual acuity, the time taken by each of three observers to read a line accurately was taken. In this way the results shown in Table II. were obtained.

From these results the authors draw the conclusion that the times of reading time of reading greater, but, during reading, fatigue soon sets in, and the time tends continually to increase; ultimately it becomes impossible to read at all.

The results described in Table II. are mainly in agreement with those undertaken with Sulzer (*Comptes Rendus*, 1903) on the time required to recognize isolated letters, though, of course, the conditions in reading print are somewhat different: our recognition being here assisted by the presence of neighbouring letters.

Leonard Weber, indeed, has stated that the speed of reading is directly proportional to the illumination, at least at feeble illuminations. This result, however, is essentially modified by the angle at which the type is viewed.

We ought to be able to specify the order of illumination needed in practice to enable reading to be carried out with the utmost speed and the least fatigue.

TABLE II.

(Illumination in lux. Time required to read a line by this illumination expressed in seconds.)

Source used.	F.L.			L.S.			A.G.		
	Lux.	Visual Acuity.	Time of Reading.	Lux.	Visual Acuity.	Time of Reading.	Lux.	Visual Acuity.	Time of Reading.
Mercury lamp	152	0·95	9·14	115	1·55	6·2	—	—	—
Glow lamp	**130**	**1·03**	**11·0**	**138**	**1·52**	**4·95**	—	—	—
Mercury lamp	16·4	0·97	9·14	15·3	1·27	5·18	—	—	—
Glow lamp	**16·2**	**0·82**	**9·5**	**16·2**	**1·31**	**7·8**	—	—	—
Mercury lamp	7·8	0·68	9·6	7·85	0·895	4·7	7·4	0·75	5·47
Glow lamp	**7·1**	**0·66**	**9·3**	**7·8**	**0·93**	**5**	**7·8**	**0·80**	**5·3**
Mercury lamp	3·5	0·57	10·2	3·5	0·71	5·2	3·8	0·64	5·8
Glow lamp	**3·9**	**0·55**	**10**	**3·9**	**0·77**	**5·9**	**4·4**	**0·68**	**11·6**
Mercury lamp	1·74	0·30	...	1·57	0·55	4·8	1·48	0·6	5·3
Glow lamp	**1·58**	**0·30**	...	**1·81**	**0·58**	**4·8**	**1 65**	**0·62**	**5·4**
Mercury lamp	0·51	0·26	...	0·46	0·22	5·1	0·5	0·33	5·6
Glow lamp	**0·50**	**0·28**	...	**0·59**	**0·32**	**4·25**	**0·51**	**0·36**	**5**

between illuminations at 0·5 to 150 lux can be regarded as practically constant. They state this conclusion formally by the following law:—

"When characters are presented to the eye, and are so arranged that they subtend an angle at the eye which is a certain given multiple of the limiting angle of distinct vision, the speed of reading is constant, whatever be the conditions of illumination, in the case of sources actually in practical use."

As will be seen from Fig. 1, however, the time of reading depends to some extent on the distance of the eye, approaching a limiting value when the latter becomes less than half the limiting angle of distinct vision.

When the limiting distance of distinct vision is reached, not only is the initial From the standpoint of accommodation of the eyes it is recommended that a person with normal vision should not approach the book he is reading nearer than 0·35 metres, and the authors consider that an illumination is to be condemned that does not permit of ordinary print being distinguishable at a distance of 1·2–1·4 metres.

The whole question is of considerable practical importance. Doctors state that patients who return to them, complaining that their glasses are no longer strong enough, find that it is mainly in the evening that they experience fatigue. Now, in general, the illumination in the evening is far less than in the daytime, and the fact that his accommodation prevents him reading at the necessary one-quarter of the limited distance of distinct vision, naturally leads to fatigue, and limits the amount of work he can turn out.

The short-sighted individual is not infrequently satisfied with an illumination too feeble for those with normal view, because he is able to accommodate with the book very close to the eyes. But before he reaches his nearest point of distinct vision he is usually exerting an injurious effort, and this, in conjunction with the effort of convergence on the part of both eyes, accounts for the number of progressive myopes, in many badly-lighted schools, that constitutes one of the curses of modern civilization. Electrical engineers cannot be too careful to provide adequate illumination in such cases.

For No. 11 an illumination of 30 lux suffices; for No. 9 and the *Journal* not even 100 lux enables the print to be read with ease. The conclusion from these figures can be drawn that the illumination should not fall below 30–40 lux. Recommendations on this point ought to be obligatory by law in schools, and also, as Javal has already insisted, the regulations forbidding the use of excessively fine print.

However, these investigations suggest that all practical sources of light stand on the same footing in this respect.

The Effect of Contractions of the Pupil-Aperture.—Alterations in diameter of the diameter of the pupil-orifice have a

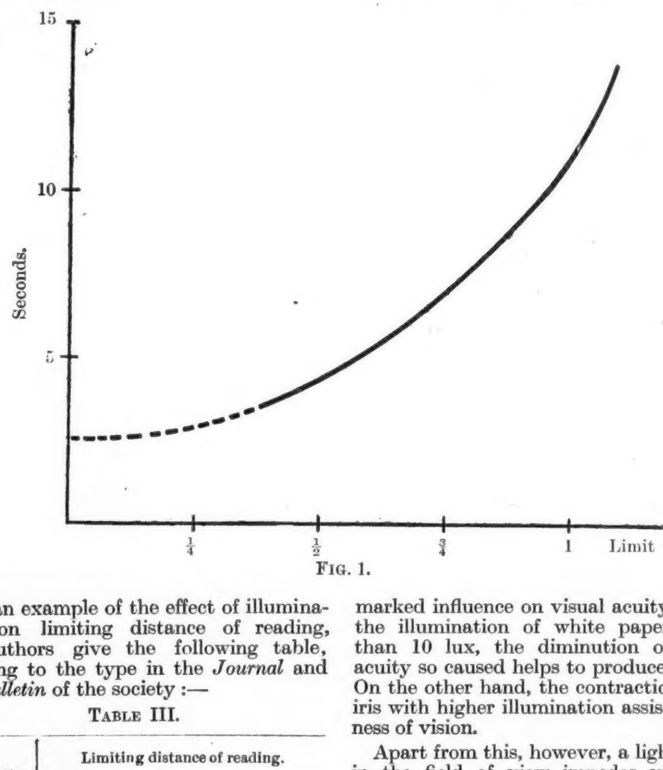


FIG. 1.

As an example of the effect of illumination on limiting distance of reading, the authors give the following table, referring to the type in the *Journal* and the *Bulletin* of the society :—

TABLE III.

Illumination in lux.	Limiting distance of reading.		
	Bull. No. 11.	Bull. No. 9.	"Journal."
1	80	70	75
2	105	85	85
10	145	130	125
30	160	140	145
100	180	145	145

marked influence on visual acuity. When the illumination of white paper is less than 10 lux, the diminution of visible acuity so caused helps to produce fatigue. On the other hand, the contraction of the iris with higher illumination assists acuteness of vision.

Apart from this, however, a light object in the field of view impedes vision by causing less bright objects to appear dark in comparison, while retinal adaptation to bright images causes the same effect (André Broca, *Comptes Rendus*, 1901).

Thus it *may* happen that, when we are looking at *brightly* illuminated paper, a very bright object in the field of view may actually increase visual acuity by diminishing the pupil-aperture, and from this point of view might seem beneficial, were it not for the fatiguing effect of the retinal image. On the other hand, the gain in visual acuity in this way is trifling in comparison with the effect of fatigue. When the paper is *weakly* illuminated, of course, the visual acuity would also be greatly reduced.

As a result of a series of observations on the diameter of the pupil of five different observers, whose eyes are affected by a bright light coming within the field of view, the authors draw the conclusion that the contraction of the pupil-orifice is mainly due to the order of brilliancy of a source, and is not affected by its dimensions or by its colour. These experiments were carried out on tantalum, naked and enclosed arcs, Nernst-lamps, and mercury-vapour lamps.

The contraction of the pupil may be regarded as a natural defence against excessive brightness, each portion of the retina on which a bright image faces being capable of independent action.

The effect of pupil-diameter on the light admitted to the eye is shown by Table IV.

TABLE IV.

Conditions.	Pupillary Diameter	Fraction of illumination transmitted.
No source in field of view	12	1
Glow lamp or ordinary flame ...	8	0·43
Mercury arc	6·8	0·32
Arc with globe	6 to 7	0·25 to 0.34
Naked arc	5·7	0·225

The effect of such changes on visual acuity when the paper is illuminated with a *comparatively low* illumination can easily be understood. Thus, if we are looking at a paper illuminated by an intensity of 1 lux, the normal visual acuity of the unconstricted eye, about 8, will fall to 0·6, 0·5, and 0·45 respectively if a glow-lamp, a mercury-arc, or a naked arc-light are brought into the field of view.

In counting on these figures the authors remark that the intrinsic brilliancy of the naked arc is about 20,000 candles per square centimetre, while that of the tantalum lamp and mercury-vapour lamp, physiologically considered, approaches 2·4 and 1·8 candles per square centimetre respectively—the value for the tantalum lamp is obtained on the assumption that the image is to be spread out on the retina so as to occupy the space apparently enclosed within the outlines of the filament.

Yet the mercury lamp, in spite of its low intrinsic brilliancy, can cause a very considerable contraction, and the authors ascribe this, partially, to the fatiguing nature of the light emitted by it. But the authors reserve their opinion as to the effects of prolonged working under the light from this lamp, remarking that the medical profession have not recorded any cases of injury so caused.

The authors conclude this section by recommending that all lights should be kept out of the normal line of vision, and preferably to employ diffusing systems such as to exclude even the possibility of their being seen.

The Study of Retinal Images.—After looking straight at a bright object two distinct phenomena occur. If we subsequently look at a brightly illuminated surface the retinal fatigue causes us to see a *dark* image of the object previously observed, on a bright background.

