ELECTRICITY · ACETYLENE · OIL · GAS

The ILLUMINATING ENGINEER

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.

Expert Knowledge applied to Public Lighting.

CONSIDERING the immense amount of money spent annually on public lighting one would naturally suppose that the method of lighting adopted in any particular case would be the subject of very careful consideration, and that before embarking on any such enterprise, those responsible would avail themselves of the best expert opinion and would take pains to secure that the system adopted was the best that could possibly be devised to meet the circumstances of the case.

Actually we know that this is, unfortunately, often very far from being the case, and that street-lighting is often regarded as a mere matter of whim or is determined by outside considerations quite apart from the really important factors in the situation. We notice, however, a striking instance to the contrary in the deliberations of the Finance Commission of Boston. The commission have definitely decided to withhold their report on the street-lighting of that city until the opinions of their expert representatives, specially visiting the chief cities of Europe for the express purpose of studying the most recent methods of street-lighting, are available.

During the last two months we have recived visits from Mr. G. U. Crocker, a member of the commission, and two appointed experts, Dr. Louis Bell, who, of course, is well known to our readers as the president of the Illuminating Engineering Society, and is also consulting engineer to the Edison Electric Co., and Mr. Whittington of the Boston Consolidated Gas Co., who were visiting London for this purpose.

To our mind this is a most interesting example of the value that is attached to expert knowledge in the United States. And it is not only the fact that the Finance Committee think fit to authorize such investigations by acknowledged experts in both gas and electric lighting that strikes us as so admirable. Dr. Bell and Mr. Whittington, though connected with electrical and gas companies respectively, are visiting Europe not as electric or gas, but as *illuminating engineers.* They are anxious to learn all that is to be learnt about the progress of both illuminants.

As a result it may be expected that the matter will be taken up and considered by men who are in touch with the whole subject, and the discussion will not degenerate into a mere controversy between representatives of gas and electric lighting who understand their own systems and do not know—and do not care to know—anything of others. Whatever the issue in this case, we can only admire the evident pains that are being taken by the authorities, and do not doubt that their wide view of the subject will be amply justified by the ultimate result.

The Education of the Gas Engineer.

Our contemporaries *The Gas World*, and *The Journal of Gaslighting*, and other periodicals, have recently commented upon the strides that have been made in the training of gas engineers in Germany as exemplified by the magnificent facilities offered to those in the profession at the Technische Hochschule at Carlsruhe under the professorship of Dr. Bunte, and also at Munich, Dessau, Bremen, and elsewhere.

At the present day the complexity of problems that expert gas engineers are called upon to solve is such that the very highest scientific attainments are required and a scientific education becomes a necessity. The recent appointment of Prof. Bone to the Chair of Fuel at the University of Leeds is an indication that this necessity is becoming generally realized. Actually the whole field, both of gas and of electrical engineering, is so wide that a certain degree of specialization becomes a necessity, and it must be realized that the engineer whose attention is concentrated upon the many problems connected with the generation of gas or electricity may not be able to give the necessary study to the equally important illuminating side of the profession. It must not be forgotten that the great bulk of the gas and electricity generated is used simply for purposes of illumination, and the study of the conditions at the consumer's end demands constant care and judgment. There is sometimes a danger that problems of generation and distribution may be studied to the exclusion of the important aspects of the subject with which we are mainly concerned.

We notice that a scheme of co-operation has now been adopted between the examining authorities of the City and Guilds Institute and the Institute of Gas Engineers, and that a wise decision has been arrived at to separate the subject of gas engineering pure and simple from the subject of the distribution and utilization of gas. We hope that in this latter section the subject of illumination will receive the attention that its importance demands.

It is also interesting to recall that the general report of the Institution of Electrical Engineers for the present year made mention of a similar decision on the part of the Council to co-operate with the City and Guilds Examination Department, and to nominate representatives in different districts to attend the practical examinations. The revision of the syllabus for the examination of wiremen has recently formed the subject of discussion, and we hope that the interest of the Institution in the matter will secure that the subject of illumination receives adequate consideration.

Another instance of the movement towards better methods of educating the rank and file of the profession is afforded by the agreement between the Gas Light and Coke Co. and the London County Council to organize special courses in gas engineering for the benefit of those wishing to enter the profession. It seems to us that a great opportunity for giving valuable training in the fundamental principles of good illumination is here presented. In previous correspondence we also had an opportunity of satisfying ourselves that the Education Department of the L.C.C. would be willing to pay attention to the subject of illumination, and we feel confident that any desire to organize courses of instruction of this nature would be sympathetically regarded. There is no need for any very elaborate instruction in theoretical aspects of the subject that are better left to the judgment of professors. But there certainly is room for instruction on practical and commonsense lines in the measurement of light and the utilization of it to the best advantage, and there can be no doubt that any trouble expended in this way would be well repaid in the future.

Public Interest in Architecture.

We observe that Mr. Delissa Joseph has addressed a letter to *The Times*, pleading for a more general recognition of the principles of architecture by the general public. He points out the City of London is slowly developing into one of the most beautiful capitals in the world, and the present rate of progress might be appreciably accelerated if the municipal patriotism and the enthusiasm for artistic productions, characteristic of many of the Continental cities, were more developed in our own city.

We ourselves sympathize with this desire, and we have frequently drawn attention to the need for a better understanding of these very principles by which architects are guided among those concerned with artificial illumination. But the exceedingly important question of the correct methods of lighting fine buildings so as to carry out the feeling and intentions of the architect responsible for their design, can only be met by joint action between the architect and the lighting engineer.

In this connexion the subject dealt with in one of the articles in our special section is of exceptional interest. Naturally the value, during the night-time, of graceful and artistic buildings is entirely subservient to the illumination by the aid of which they are rendered visible. If, therefore, as will hardly be contested, there are buildings in the streets of London of exceptional architectural and historic interest, why is not the illumination of the exteriors of these buildings, with a view to bringing out their most interesting features to the best advantage, more seriously studied? Moreover, when we bear in mind that artificial light, unlike daylight, is under control, and that we can arrange our sources so as to produce practically any play of light and shadow that the character of the building may require, one would suppose that the scientific use of artificial light in this way might lead to very fine artistic results indeed. Especially is this true as regards the lighting of buildings in exhibitions, &c. A great section of the public only enter an exhibition during the evening—indeed the illumination is a great attraction. Surely, therefore, the proper method of lighting the buildings on which so much careful design has been expended should be a matter of very careful study, and some definite agreement should be reached as to what the best method really is.

The study of illumination ought, therefore, to form an integral portion of the training of the architect, just as the study of artistic principles is essential to the illuminating engineer, in order that both may work together for a common end.

The Colour-Revealing Qualities of Different Illuminants.

In our last number we referred to some conflicting statements regarding the effects of different illuminants on eyesight; in this case we wish to draw attention to another matter on which an authoritative statement is needed, namely, the effect of different forms of artificial light on coloured objects. We note, for instance, that one of the notices outside the Machinery Hall of the electrically illuminated "Ideal Home" in the Franco-British Exhibition says of the electrical glow-lamp that "of all artificial light, it most closely resembles sunshine." In his recent paper on acetylene and petrol-air gas, Mr. Bingham likewise referred to acetylene as the nearest to sunlight of all illuminants.

The author of the article on stage-lighting in the present number, on the other hand, mentions that arc-lights are deliberately employed on the stage for imitating daylight in preference to glow-lamps. Yet we frequently hear the tungsten lamp spoken of very favourably for this purpose. It will also be remembered that Mr. Moore (*Illuminating Engineer*, Feb. 1908, p. 161), was so convinced of the exact resemblance of the carbon-dioxide Moore tube to daylight that he recommended its use as a standard.

The Spectra of Artificial Lights.

After what has been said in the last paragraph on the divergency of the views expressed on the subject of the appearance of colours as seen by the light from various sources, it may be of interest to turn to the valuable paper recently read before the Illuminating Engineering Society by Dr. Nichols. There can be no doubt but that the quantitative measurement of the intensity of the light in various regions of the spectra of different illuminants is the true scientific guide to the study of problems of this nature. Briefly, Dr. Nichols explains that although daylight itself differs considerably under different natural conditions, yet there is no serious difficulty in forming a fairly correct conception as to what is really meant by the quality of light we term "daylight," for purposes of comparison with different illuminants.

We may, of course, set aside at once sources of light that do not give a continuous spectrum, such as the mercury vapour lamp, and to a less degree the flame arc, as abnormal and out of the question where the correct delineation of delicate shades of colour is concerned. Among the continuous spectra we remark that the chief defect in all artificial illuminants would seem to be a lack of strength in the blue. In cases where a strong blue element is present, we sometimes find it in the form of a localized bright band, which will probably have the effect of distorting the appearance of coloured objects even more than a uniform weakness. We can readily understand, for instance, that the peak in the curve showing the spectrum of the arc-light would have this effect. The older incandescent mantles likewise suffered from a peak in the curve, which interfered with the correct presentation of colours.

It is, however, encouraging to find that we are making progress towards the desired type of illuminant. The general resemblance of the spectrum of the acetylene flame to that of daylight is distinctly closer than that of the old gas-flame. Similarly the tungsten lamp is in this respect a marked advance on the carbon lamp; it would be even more interesting to see the corresponding curve for the Helion filament.