Afterwards, if we retire into darkness and look at a dark surface, we see a luminous image, which gradually dies away, often changes colour, and sometimes returns after disappearance several times before finally vanishing. It is possible that this image is caused by some restoring process in the retina, and its duration may indicate the extent of fatigue.

The authors have attempted to study the effect of looking straight at various sources for a given length of time, by observing this duration of the image. When the duration of the impression—the time during which the eye was fastened on the bright source—was relatively long, it appeared that no very definite conclusion could be drawn. Thus, when the duration of impression was three seconds and ten seconds, the mercury lamp and the tantalum lamp led to apparently similar results—the duration of the image varying from 40 to 85 seconds. When the period of impression was only 0·5 seconds, however, more definite conclusions could be drawn, the mean durations of the residual image being :—

	Duration of Image.
Mercury arc... ...	33 seconds.
Tantalum lamp ...	35·5 ,,
Flame-arc with globe	43·5 ,,
Naked flame-arc ...	56·3 ,,

the lamps being thus arranged in order of intrinsic brilliancy. In any case, however, the fact that so permanent a residual image can be formed by only half a second's exposure is an additional indication that such sources ought to be kept out of the field of view.

The Public Lighting in Berlin by Means of High-Pressure Incandescent Gas Lamps.

By Prof. H. Drehschmidt.

(Paper read at the Annual Meeting of the Deutscher Verein von Gas- und Wasserfachmännern. Abstracted from the *Journal für Gasbeleuchtung*, No. 34, August 22nd, 1908.)

Good illumination is already a prime necessity in the streets of large towns, both from the point of view of safety and in the general interests of traffic; also as the traffic becomes greater the degree of illumination must be correspondingly increased.

In Berlin it has recently been realized, in consequence of the illumination in the Alexanderstrasse, that gas-lighting could still compete with electric for street-lighting. Yet the advent of the flame arc had been regarded by many as the final proof of the superiority of electric lighting. For instance the lighting of the Potsdamerplatz by four flame-arcs, and the square facing the Brandenburger Thor produced this impression.

The upright incandescent gaslight, even utilizing high-pressure gas, was disadvantageous in that much of its light was directed upwards; even the use of reflectors could only modify this bad quality, and at the expense of a certain loss of light by absorption. The inverted gaslight, however, has a much more saitisfactory curve of polar distribution of light, and some trials of inverted burners. at ordinary pressure, have recently been made in the Invalidenstrasse. More recently high-pressure gas been has used.

It was assumed that streets and squares through which heavy traffic passed would require lamps taking about 2·4 cubic metres (about 85 cubic feet) of gas per hour, and that those in the less busy streets would require half as much; each lamp was to be provided with two burners.

Originally trials were made with the Selas air-gas mixture, but it was subsequently found that equally efficient results could be obtained with compressed gas. Afterwards the firm of Ehrich & Graetz were invited to compete, and after about two years experiments some lamps were introduced into the streets.

A number of special precautions are necessary in order to secure the desired reliability. For instance, the burner, mixing-chamber, and top must be specially massive, in order to avoid over-heating from the products of combustion, to which they are freely exposed. Again, the dimensions of the mixing chamber must be so selected as to secure the most favourable conditions when the desired consumption of 600 to 1,200 litres of gas are consumed. Special design is also necessary to render the lamps windproof,

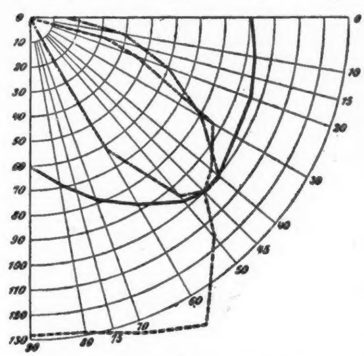


Fig. 1.—Distribution of Light.
——— High-Pressure Inverted Gas Lamps.
- - - - - - Flame Arc.
—·—·— Ordinary Arc (Vertical Colours).

and the method of leading away the products of combustion is here very material.

Considerable time was devoted to the selection and testing of a suitable mantle. In the case of high-pressure lamps the mantle, unlike that used with low-pressure, must bear up close upon the mouth of the burner, and the products of combustion are then forced through the mantle. Until recently double mantles were utilized, burnt off, and shaped upon a special apparatus. The highest illuminating power was secured by using such mantles, the light from the inner one piercing the meshes of the outer, so that their combined luminous effect was greater than that of a single mantle would have been.

Unfortunately the life of all such mantles was at first extremely short—as little as a quarter of an hour in some cases, These difficulties were, however, eventually removed by a suitable design of mantle and burner, and the lamps were put into public use last Christmas.

The lamps containing two burners, each of which consumed 600 litres (21 cubic feet approximately), were satisfactory; but the globes of lamps consuming twice this amount of gas required frequent renewal. The lamps as a whole were similar in the two cases, only the burners and mantles being different, and it appeared that the latter were too long for the lanterns in which they were included. Subsequently the two 1,200 litre burners were replaced by three, each consuming 800 litres of gas, this change being made in the Königgrätzerstrasse and the Potsdamerstrasse. The illumination resulting was considered satisfactory, the three-mantle lights giving, in favourable instances, 0·65 litres per H.K. (about 40 candles per cubic foot); the two-burner lamps yielded only 0·75 litres per H.K. (35 candles per cubic foot); but the same close attention has not been paid to these lamps as to the three-burner variety. The distribution of light from the lamps is, however, of almost equal importance, and in this connexion the curves shown in Fig. 1, where the three-burner lamp is compared with a flame arc-lamp and an ordinary open arc-lamp, as regards distribution of light, are of interest. Apparently the inverted gaslight gives the greatest illumination in a horizontal direction, and the old white-arc the least. The first-named, therefore, would seem to be the best for lighting extended spaces, and the last-named the worst.

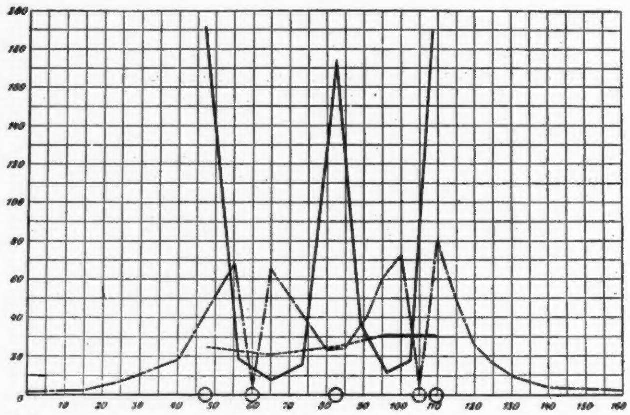


FIG. 2.—Horizontal Illumination by High-Pressure Inverted Burners in the Potsdamerstrasse.

———— In the Line of the Lamps.
– - – - – Middle of Roadway.
— — — — Flame Arc Lighting.

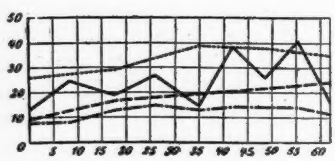


FIG. 3.—Illumination in a Vertical Plane.

– - – - – ———— In Line of Lamps.
- - - - - - - - - – – – – – In Middle of Roadway.

In Fig. 2 are shown some curves illustrating the distribution of illumination, measured on a horizontal plane, in the Potsdamerplatz and the Potsdamerstrasse, which are lighted by flame-arcs and inverted incandescent burners respectively. Fig. 3 shows corresponding results for a vertical plane.

The author regards the vertical illumination in the streets as highly important, as facilitating the recognition of people, inscriptions on vehicles, placards, &c. The curves as a whole show that in both cases marked differences in the illumination occur, especially in the line of the lamps; in the middle of the road, however, the gas-lighting is very uniform. The vertical illumination in the Potsdamerstrasse is also both high and uniform throughout.

Recent Progress in Street Illumination in Berlin.

By Dr. L. Bloch.

Dr. L. Bloch sends us a recent report on the subject of the comparison of the various systems of street-lighting, which is of exceptional interest at the present moment. Want of space prevents us from publishing this article in full, but in what follows we propose to deal with the matter in abstract.

The author prefaces his description by remarking that the rapid developments in methods of lighting the main streets of Berlin since his experiments in the year 1905 (published in the *Journal für Gasbeleuchtung*, 1906, p. 90), when the illumination of Berlin was carried out mainly by high-pressure upright incandescent gaslights, and ordinary continuous current arc-lamps, invalidated old comparison and called for further study.

The upright high-pressure incandescent mantles were replaced by inverted mantles at ordinary pressure for the first time in the Invalidenstrasse in 1906 (see Drehschmidt, *Jour. f. Gasbeleuchtung*, 1906, p. 765), and although no very marked increase in the strength of illumination was achieved in this way, the actual cost was reduced.

In 1907 high-pressure inverted lighting was introduced in the Königgrätzerstrasse, and this method was soon extended to the majority of other streets in Berlin (see Drehschmidt, *Jour. f. Gasbeleuchtung*, 1908, p. 761).

Dr. Bloch describes the lighting in this street, which is 28·5 metres broad. The lamps were spaced 42 metres apart, at a height of 5·5 metres, each lamp consisting of two burners each consuming 1,200 litres of gas per hour; yet more recently these two burners have been replaced by three smaller ones, each consuming 800 litres per hour. The author gives the results of measurement of illumination in this street from which it would appear that the maximum horizontal illumination is 99 lux, the mean 18 lux, and the minimum 1·9 lux.

Similar results are given for the Potsdamerstrasse, the mean illumination being almost identical in the two cases, but the uniformity somewhat less favourable in the latter.

A comparison of the conditions in the Königgrätzerstrasse shows that the illumination has been much improved under the new system. This will be understood from the collected results in Table I., the actual mean horizontal illumination being increased nearly eleven times, and the consumption of gas per lux per 100 sq. metres being reduced by one half. There can be no doubt that the previous value of 1·6 lux was far too small for such a prominent thoroughfare. The author, however, points out a growing danger that, nowadays, main thoroughfares may be illuminated so brightly as to plunge the adjacent smaller streets into relative darkness, with the result that it is difficult to distinguish traffic, &c., coming down them. In the same way the ever-increasing illumination in public streets induces shopkeepers to accentuate *their* illumination, for the sake of contrast; this principle incautiously applied is liable to lead to undesirable dazzling effects.