Whatever be the means by which we ultimately attain our goal there can be no question of the importance of exact knowledge on this point. Mr. Middleton, in his article on the lighting of picture-galleries, makes reference to the need for an illuminant resembling daylight exactly, and such a source of light would be of the very greatest assistance to artists, and, in fact, in any case in which the correct representation and distinction between delicate shades of colour is desired.

LEON GASTER.

Review of Contents of this Issue.

Mr. A. P. Trotter brings the theoretical parts of his articles to a conclusion in the present number. The final section deals with some SPECIAL CASES OF DISTRIBUTION, and points out the claims of illumination in a vertical and horizontal plane respectively, under various conditions. A comprehensive diagram of five illumination-curves is given.

The next part of these articles will deal with PHOTOMETRIC INSTRUMENTS AND METHODS.

Prof. J. T. Morris describes the results of some TESTS ON HIGH-AND LOW-PRESSURE GAS-LIGHTING. He expresses his results in mean spherical and mean hemispherical candle-power, and points out the inconvenience resulting from the selection of the intensity in one particular direction only as a basis of comparison. He likewise refers to the effect of fluctuations of pressure on the performances of gas-lamps and the need for specifying the calorific value of the gas used. He states, for instance, that the maximum candle-power of a lamp was found to be 1,250 in one part of London and 800 in another, owing, presumably, to a difference in the quality of the gas supplied.

Mr. B. Duschnitz describes a NEW FORM OF MERCURY-CARBON GLOW-LAMP that has been developed in Germany. The filament of the lamp is composed of carbon, but burns in an atmosphere of mercury vapour instead of in vacuo, as in the case of lamps of the ordinary variety. This atmosphere of mercury vapour is secured by the volatilization of a drop of mercury placed within the U-tube containing the filament. The lamp is said to consume about 1·5 to 1·7 watts per c.-p., and such results as are at present to hand regarding the life of the lamp are looked upon as satisfactory.

The author quotes the results of a series of experiments by Dr. Lux, having for their object to determine whether the increase in efficiency is to be ascribed to high temperature or luminescence. The conclusion is reached that the former explanation is the correct one, the envelope of hot mercury vapour restricting the conduction of heat from the filament and so raising its temperature of incandescence.

Mr. G. A. T. Middleton deals with the LIGHTING OF PICTURE GALLERIES. He points out that the artificial lighting of picture galleries is an important question, inasmuch as many people who are unable to pay attention to the subject in the daytime might be willing to visit our national collections by night. One of the most vital and essential qualities of an illuminant intended for picture-lighting is perfect safety. We must also feel certain that the source of light gives off no injurious fumes or rays of a nature likely to injure the often priceless and unique objects of art that are to be illuminated.

Other very important considerations are the provision for an adequate diffused illumination, so that all pictures may be evenly illuminated and that there may be no reflection from the glass, and the choice of an illuminant that does not unduly distort the colours.

Dr. C. V. Drysdale completes his survey of the existing methods of determining LUMINOUS EFFICIENCY AND THE MECHANICAL EQUIVALENT OF LIGHT. He gives a comprehensive list of the results obtained by previous workers in the subject and also his own determinations for white and yellow-green monochromatic light; he further suggests that an ideal source of white light ought to give us at least 10 candles per watt, while from a monochromatic light nearly 17 candles per watt should be obtained.

Dr. Drysdale's next instalment will deal with 'THE LAWS AND MEASUREMENT OF RADIATION.'

The Special Section in the present number is devoted to ILLUMINATION AT THE FRANCO-BRITISH EXHIBITION. The first of the two articles dealing with the subject describes the chief objects of interest from the standpoint of illumination, while the second contains some discussion on the general principles underlying the illumination of the grounds and buildings of an exhibition. Naturally the illumination both of the grounds and buildings and also of particular exhibits opens up a great field for ingenuity in order to secure special effects, such as cannot be obtained under ordinary circumstances.

The writer of the second of the two articles referred to suggests that the present traditionally accepted method of outline-lighting of buildings does not lead to the most perfect æsthetic effects, partly because the small unshaded glow-lamps are apt to be wearisome to the eye, and also because the method does not facilitate the revealing of light and shadow, on which the architectural charm of a building so greatly depends. He therefore prefers an attempt to imitate daylight-illumination to the extent of illuminating the building as a whole by external sources, and illustrates his contentions by several photographs of illumination-effects of this nature.

Among other articles in this number may be mentioned that on STAGE-ILLUMINATION. The author discusses the purposes which artificial light employed on the stage is intended to serve, and describes the various fixtures and arrangements of glow-lamps by the aid of which the main illumination is secured. Special interest attaches to his description of the use of arc-lights and coloured lamps of various kinds so as to imitate natural phenomena—dawn, moonshine, driving clouds, &c.

Electric lighting, the author states, is now practically exclusively used for theatre illumination, and it is interesting to note that nearly 3,000 glow-lamps are used for the lighting of the stage of the theatre at Frankfort alone.

An article on SHADES AND REFLECTORS describes some of the objects to be served by glass-ware applied to the distribution and diffusion of light, and describes some of the types developed by the Holophane Company for this purpose.

Another contribution deals with the LIGHTING OF RAILWAYS BY ACETYLENE. The author describes the four chief methods of acetylene lighting employed on trains at the present day. He distinguishes between the lighting of railway stations and carriages, and gives a number of instances in which the use of dissolved acetylene enabled a train to continue to give the requisite illumination for a long period of time at a stretch without recharging. Acetylene lighting, it is stated, is already extensively employed for the purpose of illuminating railway carriages in the United States and Canada, and is also either in actual use or under consideration on many of the railway lines in Austria-Hungary, Italy, France, and Russia.

Mention may also be made of a description of the form of LIQUID GAS recently developed by **Mr. L. Wolf,** of Zürich. Like dissolved acetylene, this gas is enclosed under pressure in suitable receivers and liberated as required.

In the present number will also be found a very important and interesting paper, recently delivered by **Dr. E. L. Nichols,** before the Illuminating Engineering Society of New York, dealing with the COLOUR OF DAYLIGHT AND VARIOUS ARTIFICIAL ILLUMINANTS. He gives a number of curves showing the composition of daylight under different circumstances and in different localities, and also a comprehensive comparison of the spectral composition of many illuminants, ranging from the oil-flame to the most recent electric flame-arcs, &c.

Many readers will also be interested in the résumé of the annual meeting of the Société Technique du Gaz, and the Report of the Photometric Committee of the Deutscher Verein von Gas- und Wasserfachmännern, likewise published in the present number.

Attention may also be drawn to some **Correspondence** on the subject of **Mr. Voysey's** REPORT ON THE CITY LIGHTING, and on **Mr. Bingham's** recent paper on ACETYLENE AND PETROL-AIR GAS.

At the conclusion of the number is to be found the usual **Review of Current Literature** dealing with illumination and the **Patent List**.

TECHNICAL SECTION.

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

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

Illumination, Its Distribution and Measurement.

By A. P. Trotter,
Electrical Adviser to the Board of Trade.

(*Continued from p.* 538.)

Although the calculation of the true mean has been discussed here at some length, this quantity must be accepted with caution as a criterion of the useful or practical illumination of any particular case. It is quite possible to have cases which agree closely in mean illumination, but which may differ largely in useful effect. It is, for example, easy to see that a street may be lighted by powerful lamps widely spaced, while another may be provided with a large number of small lamps. The two might yield the same mean. In the former case there would be a useless superfluity of light near the lamps and intervals of very low illumination, while the latter would have a more uniform distribution of illumination, only slightly exceeding the mean in some places, and having no very low illumination at all. Let it always be remembered that theory in such cases cannot be allowed to override the commonsense opinion of a man of ordinary intelligence.

Reference has been made to the proposal to consider the difference between the brightest and the dimmest parts of an illuminated area, as a measure of the quality of the distribution (p. 447). Many other considerations have to be weighed in determining the best way of carrying out practical cases of lighting, but for what it is worth, this difference is represented for the cases shown in Figs. 10, 11, 12, and 13, by the curves of maxima and minima in Fig. 42. The way in which this difference increases with the wider spacing of the lights is worth noticing, but it conveys no useful information as to the area which is illuminated.

General Cases of Distribution.—The theoretical treatment has been confined thus far in these articles to the distribution of illumination on a horizontal plane. Whether that is the best or, indeed, an intelligent way to consider practical cases of illumination has been the subject of no little controversy. When the practical modes of measurement are discussed in a later section, something more will be said about the matter, but it is obvious that for the elementary consideration of distribution of illumination, it has been desirable to take the most simple cases first.

For interiors of large buildings such as railway stations the illumination of walls is quite as important as the illumination of the ground, and in the open street, any one who wishes to consult his watch will not hold it horizontally, but with the face turned towards the light. In a railway goods-yard the illumination on the ground is practically of no consequence, but the lighting of the sides of the waggons is very desirable. No general rule can be laid down, but for ordinary street work it appears to be best to aim at a fair illumination of the ground, this being the most difficult. Practical measurement may conveniently be made at a height of 4 ft. from the ground, but this will be discussed later.