The collected results in Table I. also show that the mean illumination in the Potsdamer and Königgrätzer Strasse is about 3·3 times as strong as in the Invaliden and Alexander Strasse, which was formerly the street most brilliantly illuminated by means of gas in Berlin.

The results may be summed up by remarking that the introduction of inverted gas-lighting has increased the available mean illumination, but also increased the ratio of maximum to minimum.

As regards electrical illumination, during the last few years the ordinary white carbon lamps have been replaced by flame-arcs with inclined carbons; certain initial difficulties having been overcome, there is now no doubt as to the practicability of the system, which has been utilized in the Potsdamer Platz, near the Brandenburger Thor, &c.

More recently, however, a new variety of "Alba" carbons has been brought out, which unite the merits both of flame-carbons and carbons of the ordinary variety. These carbons yield a pure white light, and can be utilized vertically. Owing to the great diameter of the carbons, they approximate to the same burning

Variety of Lamp.	Place.	m, by measurement, c, calculation.	Height of Lamp.	Distance between Lamps.	Width of Street.	Surface-Area of Street per Lamp Post.	Consumption per Lamp.	Consumption per 100 squ. m. of Surface. Area of Street.	Consumption for 1 Lux and 100 sq. m. Area.	Horizontal Illumination.			
										Mean.	Max.	Min.	Max, Min.
			mtrs.	mtrs.	mtrs.	squ. mtrs.	ltrs. p. hr.	ltrs. per hr.	ltrs. per hr.				
GASLIGHTING :													
Inverted Incandescent ... High Pressure Gaslighting	Potsdamer Strasse	m	5·5	40	36·6	732	3×800	328	19	17·3	123	1·7	72
	Königgrätzer Str.	m	5·5	42	28·5	600	2×1200	400	22	18·0	99	1·9	52
Upright Incandescent Gaslight ordinary Pressure	Königgrätzer Str.	c	3·5	28	28·5	400	2×125	62·5	39	1·6	11·1	0·25	44
Upright High Pressure Gaslight	Alexanderstrasse	m	5·7	42	21	441	2×600	272	52	5·2	18·9	0·8	23·5
	Königstrasse ...	m	5·7	42	20·5	431	2×1200	557	48	11·7	41	2 0	20·5
Inverted Gaslight, ordinary Pressure	Invalidenstrasse	m	4·5	28	17	238	4×114	192	35	5·5	58	0·6	97
ELECTRIC LIGHTING :													
							Watts	Watts	Watts				
Ordinary Arc Lamp with Pure Carbons	Friedrichstrasse	m	10	30	22	660	825	125	18·4	6·8	11·1	2·6	4·3
Flame-arc Lamps with "Alba" Carbons ...	Friedrichstrasse	m	10	30	22	660	825	125	6·9	18·2	31·2	6·6	4·7
	Potsdamer Strasse	c	5·5	40	36·6	732	825	112	4·9	23·1	132·3	2·0	66
	" "	c	7	40	36·6	732	825	112	5·2	21·7	71·5	2·9	24·6
Intense Flame-arc lamp	Potsdamer Strasse	c	7	40	36·6	732	825	112	5·4	20·7	121·5	2·5	49
	" "	m	18	45	—	3640	4×1100	120	6·5	18·8	82	1·3	63

Table showing the details of the illumination of various streets in Berlin by gas and electric lighting.

hours as in the case of ordinary carbons. On the other hand, the efficiency is very high, being given as 0·14 to 0·15 watts per mean hemispherical H.K., exclusive of the loss by absorption of globes and in the series resistance. Finally, the curve of distribution of light from such carbons is preferable to that of the older flame-arcs, which throw all the light immediately downwards, for purposes of street-lighting.

Sixteen ordinary continuous current arc-lamps in the Friedrichstrasse were equipped with these new carbons, and were experimented with during June of the present year. The lamps are suspended at a height of 10 metres, and yield a light of 3,100 H.K. (mean hemispherical) with opal glass globes. The horizontal illumination (measured as usual at a height of 1 metre from the ground) varied from 5·3 to 39·4 lux.

As will be seen from Table I., the mean illumination was increased as much as 2·7 times by the use of the new lamps. Moreover, on account of the great height of the lamps, and the advantageous shape of the polar curve of distribution, the uniformity of the illumination is materially improved. By comparison with the inverted high-pressure lighting we observe that the value of the mean horizontal illumination is approximately the same in each case; on the other hand, the *degree of uniformity* is very different.

This arises partially from the fact that the arc-lamps are 10 metres high and the gas lamps only 5·5 metres. But it is also dependent on the difference in the widths of the streets in the respective cases, and therefore the author proceeds to calculate the illumination of the Potsdamerstrasse, on the assumption that it is lighted by flame-arcs, and finds that a somewhat more uniform illumination than by gas, and a mean value 33 per cent higher, would be obtained. The vertical illumination would also be improved; even if the height of the lamps were increased to 7 metres, more favourable results both as regards intensity and uniformity of illumination would be obtained by electricity.

In the concluding portion of the article the author enters into a comparison of the running costs of both gas and electric systems. He sums up the situation by remarking that gaslighting has made great progress by the introduction of the inverted high-pressure light, but that electric lighting has likewise been enabled to hold its position by the use of intense flame-arcs, and, more recently, by the introduction and use of flame-arcs with the "Albo" carbons.

In cases in which high-pressure gas had begun to displace the old ordinary arc-lamps, the introduction of the newer lamps referred to above has once more enabled electric lighting to more than hold its own.

But it is as impossible as ever to contend that either of the illuminants is invariably the cheaper; each case must be considered on its merits, and depends on the local conditions.

Recent Progress in Arc-Lamps and Incandescent Glow-Lamps.

Prof. A. Blondel has sent us copies of his recent papers on the above subjects at the Marseilles International Electrical Congress. We regret that we are unable to make detailed reference to these interesting contributions in this number, but mean to do so shortly. The paper dealing with progress in incandescent glow-lamps contains an exceptionally complete resumé of recent patents on metallic filament lamps, while Prof. Blondel's second contribution discusses in detail recent developments in the theory of ionization and their application to the manufacture of flame and mineralized carbons.

Another Effect of Ultra-Violet Light.

An additional and hitherto unsuspected effect of the ultra-violet rays from a quartz-mercury lamp was mentioned by Dr. Schanz and Stockhausen in a recent article in *D. Graefe's Archiv für optahlmologie.* In this case Dr. Schanz was working in a room brightly illuminated by the quartz lamp, all *direct* rays being, however, screened. Nevertheless, Dr. Schanz, who had not previously worked under these conditions, was seized with such an unpleasant dizzy feeling in the head that he had to abandon all further work for the day.

It is also related that the same observer on another occasion experienced a most disagreeable feeling in the pit of the stomach, and a lack of breath. An engineer who was engaged in a works for the manufacture of electric lamps stated that this was a recognized experience, and that the workmen's position was therefore so chosen that the abdomen was protected from the direct rays of the lamp.

The Relative Merits of Compressed Gas and Compressed Air for Lighting.

An interesting discussion on this point has recently been raging in the gas journals in this country and in Germany. In the *Zeitschrift für Beleuchtungswesen* for May 20th appeared a communication from the laboratory of Dr. Lux, in which the merits of the system of compressed air were dwelt upon, and this has been followed by a correspondence in the columns of the *Journal für Gasbeleuchtung und Wasserversorgung* by those interested in both systems.

Dr. Lux points out that though it is, of course, incontestible that a great increase in efficiency has followed the adoption of high-pressure gas, yet there seems to be some misconception in the minds of many as to what, exactly, this improvement is due. According to the view referred to above, there is no special quality in compressed gas itself. The use of the pressure is only for the purpose of bringing the gas and air in the burner into intimate mixture in order that the most favourable conditions for rapid and complete combustion of the gas may prevail. The efficiency of an incandescent body depends mainly upon the flame temperature, and the maximum temperature is attained when the combustion of the gas takes place in the smallest imaginable period of time.

The use of high-pressure gas, therefore, serves merely to utilize the injector-action so as to secure intimate mixture. There are, however, practical limitations to the pressure that can be employed. A pressure of about 1 atmosphere is certainly about the utmost that can be regarded as reliable, while the systems of high-pressure gas-lighting in practical use do not utilize pressures higher than $\frac{1}{16}$ to $\frac{1}{8}$ of an atmosphere (*i.e.*, about 40 to 80 inches of water). The Salzenburg globe light, it is true, employed a pressure as high as 1·1 atmospheres, but this lamp, while yielding results of interest from the theoretical standpoint, can hardly be said to have achieved great practical success.

That compressed gas has no specific effect, and only acts by accentuating the injector action at the nozzle is shown by the fact that the actual pressure in the interior of the burner only reaches a few millimetres. On the other hand, it may legitimately be suggested that the use of compressed gas in order to put a body of air into motion and mix it with the gas is but an indirect and cumbrous method, and must involve the expenditure of a considerable amount of energy. Moreover, the loss of energy in overcoming the inertia of such a large volume of air results in but a small ultimate velocity of outflow of gas, and this is apt to lead to the production of too small a flame, and to a danger of the flame "striking back"—an effect that is particularly liable to take place in the case of compressed gas systems.

As an alternative and preferable method of producing the desired mixture of gas and air, therefore, the writer suggests that it is better to lead compressed air direct into the burner from separate pipes.

The use of compressed gas is open to other drawbacks. It is often contended that the arrangement is exceedingly simple, but in reality it is doubtful whether this can be considered to be the case. For one thing, the use of high-pressure gas entails the use of a special system of pipes, and it is particularly essential to attend carefully to the laying of these pipes so as to minimize the possibility of leakage, this being naturally of greater consequence than in the case of ordinary gas supply.