For any source of light, and at any given distance from that source, and with a screen which may be turned at any angle, the illumination of the screen will be greatest when it is turned full to the light, so that the light falls

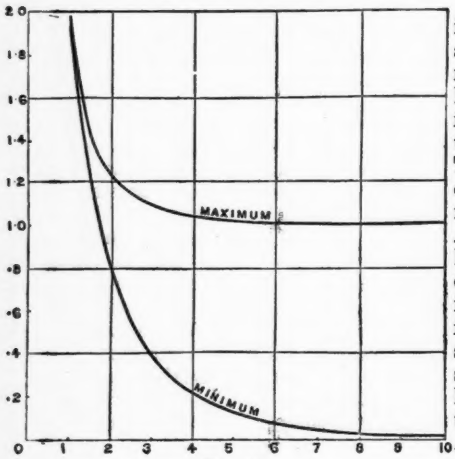


Fig. 42.

perpendicularly on it. The illumination is then inversely as the square of the distance, or, according to the convention assumed in these articles (the height of the source being unity), as the square of the cosine of the inclination of the ray to the vertical. The curve of cosine squared is given in Fig. 43.

The illumination of the vertical plane, the height of which is small compared with the height of the lamp, for example, the side of a truck in a goods-yard lighted by high lamps, is proportional to the product of the sine of the angle of incidence into the square of the cosine. This curve is given in Fig. 43. It will be noticed that it is zero below the lamp, and is equal to the illumination on a horizontal plane at 45 degrees. In other words, the illumination on the top and on the side of a small cube placed on the ground at this position would be the same. At greater distances the curve continually approaches the curve of the squared cosine. The illumination on the wall of a house facing a lamp, and at a distance measured by the angle of incidence of a ray striking its foot, follows the square of the cosine on that part which is level with the light (that is, inversely as the distance), and falls off to the product of the sine into the square of the cosine at the foot of the wall.*

Precisely the same law is followed in the variation of the illumination at a given point, when a lamp in the neighbourhood is placed at different heights in a perpendicular line. This is one of the few theorems of illumination which are to be found in text-books. The curve in Fig. 44 is the same as the $\cos^2\theta \times \sin\theta$ curve of Fig. 43. It represents the illumination at the point A by a source of light placed at different heights in the vertical line BC. This diagram differs from the preceding ones in these articles, since the illumination is here measured along a horizontal scale instead of a vertical. The vertical scale in Fig. 44 represents the variable height of the source of light. When the light is low the illumination at A is feeble, in spite of the proximity of the light, because the angle of incidence is so great. As the light rises this angle is reduced, and the illumination at A increases, until the light reaches the point D. It is then a maximum, and it may be shown that $BA = BD \times \sqrt{2}$, the angle of incidence BDA being 54° 44. It will

* Since the practical section of these articles will contain no reference to cases of purely horizontal illumination, it may as well be recorded here that such cases exist. Passengers on the tops of omnibuses, the audience in the gallery of a theatre, readers consulting books in the upper gallery of a library receive practically horizontal illumination. The sentry at the west entrance to Wellington Barracks enjoys horizontal illumination from the considerable number of electric arc lamps in front of Buckingham Palace.

be observed that a small change in the height BD may be made without appreciably altering the illumination at A. If the height be increased, the illumination will be diminished, owing to the increased distance.* lamp situated at any point in the line CB. The practical application for lighting a desk by means of one or two lamps, which are conveniently placed otherwise than immediately over the middle, is obvious.

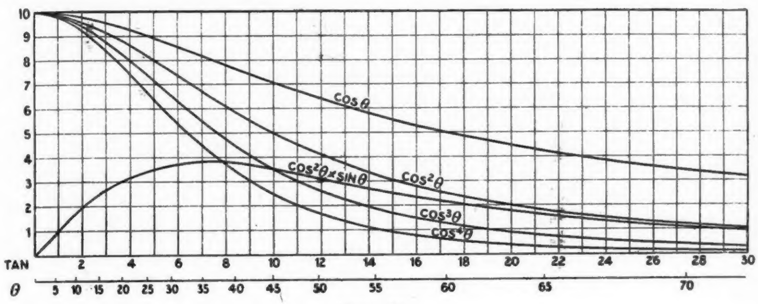


FIG. 43.

This maximum illumination of a point has been misunderstood. There is no special virtue in the angle of incidence whose tangent is $\sqrt{2}$, and it cannot be deduced that when lamps are arranged so that each one commands a circle of radius $\sqrt{2}$ (the height being unity), it is more "efficiently" illuminated than any other. The illumination of the circumference of such a circle is very nearly 0·2 of the maximum. The total light falling within the circle is 0·427 of the whole light falling on the horizontal plane. The distribution produced by several lamps in a row, each being $2\sqrt{2}$ apart, would closely resemble that represented in Fig. 12, p. 271. The characteristic would resemble $d=3h$ in Fig. 37, p. 538. The usefulness of this arrangement is really limited to the particular case represented in Fig. 44, viz., the maximum illumination of the point A by a

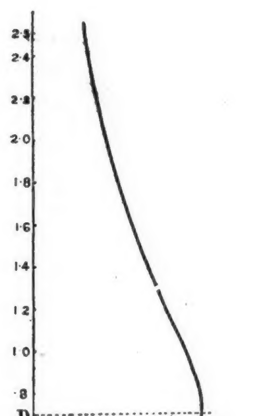


FIG. 44.

* It may be remarked that the $\cos^2\theta \times \sin\theta$ curve is the slope or differential of the $\cos^3\theta$ curve, the maximum ordinate occuring at the point of inflection, when $3\cos^2\theta = 1$.

(To be continued.)

The Report of the Photometric Committee of the Deutscher Verein von Gas- und Wasserfachmännern.

THE numerous technical committees of the German Society of Gas Engineers have now reported, and among these reports special interest attaches to that on Photometry, presented by Dr. H. Krüss.

The question was raised whether the photometric rules adopted by the German Institution of Electrical Engineers could be applied to gas-lamps, or whether any modification was desirable.

The most important recommendation embodied in the report is that specifying the mean lower hemispherical candle-power as the practical basis of comparison of different sources of light. The committee, however, recognize that while this constitutes the best simple basis of comparison, a too rigid reliance on this method alone might, in certain practical cases, lead to misconceptions, and therefore regard the polar curve of light-distribution as the only really absolutely reliable guide in planning illumination; they also mention a series of methods by the aid of which such curves may be obtained experimentally. A list of the references to these researches is to be found in the detailed report in the *Journal für Gasbeleuchtung* (June 20th, 1908), and they are also described and reviewed in Liebenthal's 'Praktische Photometrie.' It is also advised that a factor connecting the values of the mean spherical and mean lower hemispherical candle-power should be given.

The value of the Ulbricht globe for determining the mean spherical candle-power of gaslights is also discussed, and it is pointed out that care must be exercised in its application to the measurement of light from inverted mantles which are known to be so sensitive to any interference with the air supply.

The commission, however, propose to carry out further tests on the effect of enclosing combustible sources of light within the Ulbricht globe, and to study the application of the globe to the general testing of gaslights.

In calling attention to the confusion that is created by the loose use of terms denoting the intensity of the light in different directions, the mean spherical and hemispherical candle, &c., the report repeats the symbols specially devised by the International Photometrical Commission at Zürich last year (see *Illuminating Engineer*, January, 1908, p. 78).

Some interesting discussion also took place with reference to the photometric testing of different qualities of illuminating gas, mixtures of coal gas and water gas, &c. The question of the effect of burning enriched gas with mantles was also brought up, especially with regard to the regulation of the air-supply.

Some details are also given of the results of experiments on the effect of transmitting gas at high-pressure from Lübeck to Travemünde.

The results suggest that the illuminating and calorific power was, as a rule, but slightly affected in the process. The decrease was however more marked in winter, when cold temperatures prevail. It was also found that under the exceptional conditions involved in long distance transmission, the accepted formulæ governing the size of main and quantity of gas transmitted do not rigidly apply.

The experiments, however, are to be extended with the object of clearing up certain apparently contradictory results.

A grant of 900 marks was voted to the Committee for the continuation of these and other researches during the following year.

Tests of High and Low Pressure Incandescent Gas Lighting.

By J. T. Morris, M.I.E.E.,

Professor of Electrical Engineering at the East London College.

During the preparation of material for a discussion on Gas *v.* Electricity, held by the engineering societies of the East London College, the supporters of the two sides were in search of reliable up-to-date figures of the efficiencies of the two kinds of illuminants. Having found considerable difficulty in obtaining such data, tests were instituted in the electrical engineering laboratories of an ordinary 3-light incandescent gas-burner, high pressure gas lamps, and a number of electric arcs of the most recent type.

It is the object of the present article to summarize and discuss the tests made with gas, reserving for a future communication those obtained with electric flame arc-lamps.

Tests on a 3-light incandescent gas lamp.