Again, in the case of buildings running on an ordinary lighting system, high-pressure gas is usually undesirable, and, when the public lighting is carried out by high-pressure, two distinct systems of piping become necessary. When pressure-gas is installed, separate meters are needed; in short, transformation from one system to another is not possible without altering entirely the nature of the service.

Another objection may be lodged against the use of pressure gas, namely, that any escape is liable to jeopardise the health of vegetation and trees lining the public streets.

In addition to the theoretical merit of facilitating the admixture of gas and air, the following advantages may, therefore, be claimed for pressure-air, as opposed to pressure-gas :—

1. Ordinary lamps and high-pressure-air lamps can be fed from the same gas-supply system.
2. When a change to compressed air is contemplated, it is unnecessary to alter the existing pipes in any way.
3. No special meters are necessary. Private and public lighting can be fed from the same gas mains.
4. In badly-ventilated rooms, pressure-air has the advantage of diminishing the consumption of air in the room, for the essential portion of the air feeding the burner is led in from without by the pressure-air pipes.
5. An escape of compressed air, unlike compressed gas, leads to no danger.

It must, of course, be recognized that a separate system of pipes is needed to feed burners with compressed air. Nevertheless, the system, besides possessing the advantage of being easily applicable to existing low-pressure installations, works out cheaper than a corresponding pressure-gas system. High-pressure air pipes can be economically constructed because an escape of air leads to no dangerous results.

Such are the main advantages claimed for pressure-air in the article mentioned, the merits of the method being illustrated by a description of the " Pharos " system.

A recent number of the *Journal für Gasbeleuchtung*, &c. (No. 24, 1908) contains a letter from the Pharos Co., who utilize both systems, but prefer pressure-air. The Pharos Co. also set forth most of the claims described above, namely, that compressed gas entails special meters, that the danger due to leakage is increased by its use, and that difficulties arise in the case of the salesman who at present utilizes a low-pressure system, but would like to have the benefit of high-pressure lamps outside the shop.

It is also pointed out that, in the case of compressed gas, the lighting and extinction of individual burners is attended by difficulties; in particular, it is inconvenient to light up individual flames without interfering with the by-pass.

Also inconveniences arise in connexion with the measurement and rates of charging in the case of high-pressure gas, and in any case special rates, differing from those employed by low pressure, must be charged to consumers for high-pressure lamps as they care to instal.

This letter called forth two others in the same journal, arguing the merits of pressure-gas (No. 30, July 30th, 1908).

The *Köln Aktiengesellschaft für Gas und Elektricität* preface their arugments by pointing out that pressure-air installations were actually installed before pressure-gas had become common, but were eventually replaced by the latter.

It is also contended that the injector-action of the ordinary high-pressure arrangement is satisfactory for the purpose in view, and that the fall in pressure allowed in the burners must be considered in connexion with the wear and tear of mantles; the wire-gauze employed with high-pressure burners not only serves the purpose of preventing the flame from lighting back, but also guards the mantles from being torn away. From this point of view pressure-air burners are open to objection, because they form long and narrow intense flames which penetrate the mantles, and may also injure the surrounding glass-globes.

The suggestion that the pressure-air system is a more economical method of mixing the air and gas is also contested. In the case of pressure-gas systems a pressure of 1000 to 1,300 mm. (*i.e.*, about 40 to 52 in.) is all that is necessary in order to secure the desired results. Now in the case of pressure-air a much larger bulk of air has to be set in motion and at a pressure of 1300 mm. (*i.e.*, about 52 in.) to secure similar results, and therefore the actual expenditure of energy can hardly be considered less than in the case of compressed gas.

It is also contended that pressure-air systems cannot be considered to be cheaper than those utilizing compressed gas. Also that:—

1. A meter for high-pressure gas is but little dearer than one of the ordinary variety, and even in the case of pressure-air a larger meter will be needed if a change in the conditions has to be made.
2. Extra installation work is necessary when pressure-air is installed just the same as in the case of pressure-gas. Moreover, in many cases the existing pipes answer for feeding high-pressure gas-lamps.
3. If the workmanship of an installation is satisfactory it matters little whether the pressure in the pipes is 40 mm. or 1300 (*i.e.*, 1·6 inches or 52). Accidents have caused no trouble in the case of the many high-pressure gas installations in actual use. Moreover, the pressure in the pipes during the night hours,

when no use of them is contemplated, is usually not maintained at a high value.

4. At the present time there are many perfectly satisfactory lighting and extinguishing devices for single flames on the market.
5. Any damage to high-pressure air lamps is just as serious in its consequences as in the case of pressure-gas lamps, and must be repaired with equal celerity. The effect of escaping high-pressure gas on trees in the streets can safely be ignored.

A letter from the *Millenium-Gesellschaft* in the same number covers similar ground. It is contended that high-pressure gas is in no way dangerous, that high-pressure meters, especially those of the dry variety, are easily and cheaply constructed, and that there is no inherent difficulty in making allowance for the compression of the gas and its consequent reduction in volume, when charging the consumer. It is, however, true that ordinary gas-meters can be used with compressed air, and this is the solitary advantage of systems of this nature.

Installations of high-pressure gas and high-pressure air systems entail the laying of practically identical amounts of pipe. All well-laid ordinary pipes, however, are tested up to a pressure of 1,500 mm. of water (approximately 60 in.), and are capable of taking gas at this pressure without the danger of leakage exceeding that of an ordinary gas-supply. Pressure-air pipes must be carefully looked after just like pressure-gas pipes. An escape of pressure-gas is immediately made evident by its odour. Pressure-air having no odour is more likely to be overlooked.

It is a mistake to suppose that pressure-air systems can usually be applied without any alteration to ordinary pipes. On the contrary, such pipes are too often hardly wide enough for existing conditions, and they are, therefore, unfitted to supply the higher quantities of gas that the introduction of high-pressure air high candle-power lamps would entail. It is also incorrect to suppose that high-pressure gas must necessarily lead to increased leakage. For instance, in Munich mains are regularly tested at a pressure of two atmospheres (780 in.), and no leakages are detected, as they certainly would be if they existed, at this high pressure.

The assumption that the pipe-supply of air alone feeds the burner with the necessary oxygen is unjustified. For in order to supply the correct proportions of 5·5 parts of air to 1 of gas, this would involve the use of exceedingly compressed air and very thick pipes.

Lastly, it is contended that the cost of high-pressure gas is in no respect higher than high-pressure air; that the extinction and lighting-up of high-pressure gas-burners is successfully accomplished in the streets of Berlin and elsewhere, and that there is ample evidence to show that existing high-pressure gas installations have no injurious effect upon vegetation.

References:—

Zeitschrift für Beleuchtungswesen, May 20. See also *Gas World*, May 30, 1908.

Journal für Gasbeleuchtung und Wasserversorgung, Nos. 24 and 30. See also *Gas World*, September 12, and *Journal of Gaslighting*, August 25, 1908.

The Theory of the Incandescent Mantle.

On Monday, October 12th, a lecture was delivered by Prof. Vivian Lewes before a meeting of the employees of the Gas, Light and Coke Co. The lecturer dealt briefly with the theory of the incandescent mantle, and expressed his adhesion to the catalytic theory as a basis of explanation of the luminosity of a suitable mixture of thorium and cerium.

It is stated that as many as 700 inspectors, foremen, and other workers in the employ of the company were present and evidently keenly appreciated Prof. Lewes's address. This furnishes one more indication of the great general interest in all aspects of lighting at the present day, and it is satisfactory to feel that the importance of educating employees in such subjects is becoming more and more appreciated.

New Method of Harbour-Lighting.

A novel system of harbour and coast lighting has recently been introduced in the United States, and some details of the experiments now taking place are given in a recent number of *The Progressive Age*.

The existing methods of using buoys, &c., are open to objection in several respects, and it is now proposed to utilize a submarine system of lighting, according to which electric lamps are installed beneath the surface of the water with the object of illuminating the rocks and other obstructions, and the various channels, thus simplifying the work of the pilot.

CORRESPONDENCE.

Absorption of Arc-Lamp Globes.

Dear Sir,—Dr. Marchant's proposal to measure the light-absorption of globes by the difference between the light coming through a hole in the globe, and that of the surrounding surface, might indicate the very large loss of light he mentions as commonly occurring, but such a method is quite inaccurate.

The distribution of light is entirely altered by even a clear globe, the various portions of the globe deflecting and diffusing the light. Added to this source of error, the inside of all globes acts as a reflector, and light is reflected from the opposite side of the globe through the hole, in addition to that coming direct from the arc. The polar illumination curves with and without a globe are usually entirely different.

The alteration in the polar curve may be so great that if single measurements only are taken at a given angle, the light may be increased at the particular point measured; and the globe apparently add to instead of absorbing the light.

It is necessary in any absorption measurements to take the mean spherical candle-power.

Dr. Stine, from the mean of a large number of measurements, gives the absorption of clear globes at about 6 per cent, and frosted globes at about 11 per cent.

A number of measurements were also made by Messrs. Westerdale and Prentice, Proc. I.E.E., March 14th, 1906. The absorption given in all these measurements correspond closely with Prof. Morris's results.

Unfortunately I cannot entirely agree with Prof. Morris's method of measuring the efficiency of an arc-lamp globe by an incandescent lamp. Prof. Morris does not state if the mean spherical candle-power was taken, although the figures he gives indicate that this was done, but even then the apparent absorption by the globe apart from the lamp and reflector might be misleading. The distribution of light will be altered, and absorption or blocking of the light by a reflector and the lamp mechanism may give very different results.

The enclosed lamp was also rather handicapped by allowance having been made for one globe only. They certainly cannot be operated commercially without their globes, but neither can the ordinary open flame arc, without in either case excessive consumption of the carbon taking place and the additional reasons that Prof. Morris gives.

I think a method giving sufficient accuracy for all commercial needs would be the measurement of the loss of mean spherical candle-power given by a standard incandescent electric lamp when placed in the position usually occupied by the arc in the arc-lamp, the lamp being complete with globes, case, reflector, &c., in position. The difference in absorption due to the different spectra of an incandescent lamp and an arc - lamp may be disregarded with new globes.