The form of lamp tested was of the type which is commonly adopted for lighting the outsides of shops. It had a clear glass enclosure, and consumed about 16 cubic feet of gas per hour, requiring for satisfactory working a pressure of some 3½ in. of water. It should be clearly understood that this lamp was not adjusted by an expert to give the best possible results. The author is convinced, however, from a fair experience of incandescent gas lamps, that during the photometric tests it was certainly not below the average of such lamps in the illumination it gave. During the 2½ hours that the lamp was burning the gas pressure from the street supply varied between the limits of 2·9 and 4·0 inches of water; while under test, however, the pressure at the lamp itself varied from 3·5 to 3·8 in. of water. The mean gas consumption was 16·1 cubic feet per hour. The lamp, as in all succeeding tests made at this College which are described here, was hung with the centre of the light-giving portion of the lamp on a level with the photometer, and the direct light of the lamp itself was screened from the photometer. By the help of two oval-shaped plane mirrors two beams were picked out on opposite sides of the lamp, and the combined beam was caught on another larger rectangular mirror, and so reflected into the photometer. The coefficient of absorption of this system of mirrors, determined on various occasions, was found to approximate closely to 30 per cent, that is, each mirror at an angle of 45 degrees reflects 84 per cent of the light which it receives.

In order to obtain the polar diagrams for these lamps it was merely necessary to shift the two oval mirrors into various positions, and then photometer the combined beam. The advantage, as is generally known, of this method is that it obviates the necessity for moving the lamp at all during test. The polar diagram is shown in Fig. 1, and the results are given in Table I. It should be mentioned that a 16 candle-power carbon filament lamp was used as a working standard. The photometer was either a Bunsen grease-spot or a Wild flicker.

Test on a High-Pressure Gas-Lamp.

Considerable progress has been made in recent years in the use of high-pressure gas in connexion with mantles. The Keith light of Messrs. Keith & Blackman was selected for the purposes of these tests, as a typical example of the latest practice. The author desires here to record his thanks to Mr. George Keith for the loan of apparatus and the facilities he placed at his disposal, and also to Mr. Chapman, of the same firm, for his kind assistance throughout these tests.

The form of lamp tested was a nominal 1,500 candle-power inverted "arc-lamp" having a single mantle. Gas was supplied to the lamp at a pressure of 4 in. of mercury by means of a special rotary pump.*

The mantle is some 7 or 8 in. in length before insertion in the lamp, and is of a woven texture and very flexible. It is attached to a fire-clay collar having a screw thread. When screwed on to the nipple of the lamp, before any gas is turned on, it is ignited by a match, and it then shrinks to an irregular shape about 5 in. in length. The by-pass of the lamp is then lighted, and the gas pressure carefully turned on, with the result that the mantle now fills out with the pressure to a diameter of about 1¾ in. near the bottom, 1⅝ in. near the top, and 3¾ in. in length. Thus there is about 18 sq. in. of mantle. The lamp has two clear glass enclosures.

Tests were carried out at a pressure of 4 in. of mercury, that is 54½ in. of water. Polar diagrams of two tests made on different days are given in Fig. 2, and the numerical results are collected in Table I.; it will there be noticed how great an increase in the candle-power of the lamp results from quite a moderate increase in the calorific power of the gas.

In Fig. 3 is shown the result of a few tests made with the object of determining the effect of variation of pressure on the candle-power of the lamp. It will be seen that the lamp is not at all sensitive to these fluctuations of pressure. Thus a 1 per cent. change of pressure produces only half a per cent change in candle-power—a result very different from the magnitude of those produced in electric glow-lamps by pressure changes.

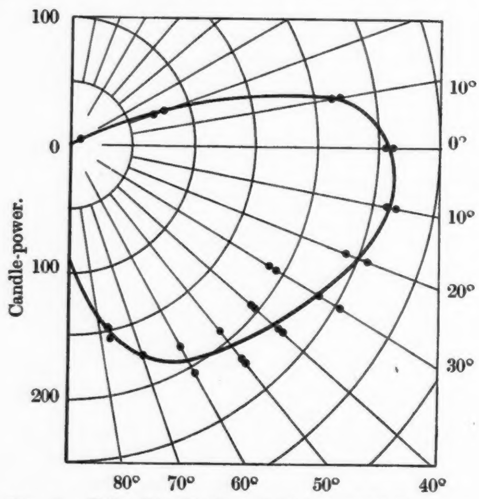


FIG. 1.—Polar Distribution of Light. 3-Light Incandescent Gas Lamp, with Shade, and Clear Globe.

NOTES ON GAS PHOTOMETRY.

Attention should be drawn to the fact that it is only with great difficulty that a 10 candle-power pentane lamp can be used with precision as a standard for determining the c.-p. of such high power incandescent gas-lamps as these, owing partly to the vast difference in the c.-p. of the lights under comparison, and also to the fact of the considerable colour difference of the two sources.

* Other tests of these lamps are described in the June number of this journal, on pp. 476 to 478, in the article by Mr. W. R. Herring on Gas Lighting at the Edinburgh Exhibition.'

The author has found a "sun" tantalum lamp to be well suited for use as a working standard, provided, of course, a reasonably steady source of electric current is available.