Modern arc-globes when new are colourless, and although I have examined many with the spectroscope, I have found no appreciable selective absorption by either clear or opal globes.

Arc-lamp globes that have been long in use will sometimes turn to a yellowish tint, and dirt, either from the arc or ordinary town atmosphere, may absorb almost any percentage of light, unless the globes are cleaned when recarboning the lamp.

As a matter of practice I have long held that 20 per cent should be an outside limit of absorption for a globe of good glass, and have found little difficulty in obtaining glass well within this figure, although sufficiently opaque to give good diffusion.

After all, the actual amount of light coming from the lamp gives the figure of merit of the lamp, and we are greatly indebted to Prof. Morris for such an accurate and complete set of figures on modern lamps.

I remain, sir,

Yours very truly,

A. Denman Jones.

Some Exhibits at the Ideal Home Exhibition.

The Ideal Home Exhibition naturally afforded an excellent opportunity of displaying different systems of lighting, and it is interesting to observe that not a few of the firms represented make a point of insisting that good illumination is not a luxury, but a necessity, and, in fact, as essential a characteristic of an ideal home as good furniture or anything else.

One feature of the lighting display was the number of makers of petrol-air apparatus that exhibited. Thus the Praed Patent Safety Gas Light Co. and the De Laitte Co., to both of whom we have referred previously, occupy adjacent stalls. Among other exhibitors we note: The National Air Gas Co., The Bens Gas Co., The "Litz" System, The Centenary Air-Gas Co., Cox's Non-Explosive Air-Gas System, The "Loco" Vapour-Gas Machine Co., "Aerogen Gas" (Messrs. Strode & Co.), &c.

The public has therefore ample opportunity to compare the merits of various systems of air-gas manufacture, and the number of systems now on the market would seem to indicate the existence of a wide field for such independent generating types of lighting.

In all cases the cheapness of air-gas is dwelt upon; for instance, the cost per 1,000 candle hours of the "Loco" and other illuminants is said to work out as follows: acetylene, 1*s.* 3*d.*; electric incandescent, 1*s.* 2*d.*; flat flame coal-gas, 1*s.*; duplex oil lamp, 7½*d.*; incandescent coal-gas, 2½*d.*; and "Loco" gas, 1¾*d.* In the same way the "Litz" machine is said to produce 1,000 candle hours at 1½*d.*, and the cost is generally stated by other exhibitors to be between one penny and twopence. At the same time it is pointed out that the air-gas generated is non-explosive, and non-poisonous, and some claim that no dangerous rays are present in the spectrum. According to one firm their system "is not dangerous like acetylene and electricity."

On the other hand, the claims of acetylene for country districts, where gas and electricity are not available, are represented by the Rural Districts Gaslight Company, who exhibit a complete acetylene installation.

Another illuminant on exhibition, available for use in country districts, was the "Petrolite" lamp, the chief recommendations of which are claimed to be that it cannot explode or take fire, and if overturned goes out; in addition it can be used in conjunction with incandescent mantles, and may therefore yield a high candle-power, but yet is independent of any generator, and is perfectly transportable, merely utilizing the petroleum in the reservoir of the lamp.

Among other miscellaneous gas exhibits we may mention the "Vulcan," Southwark, and other mantles and fittings exhibited by S. P. Catterson & Sons, the "Eureka" mantle, and the "Telephos" patent distance gas lighter which, it is claimed, enables gas to be turned off and on at a distance with the same convenience as electric light. In the electrical section mention may be made of the exhibit of fittings and electrical heating devices of Messrs. Rashleigh, Phipps & Co. and the Bryant Trading Syndicate, who claim to sell an entirely British-made metallic filament lamp which, by the way, is listed for pressures up to 250 volts.

The Calux Electric Co. also exhibit their "Solium" metallic filament lamp, which is stated to be capable of burning in any position, and this, too, is listed for pressures up to 260 volts. Electric heating apparatus was also exhibited.

Finally mention may be made of the "Tredegar" electric fittings, the special feature of which is that the lamp is mounted and suspended from an ornamental wooden bracket.

One of the chief impressions given by the exhibition is the importance now attached to illumination in the home, and the recognition that good lighting is absolutely essential. Exhibitions in which the public have an opportunity of contrasting different methods of lighting, and comparing the statements on behalf of different illuminants, have a distinct educational value.

Review of the Technical Press.

THIS month it is again necessary to draw attention to the immense amount of matter dealing with photometry and illumination that has been published in Europe and the United States—far more than could possibly be adequately dealt with in the pages that can be allotted to this review. Last month a variety of papers were published in the special number of *The Electrical Review* and *Electrical World* of New York. On this occasion special attention is merited by the series of eighteen papers read before the Second Annual Convention of the Illuminating Engineering Society recently held in Philadelphia.

PHOTOMETRY AND STANDARDS OF LIGHT.

Dr. A. C. Humphreys presents a very important report of the results of conferences of the committees of the Illuminating Engineering Society, the American Institution of Electrical Engineers, and the Institution of Electrical Engineers for the purpose of coming to agreement on the subject of A NATIONAL UNIT OF LIGHT. It appears that the units employed by the gas and electric industries in the United States, though both nominally derived from the British standard candle, actually differ by about 4 per cent.

It is therefore proposed to adopt a value for the national unit midway between these two, and it is expected that the coming international unit will fall within 1 per cent of this value.

A paper by **Dr. A. H. Elliott** deals with the use of OIL-LAMPS AS PHOTOMETRIC STANDARDS. He has found that very few data as to the constancy of petroleum flames are available, and therefore describes a series of tests on the subject with, on the whole, favourable results.

Dr. Clayton Sharp and **Mr. P. S. Miller** describe some experiments on the INTEGRATING GLOBE-PHOTOMETER of Ulbricht—a subject that has hitherto been almost exclusively treated in Germany. The authors used a number of globes of different sizes, including some small ones which served for the testing of glow-lamps. In this connexion they comment on the convenience of this method which avoids the troubles attending rotation of the lamp, and can easily be so arranged as to be employed in an undarkened room. They also describe a set of experiments carried out with the object of investigating the errors that can arise from the presence of screens and other foreign objects within the globe.

Dr. H. E. Ives describes the use of his form of "COLOUR-METER" IN ILLUMINATING ENGINEERING, and gives the results of a number of actual tests on the effect of various illuminants.

C. W. Waidner and **G. K. Burgess** contribute an interesting note to *The Electrical World* (Sept. 19th) on THE PRIMARY STANDARD OF LIGHT. After reviewing the flame and other possible standards they turn to the incandescent platinum type of Violle. The light from such a source depends upon three factors, the area of surface, the temperature, and the nature of the surface of the platinum. The last two quantities are the most difficult to maintain accurately constant. Special care is needed to eliminate changes in the radiating nature of the surface. The authors, therefore, suggest that it would be preferable to use a truly black surface such as could be obtained by the Reichsanstalt method. The intensity per square centimetre of such a surface, at the temperature of melting platinum, would be about 88 Hefner, and this value could be depended upon provided the temperature is maintained at a constant value.

A recent number of *The Journal of Gas Lighting* contains a description of some photometrical apparatus exhibited at the Manchester exhibition. This includes a description of the BENCH AND ROTATING LAMP-HOLDER used at the **National Physical Laboratory** and a new form of SIMMANCE - ABADY STREET-PHOTOMETER. An ingenious method of varying the intensity of the light is employed. A glow-lamp, let into a tube, illuminates the whitened interior of a hollow sphere so as to produce perfect diffusion. The amount of light emerging from this sphere and striking the photometer screen is regulated by using an adjustable aperture.

Recent numbers of the *Journal für Gasbeleuchtung* contain a reprint of the recent paper by **Paulus** on the PHOTOMETRY OF METALLIC FILAMENT LAMPS, and a report of an interesting discussion (arising therefrom) on the question of applying the standard specification to them. The *Zeitschrift für Beleuchtungswesen* for Oct. 10th prints a synopsis of the RULES OF THE VERBAND DEUTSCHER ELEKTROTECHNIKER, relating to the Photometry of arc-lamps.

ILLUMINATION.

The papers that have appeared on the subject of illumination are too numerous to receive anything but very brief notice. The PRESIDENTIAL ADDRESS of **Dr. Louis Bell** at the Convention, dealt mainly with STREET LIGHTING. In the course of his remarks Dr. Bell insisted upon the necessity for taking due account of the purpose for which each illuminated street was intended, and not aiming at a uniform illumination all over the town, as was sometimes done in the United States. He also expressed himself in favour of the method of measurement, with a horizontal screen, mainly employed in Europe, and criticized the so-called "moonlight-schedule," as applied to street lighting.

A very valuable and exhaustive paper by **L. B. Marks**, before the Convention, described the system of illumination adopted in the Carnegie libraries of New York. The paper, containing, as it does, a full record of the lamps employed and their exact position, and the considerations on which the various plans of lighting were adopted, should serve as a standard reference to those interested in the lighting of libraries.

Several articles and papers from the pen of **C. Hering** have appeared. These deal with the FUNDAMENTAL UNITS AND QUANTITIES OF ILLUMINATING ENGINEERING, the paper before the Convention containing a comprehensive summary of the different formulæ involved. The author criticizes many of our existing methods of expressing photometrical quantities, and we may expect that some time must elapse ere these quantities and the scientific ideas utilized in illuminating engineering have become sufficiently familiar to be put upon a truly scientific basis.

In this connexion it is interesting to observe how the idea of "FLUX OF LIGHT," at one time a little understood scientific conception, is gaining ground. For instance a paper by **J. R. Cravath** and **V. R. Lansingh** before the Convention discusses the application of this quantity to practical problems in a very lucid manner, the authors arguing that in very many cases the introduction of the idea leads easily to an approximate prediction of the illumination over a given space, and avoids much needless elaboration of detail.

Among other papers before the Convention mention may be made of the series of experiments on DAYLIGHT ILLUMINATION by **L. J. Lewinson,** some experiments on the REFLECTING QUALITIES OF WALLS AND CEILINGS, by **V. R. Lansingh** and **T. W. Rolph,** and a paper on ARCHITECTURE AND ILLUMINATION by **E. G. Perrot.** The latter contains a suggestion that the Illuminating Engineering Society should undertake the preparation of standard data on illuminating matters in order to assist those in both professions.

A recent number of the *Journal für Gasbeleuchtung* contains a continuation of an interesting article by **Niemann** and **Du Bois** dealing with the HISTORY OF ARTIFICIAL ILLUMINATION; the authors now deal with a period up to the middle of the nineteenth century, and describe the early efforts to manufacture candles and oil lamps.

In the September number of *Annalen der Elektrotechnik* is to be found a reference to some work with a SELENIUM RECORDING APPARATUS, by the aid of which a chart of the VARIATION IN THE DAYLIGHT INTENSITY DURING A TOTAL SOLAR ECLIPSE was obtained. The value of selenium for *comparative* measurements of this description deserves special attention now that so much more is known about the preparation of this material. Such apparatus seems particularly adapted to recording purposes on account of its simplicity, and it seems possible that it might be applied with success to the study of conditions of illumination in schools, &c.

ELECTRIC LIGHTING.

Two very valuable contributions at the Marseilles Electrical Congress by **Prof. Blondel** deserve special mention. These two papers contain a comprehensive summary of recent progress in the fields of ELECTRIC ARC- AND GLOW-LAMP LIGHTING. The résumé of recent patents in metallic lamp manufacture in the latter paper is unusually up to date and complete, and the same may be said of the treatment of flame and mineralized carbons.

F. E. Cady's paper before the Convention of the Illuminating Engineering Society dealt with the CONNEXION BETWEEN P.D. AND LIGHT FROM INCANDESCENT ELECTRIC LAMPS. Besides detailing the results of original work carried out at the Bureau of Standards, the paper contains a useful collection of references to this particular subject. The chief result stated by the author is that the so-called constant k in the formula: Change in C.P. = Const. × (Change in C.P.)^k is not really constant but a function of the efficiency at which the lamp is working.

Another paper before the Convention by **J. R. Strong** deals with STRUCTURAL DIFFICULTIES IN INSTALLATION WORK. The paper advocates the locating of outlets in such a way as to enable an existing system of lighting to be modified if the furniture in a room is rearranged or the conditions are otherwise altered;

though this subject is of interest to those connected with all systems of lighting, the author deals mainly with the electrical aspects of the problem, and therefore the paper is classed in this section.

The *E.T.Z.* for Oct. 8th contains a paper by **R. Hopfelt,** recently read before the German Institution of Electrical Engineers, on a NEW FORM OF MERCURY-CARBON INCANDESCENT LAMP. This lamp was briefly described by B. Duschnitz in *The Illuminating Engineer* of August. The essential characteristic of it lies in surrounding a carbon filament, run at an exceptionally high efficiency, with mercury vapour, which, it is claimed, hinders the volatilization of the carbon, and so enables the filament to be run at a higher temperature than would be possible in an ordinary vacuum.

Mention may be made of two serial articles which deal comprehensively with recent patents and developments in incandescent and arc lighting by **B. Duschnitz** and **I. Ladoff** respectively. A third article on similar lines in the *Zeitschrift für Beleuchtungswesen* is concerned with the subject of arc-lamp mechanisms.

GAS, OIL, AND ACETYLENE LIGHTING.

Two of the papers before the Conventoin dealt with gas lighting. That by **T. J. Litle** was mainly devoted to METHODS OF AUTOMATIC IGNITION, including the electrical "jump-spark" method; one interesting development described by the author, however, consisted in a mantle mounted permanently within the small mica chimney, both being supplied as one unit.

E. N. Wrightington summarized the methods of STREET-LIGHTING IN EUROPE from the American point of view. The author was much struck by the development of high-pressure gas lighting, particularly the use of small units spaced close together. He remarks on one noticeable feature of European streets as compared with American ones. In America street-lighting from the recognized sources in main thoroughfares is often hardly necessary on account of the contribution from the many illuminated signs, shop-windows, &c., that line the street; in Europe, on the other hand, illuminated signs have not the vogue that they have attained in America, and in some cases the shops are closed and the shutters up at a relatively early hour in the evening. The method of street lighting provided by the authorities is therefore of greater consequence, and higher units are usually employed.

Prof. Vivian Lewes recently delivered a lecture at the Gas, Light and Coke Company's offices in London. He gave a summary of the present state of 'THEORIES OF THE ACTION OF THE INCANDESCENT MANTLE,' and expressed his adherence to the catalytic theory. An interesting point brought out by him was the high heat-radiating qualities of Cerium. In consequence of this property, if the Cerium in a mantle is increased above the desirable percentage its efficiency is decreased by the falling temperature arising from increased radiation. Prof. Lewes seems to have entertained the idea that this property might be utilized in heating apparatus. He found, however, that Cerium apparently only exhibits this quality when finely divided, and not when used in masses.

Recent numbers of the *Zeitschrift für Beleuchtungswesen* again contain a series of notices of new methods of utilizng liquids in incandescent lamps; recent numbers of *The Journal für Gasbeleuchtung* contain a brief discussion (abstracted) of methods of kindling and extinguishing the lamps in railway carriages, and a protest against the suggested tax on gas in Germany.

List of References:—

PHOTOMETRY AND STANDARDS OF LIGHT.

Elliott, Dr. A. H. Illuminating Value of Petroleum Oils (Sec. Ann. Conv. I. E. S.).

Humphreys, A. C. Report of Committee on Nomenclature and Standards (Sec. Ann. Conv. I.E.S.).

Ives, H. E. The Ives Colorimeter in Illuminating Engineering (Sec. Ann. Conv. I. E. S.).

Paulus, C. Vergleich der verschiedenen technischen Methoden zur Bestimmung der mittleren Horizontallichtstärke von Metallfadenlampen (J. f. G., Oct. 3).

Sharp, C. H., and Millar, P. S. The Integrating Sphere in Industrial Photometry (Sec. Ann. Conv. I. E. S.).

Waidner, C. W., and Burgess, G. K. Note on the Primary Standard of Light (*Elec. World*, N.Y., Sept. 19).

New Photometers and a Colorimeter (J. G. L., Oct. 6).

Normalien für Bogenlampen, aufgestellt vom Verbande Deutscher Elektrotechniker *Z. f. B.*, Oct. 10).

Ueber die Photometrierung und die technischen Lieferungsbedingungen von Metallfadenlampen (J. f. G., Oct. 3).

ILLUMINATION.

Bell, Dr. Louis. Presidential Address (Sec. Ann. Conv. I. E. S.).

Cravath, J. R., and Lansingh, V. R. The Calculation of Illumination by the Flux of Light Method (Sec. Ann. Conv. I. E. S.).

Editorials. The Symbolism of Light......The Second Annual Convention of the Illuminating Engineering Society......The Illuminating Engineer as an Architectural Critic, &c (*Illum. Engineer*, N.Y., Sept.).
The Illuminating Engineer (*Elec. Rev.*, Oct. 15).
A New Departure in Illuminating Engineering (*Elec. Rev.*, N.Y., Sept. 26).
The Future of the Tungsten Lamp......The Primary Standard of Light......The Relations of the Measures of Light and Power (*Elec. World*, N.Y., Sept. 19).
Eshleman, C. L. Developments in Ornamental and Boulevard-Lighting (*Illum. Engineer*, N.Y., Sept.).
Hering, C. Calculating and Comparing Lights from Various Sources (Sec. Ann. Conv. I. E. S.).
On the Relations of the Measures of Light and Power (*Elec. World*, N.Y., Sept. 19).
Simplifying Some of the Calculations of Light (*Elec. World*, N.Y., Sept. 26).
Lansingh, V. R., and Rolph, T. W. Experiments on Reflection from Ceiling, Walls and Floor (Sec. Ann. Conv. I. E. S.).
Lewinson, L. J. Intensity of Natural Illumination throughout the Day (Sec. Ann. Conv. I. E. S.).
Marks, L. B. Design of the Illumination of the New York Carnegie Libraries (Sec. Ann. Conv. I. E. S.).
Niemann and Du Bois. Zur Geschichte des Beleuchtungswesens (J. f. G., Oct. 17).
Perrot, E. G. Architecture and Illumination (Sec. Ann. Conv. I. E. S.).
Thurston Owens, H. Street-lighting Fixtures, Gas and Electric (Sec. Ann. Conv. I. E. S.).
Williams, G. Outline-lighting and the Central Station (*Illum. Engineer*, N.Y., Sept.).
Wohlauer, A. A. Engineering Problems in Illumination (Sec. Ann. Conv. I. E. S.).
Illuminating Engineering and the Central Station (*Illum. Engineer*, N.Y., Sept.).
Illuminating Engineering in America (J. G. L., Oct. 20).
Die Intensität des Tageslichtes (*Ann. der Elektrotechnik*, Sept., p. 369).
Modern Light-Shades (*Am. Gas Light Jour.* (Oct. 12).

ELECTRIC LIGHTING.

Bainville, A. Nouveaux Filaments Electriques (*l'Electricien*, Oct. 10).
Bloch, L. Ueber neuere elektrische Lichtquellen (*J. f. G.*, Sept. 26).
Blondel, A. Les Progrès de l'Incandescence Electrique ; Progrès des Lampes à Arc Electrique. (Two papers read at the Marseilles Electrical Congress.)
Cady, F. E. The Relation between Candle-power and Voltage of different types of Incandescent Lamps (Sec. Ann. Conv. I.E.S.).
Cateaux, J. L. Auto-transformers for Electric Lamps (*Elec. Review*, Oct. 16).
Duschnitz, B. Metallische Leuchtfäden und Metallfadenlampen in der Fabrikation und in der Praxis (*Elek. Anz.*, Oct. 15).
Editorial. Street-lighting Contracts and the Tungsten Lamp (*Elec. Rev.*, N.Y., Sept. 19).
Hoadley, E. E. The Present Position of Arc lamps and Arc lighting (*Elec. Rev*, Oct. 15).
Hopfelt, R. Eine neue Kohlenfaden-Quecksilberlampe (*E. T. Z.*, Oct. 8, 1908).
Ladoff, I. Recent Progress in the Voltaic Arc (*Illuminating Engineer*, N.Y., Sept.).
Mollenkopf and Remané. Betriebskosten kleiner Bogenlampen und hochkerziger Osramlampen (*E. T. Z.*, Oct. 1, Correspondence).
Strong, J. R. Structural Difficulties in Installation Work (Sec. Ann. Conv., I. E. S.).
Davy Arc Lamps (*Elec. Engineering*, Oct. 1).
Fittings at new Holborn Borough Council Office (*Elec. Engineering*, Oct. 8).
Public Lighting by Incandescent Lamps (*Elec. Review*, Oct. 9).
Tungsten and Nernst Incandescent Lamps (*Elec. World*, N.Y., Oct. 3).
Die neueren Bogenlampen (*Z. f. B.*, September 20 and 30).
Neue Lichtpausapparat (*E. T. Z.*, Oct. 8, *Elek. Anz.*, Oct. 4).

GAS, OIL, AND ACETYLENE LIGHTING.

Litle, T. J. Modern Gaslighting Conveniences (Sec. Ann. Conv. I. E. S.).
Marshall, F. D. A New and Improved Method of Lighting Railway Carriages by Liquified Oil-Gas (Blau Gas). (*G. W.*, Oct. 3).
Morris, J. T. High-power Gas and Electric Arc-lamps (*G. W.*, Oct. 17).
Wrightington, E. N. Street-lighting with Gas in Europe (Sec. Ann. Conv. I. E. S.).
A Lamp for Florists (*J. G. L.*, Oct. 6).
High Pressure Gas for Distribution (*G. W.*, Oct. 17).
The Chipperfield Self-Compressing Lamp (*J. G. L.*, Sept. 29).
Night Views at the Franco-British Exhibition (*J. G. L.*, Sept. 29).
Lampe für flüssige Brennstoffe (*Z. f. Bel.*, Oct. 10).
Prof. Lewes on the Incandescent Mantle (*J. G. L.*, Oct. 20, *G. W.*, Oct. 17).
Comparison du Developpement de l'Acétylène dans le Nord et le Midi de la France (*Rev. des Eclairages*, Sept. 30).
Zündung des Gasglühlichtes in Eisenbahnwagen (*J. f. G.*, Sept. 26).
Gegen die Gassteuer (*J. f. G.*, Oct. 17).

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.*
Sec. Ann. Conv. I. E. S.—Denotes a paper read at the Second Annual Convention of the Illuminating Engineering Society, which took place on Oct. 5th and 6th of this year.

PATENT LIST.

PATENTS APPLIED FOR, 1908.

I.—ELECTRIC LIGHTING.

19,365. Holders, sockets, etc., for lamps. Sept. 15. F. W. Bayliss, 18. Southampton Buildings, London.
19,395. Arc lamps. Sept. 15. H. J. J. Jaburg. jun., 111, Hatton Garden, London.
19,659. Filaments for incandescent lamps (C.S.). Sept. 18. W. P. Thompson, 6, Lord Street, Liverpool. From O. Inwald and R. von Inwald, Austria.
19,679. Safety device for portable hand lamps. Sept. 19. J. Lightfoot, 15A, Cooper Street, Manchester.
19,866. Holders, sockets, etc., for lamps. Sept. 22. F. W. Bayliss, 18, Southampton Buildings, London.
20,085. Incandescent light unit. Sept. 24. J. K. Heydon, 23. Southampton Buildings, London.
20,158. Arc lamps. Sept. 25. F. Proctor, 2, Jackson Road. Holloway, London.
20,266. Portable lamps for use in mines (C.S.). Sept. 26. The New Ignition Syndicate, Ltd., F. J. Rouse, and W. J. L. Sandy, 24, Southampton Buildings, London.
20,344. Filaments for incandescent lamps. Sept. 28. R. de Fazi, F. G. Claussen, and G. T. B. Cobbett, 37, Essex Street, Strand.
20,565. Lamps. Sept. 30. A. J. Bonnella, 9, Warwick Court, Gray's Inn, London.
20,582. Pedestal electric light fittings. Sept. 30. C. H. Fisher, 38, Chancery Lane, London.
20,715. Repairing metal filament lamps (C.S.). Oct. 1. H. Sefton-Jones, 322, High Holborn, London. (From H. Küzel, Austria).
20,877. Holders, sockets, &c., for lamps. Oct. 3. F. W. Bayliss, 18, Southampton Buildings, London.
20,915. Fastening the filaments of incandescent lamps (C.S.). Oct. 3. T. Mc. Kenna, 31, Basinghall Street, London. (From Glühlampenwerk, Auker G. m. b. H., Germany).
20,930. Lamp-holders. Oct. 5. W. Fennell and W. P. Perry, 27, St. Jude's Road, West Wolverhampton.
20,937. Arc lamps. Oct. 5. C. E. G. Gilbert, Cautley, Chingford.
21,332. Holders for incandescent lamps (C.S.). Oct. 9. C. M. Dorman, R. A. Smith and H. G. Baggs, Ordsal Electrical Works, Salford, Manchester.
21,602. Electric light stand (C.S.). Oct. 12. J. F. Pierce, Norfolk House, Norfolk Street, Strand.
21,670. Mounting incandescent lamps. Oct. 13. H. Girard, 7, Southampton Buildings, London.
21,760. Incandescent lamps. Oct. 14. C. Polden, 18, Southampton Buildings, London.
21,834. Mercury and other vapour lamps. Oct. 15. H. A. Kent, H. G. Racell and The Silica Syndicate, Ltd., 47, Lincoln's Inn Fields, London.
21,835. Suspension devices for arc lamps (C.S.). Oct. 15. J. New, 77, Chancery Lane, London.

II.—GAS LIGHTING.

19,496. Incandescent burners. Sept. 16. H. F. Boughton and F. Pudney, 276. High Holborn, London.
19,577. Burners for high-pressure lamps. Sept. 17. W. H. Chipperfield, 149, Strand, London.
19,722. Mechanism for automatic gas lighting. Sept. 19. M. G. Cowper-Smith, 1, Great James Street, Bedford Row, London.
19,723. Incandescent lamps (C.S.). Sept. 19. S. Chandler and J. Chandler, Birkbeck Bank Chambers, London.
19,731. Incandescent burners (C.S.). Sept. 19. F. W. Marillier, E. H. Still and A. G. Adamson, 46, Lincoln's Inn Fields, London.
19,755. Suspension fittings for inverted burners. Sept. 21. D. Mitton, 3, Brown Street, Market Street, Manchester.
19,785. Incandescent lamps and burners. Sept. 21. J. Thomas, 53, Hanley Road, London.
20,004. Lanterns (C.S.). Sept. 23. J. Gunning, Birkbeck Bank Chambers, London. (Addition to 2960/08).
20,197. Incandescent burners (C.S.). Sept. 25. C. Dearnley, 18, Southampton Buildings, London.
20,348. Automatic lighting and extinguishing apparatus. Sept. 28. B. Bonniksen and T. Berridge, 18, Hertford Street, Coventry.
20,465. Inverted incandescent burners (C.S.). Sept. 29. C. W. Bland, 33, Cannon Street, London.
20,667. Inverted regenerative incandescent lamps. Oct. 1. R. J. Liebisch and C. Woolley, 55, Market Street, Manchester.
20,712. Incandescent burners. Oct. 1. C. W. Bland, 33, Cannon Street, London.
20,762. Lamps and burners. Oct. 2. G. Helps, Izons Croft, Ansley, Atherstone.
21,117. Economising gas in incandescent lamps. Oct. 7. J. R. Lindsay and W. Earnshaw, 55, Market Street, Manchester.

21,185. Controlling lights from a distance (C.S.). Oct. 7. J. M. Tourtel and W. R. Mealing, 33, Cannon Street, London.
21,409. Electrical ignition devices for gas lamps, etc. Oct. 10. J. Keith and G. Keith, 65, Chancery Lane, London.
21,507. Lamps (C.S.). Oct. 10. H. Köhler, 345, St. John Street, London.
21,658. Incandescent mantles. Oct. 13. A. C. Thomas, 33, Cannon Street, London.
21,669. Incandescent burners. Oct. 13. J. M. Lecomte and M. Roy. 7, Southampton Buildings, London.
21,791. Mantles and holders for incandescent lighting. Oct. 15. H. S. Thompson, 4, Corporation Street, Birmingham.

III.—MISCELLANEOUS

19,289. Oil vapour lamps. Sept. 14. F. Daintree, 3, Broad Street Buildings, Liverpool St., London.
19,344. Photometer screens (C.S.). Sept. 15. Siemens Bros. & Co., Ltd., Queen Anne's Chambers, Broadway, Westminster. (From Siemens & Halske, Akt.-Ges., Germany.)
19,545. Acetylene lamps. Sept. 17. A. Guilbert, 20, High Holborn, London.
19,719. Vapour lamps (C.S.). Sept. 19. W. Fairweather, 65, Chancery Lane, London. (From Landers, Frary and Clark, U.S.A.)
20,076. Acetylene and like burners (C.S.). Sept. 24. A. Bray, Sunbridge Chambers, Bradford, Yorks.
20,314. Lamps and lanterns. Sept. 28. J. Neville, 78, Trintonville Road, Sandymount, Dublin.
20,341. Lamp burners or sockets. Sept. 28. A. Godefroy and H. Lemaire, 20, High Holborn, London.
20,610. Incandescence vapour lamps. Sept. 30. Kitson Empire Lighting Co., Ltd., and R. H. Stephens, Birkbeck Bank Chambers, London.
20,713. Burners for incandescent lighting by oil or spirit. Oct. 1. W. G. Potter, 14, Ingleton Street, Brixton, Surrey.
20,794. Hurricane and like lanterns. Oct. 2. D. Cunningham, 33, Cannon Street, London.
20,806. Production of light. Oct. 2. C. K. P. Eden, Westinghouse Buildings, Norfolk Street, Strand.
20,883. Incandescent lighting (C.S.). Oct. 3. A. J. Boult, 111, Hatton Garden, London. (From L. Hooker, New South Wales.)
21,725. Illuminated signs. Oct. 14. W. J. Beville, 1, Stock Orchard Crescent, Holloway, London.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

24,027. Arc lamps (C.S.). I.C. Sept. 7, 1907, Germany. Accepted Oct. 7, 1908. D. Timar and K. von Dreger, 7, Southampton Buildings, London.
25,355. Arc lamps. Nov. 15, 1907. Accepted Sept. 30, 1903. P. M. Capitaine, 43, Boulevarde Voltaire, Paris.
25,831. Cluster sockets (C.S.). I.C. Nov. 22, 1906, U.S.A. Accepted Oct. 14, 1908. G. A. Harter, 165, Queen Victoria Street, London.
461. Incandescent lamps. Jan. 8, 1908. Accepted Oct. 7, 1908. C. H. Stearn and C. F. Topham, 47, Lincoln's Inn Fields, London.
3,464. Arc lamp (C.S.). I.C. Feb. 18, 1907, Sweden. Accepted Oct. 14, 1908. L. S. Andersson, 65, Chancery Lane, London.
4,760. Conducting connection for use in incandescent lamps (C.S.). Mar. 2, 1908. Accepted Oct. 14, 1908. H. W. Lake, 7, Southampton Buildings, London. (From Elektrische Glühlampenfabrik Watt, Scharf, Loti & Latzko, Austria.)
5,318. Sockets for incandescent lamps (C.S.). I.C. Mar. 15, 1907, U.S.A. Accepted Oct. 14, 1908. F. A. Swan, 72, Cannon Street, London.
5,560. Incandescent lamps. Mar. 12, 1908. Accepted Oct. 14, 1908. C. H. Stearn and C. F. Topham, 47, Lincoln's Inn Fields, London.
6,245. Metal filament lamps (C.S.). I.C. Mar. 27, 1907, Germany. Accepted Oct. 14, 1908. The Westinghouse Metal Filament Lamp Co., Ltd., Westinghouse Buildings, Norfolk Street, Strand.
10,891. Filaments for incandescent lamps (C.S.). I.C. Oct. 7, 1907, Germany. Wolfram-Lampen. Akt.-Ges., 7, Southampton Buildings, London.
18,054. Incandescent lamps (C.S.). I.C. Sept. 16, 1907, U.S.A. W. C. Arsem, 83, Cannon Street, London.
19,311. Tungsten incandescent bodies (C.S.). I.C. Sept. 26, 1907, Germany. Siemens & Halske, Akt.-Ges., Birkbeck Bank Chambers, London.
19,847. Preventing disintegration of incandescent filaments (C.S.). I.C. Oct. 3, 1907, Germany. Glühlampenwerk Auker G. m. b. H., 31, Basinghall Street, London.
19,932. Incandescent filaments of tungsten or its alloys (C.S.). I.C. Sept. 26, 1907, Germany. Siemens & Halske, Akt.-Ges.. Birkbeck Bank Chambers, London.
21,385. Vacuous metallic filament lamps (C.S.). I.C. Nov. 2, 1907, Germany. Siemens & Halske, Akt.-Ges., Birkbeck Bank Chambers, London.

II.—GAS LIGHTING.

21,691. Incandescent fittings. Oct. 1, 1907. Accepted Oct. 7, 1908. J. W. Blakey, 8, Alexandra Street, Bradford.
26,501. Gas heating and illuminating apparatus. Nov. 30, 1907. Accepted Sept. 23, 1908. S. N. Wellington and W. P. Gibbons, 33, Chancery Lane, London.
28,393. Inverted incandescent lamps. Dec. 24, 1907. Accepted Sept. 30, 1908. S. Biheller, 1, Great James Street, Bedford Row, London.
227. Appliances for use with incandescent lamps. Jan. 4, 1908. Accepted Sept. 30, 1908. S. A. Jackson, 317, Regent Road, Salford, Lancs.

1,026. Supporting incandescent mantles. Jan. 16, 1908. Accepted Sept. 23, 1908. M. Kriegel, Prudential Buildings, Corporation Street, Birmingham.

8,730. Automatic ignition and control (C.S.). April 21, 1908. Accepted Sept. 30, 1908. P. Jensen, 77, Chancery Lane, London. (From. L. G. Bartlett, U.S.A.)

10,782. Inverted incandescent lamps (C.S.). I.C. May 17, 1907, Germany. Accepted Sept. 30, 1908. T. Eberhard, 56, Myddleton Square, London.

11,122. Incandescent burners (C.S.). May 22, 1908. Accepted Sept. 23, 1908. H. W. Lake, 7, Southampton Buildings, London. (From Neue Kramerlicht-Ges., m. b. H. Germany.)

11,942. Inverted incandescent burners (C.S.). June 2, 1908. Accepted Oct. 14, 1908. A. L. Dunphy and J. Tysoe, 163, Queen Victoria Street, London. (Addition to 20/07.)

19,315. Automatic ignition of gas lights (C.S.) I.C. Sept. 14, 1907, Switzerland. H. Ruppert, 6, Lord Street, Liverpool.

III.—MISCELLANEOUS

22,036. Filaments for illuminating and heating (C.S.). Oct. 5, 1907. Accepted Oct. 14, 1908. W. E, Lake, 7, Southampton Buildings, London. (From G. Michaud and E. Delasson, France.)

26,504. Holders for lamps, globes, mantle supports, &c. (C.S.) I.C. Dec. 1, 1906, Germany. Accepted Sept. 30, 1908. O. Mannesmann, trading as Sparlicht-Ges. m. b. H., 53, Grabenstrasse, Essen-on-the-Ruhr, Germany.

27,350. Gas and electric lighting for spinning frames, &c. Dec. 11, 1907. Accepted Sept. 30, 1908. H. M. Girdwood, 17, St. Ann's Square, Manchester.

28,004. Search lights. Dec. 19, 1907. Accepted Sept. 23, 1908. Siemens Bros. Dynamo Works, Ltd., and G. S. Grimston, 139, Queen Victoria Street, London.

136. Electric lamp and shade holders for oil lamp reservoirs. Jan. 2, 1908. Accepted Sept. 23, 1908. A. H. Entwistle, 8, Quality Court, Chancery Lane, London.

16,440. Flash-light apparatus (C.S.). May 14, 1908. Accepted Sept. 23, 1908. J. P. O'Hea, 133, Ruthey Green, Catford, London.

20,746. Condensing globe or lamp shade (C.S.). I.C. Oct. 3, 1907, Belgium. B. Bronislawski, 24, Temple Row, Birmingham.

21,667. Suspending device for incandescent bodies (C.S.). I.C. Oct. 16, 1907, Germany. A. Martini, 31, Bedford Street, Strand.

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.

We note that Mr. L. B. Marks, consulting illuminating engineer, and formerly President of the Illuminating Engineering Society, and Mr. J. E. Woodwell, recently engineer in the United States Government service, Washington, have opened offices in the Terminal Building, 41st Street, New York City.

Trade Notes, Catalogues Received, &c.

During the last month we have received from *Messrs. Siemens Bros.* several notes relating to the development of Tantalum lamps. We are informed that this firm have placed a large contract for bill posting on public hoardings in the provinces and on the "Underground" in London. The picture in question, representing an evidently satisfied consumer, is shown in the adjoining illustration. We are asked to state a reproduction of the same in show card form can be supplied from the Company's Offices in Bath Street, City Road, E.C.

We have since been informed that the demand for the new Tantalum show-cards exceeded expectations, and some delay in delivering occurred; reprints, however, were in course of preparation, and are doubtless now available. We have also to acknowledge the receipt of a neat little booklet from the same firm, measuring 3¼ in. to 6 in., and giving particulars of various types of Tantalum fixtures and installations.

The Holophane Co. send us the September number of their bulletin, which is, as usual, tastefully got up, and contains full description and particulars of the d'Olier metal reflectors. This number includes a reprint of a recent article by Messrs. Cravath and Lansingh entitled "Some Preliminary Calculations of Illumination."

The Union Electrical Co. send us current lists describing the "Union" auto-transformers for use with metallic filament lamps, which are listed for the reduction of standard pressures ranging from 100 to 250 volts; also lists giving particulars of the "Fortiter" Resistance apparatus, and Excello Carbons, and alternating current arc lamps. This firm also send us an account of the exhibit of arc lamps at the Manchester Electrical Exhibition. Excello white and yellow flame arcs were largely employed, and there were also exhibitions of the inverted system of lighting.

The *Quarzlampen-Gesellschaft*, of Pankow, Berlin, send us a series of pamphlets describing the new Küch quartz tube mercury vapour arc lamp. It is claimed for these lamps that they yield 3,000 H.K., taking a current of 3½ ampéres, and burning direct on 220 volts, and that they will burn 2,000 hours without any attention.

Messrs. Porter and Co., of Lincoln, send us an attractive pamphlet describing some of the gasholders installed by this firm, and also undertake the supply of ironwork, tanks, &c., of all descriptions, as employed in gas manufacture.

The Heatley-Gresham Engineering Co. send us an illustrated descriptive pamphlet of their patent oil engines, "Rational" electric lighting sets, deep-well pumps, and switch-boards, &c.

We have also received a little booklet setting forth the claims of the *Mitchellite* petrol air gas system, which is stated to be "cheaper than coal gas, non-explosive, and absolutely automatic."

Messrs. Heller & Knappich, of Augsburg send us a description of their "Baldur" Acetylene Gas-Generators, together with a booklet describing the oxy-acetylene system of welding.

ERRATA.—October Number, p. 854. In title, for "Hint" read "Unit."
" " p. 847. In heading below Fig. 3, for "ft." read "inch."