Further, the mode of expressing the candle-power of gas-lamps leaves a great deal to be desired. Apparently a not uncommon way of expressing the efficiency of such lamps is to pick out the maximum beam, and divide the candle-power of this beam by the cubic feet of gas consumed per hour, the result being given as a measure of the efficiency.

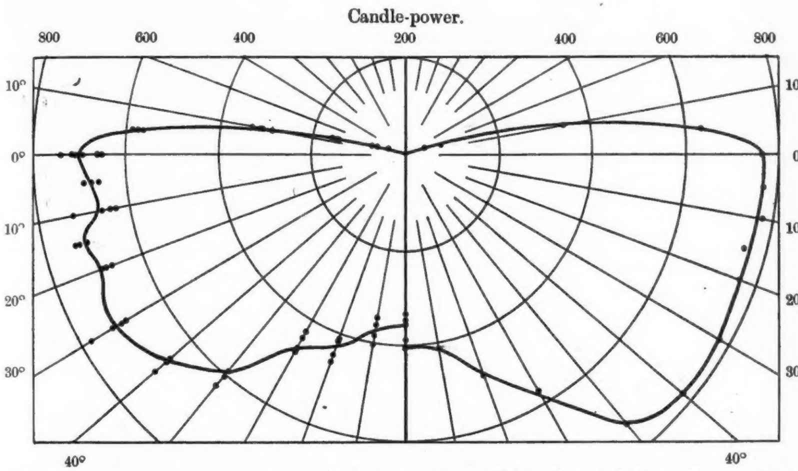


FIG. 2.—Polar curve of distribution of Light of Single Keith Inverted Incandescent High-Pressure Gas Lamp, having a double clear glass enclosure. Two tests. Shade in position.

This, however, is open to the obvious objection that if any focussing reflectors were used it would be possible to force this figure up by several hundred per cent. The results are therefore given, as is customary in arc-lamp work, in mean spherical—and mean hemispherical—candle-power as well as in terms of the maximum candle-power.

NEED FOR CONTROL OF CALORIFIC POWER OF GAS.

Another matter deserving of attention is the constancy of pressure of the gas supply. Especially is this necessary for some types of ordinary incandescent gas-burner. Many of these are very sensitive to pressure fluctuations. It is frequently true, however, in house lighting that these changes of pressure are due more to the use of too small piping in the house itself than to external variations of pressure.

But a matter of far greater moment, and one the importance of which the author wishes strongly to emphasize, is the urgent need which exists for the supply of gas of a minimum value of *heat energy* for a given price; and not, as at present is the case, for the supply of a nearly definite volume of gas for this price, trusting to the off-chance that this volume is capable of yielding a proportionate supply of heat.

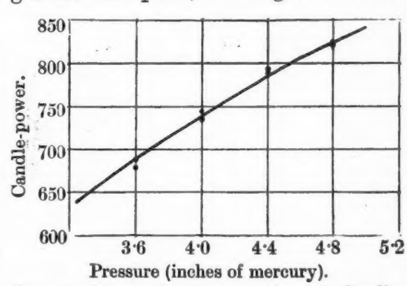


FIG. 3.—Curve showing relation of Candle-power to gas pressure for Keith Light.

The author is aware that at the present time tests are daily made in the gas-testing stations in London of the calorific power of the gas,* with the object of possible *future* legislation. But gas is so largely used for illuminating purposes (by the medium of heated mantles), for heating, for cooking, and for power, that surely the time has already come when the *calorific power* of gas should be the *most important factor* in determining the price paid per cubic foot. Possibly mere volume might again become of greater importance in the event of airships and balloons becoming a recognized means of transit!

* See article on 'Gas Testing in London,' by Mr. R. A. Dibdin, in this journal, May, 1908, p 390.

However this may be, the inequity of the present system of charging by volume is well illustrated by the results obtained with the Keith lamp previously referred to. It is supplied by the manufacturers with the object of giving a specified candle-power for a given rate of consumption of gas. What do we find it does in actual practice? The above tests show that the maximum candle-power of the lamp is in one part of London about 800 candles; take it to another part of this city, and it yields 1,250 candles; and take it to Edinburgh, when it would probably yield some 1,500 candles! Truly a most disconcerting state of affairs for the much-tried incandescent gas lamp manufacturer!

TABLE I.

Date.	Name of Lamp.	Globe.	Mean Spherical Candle-power.	Mean Hemispherical Candle-power.	Maximum Candle-power.	Angle below horizontal at which maximum Candle-power occurs.	Gas consumption in cubic feet per hour.	Gross calorific power of Gas.	Mean Spherical Candle-power per cubic foot per hour.	Mean Hemispherical Candle-power per cubic foot per hour.	Maximum Candle-power per cubic foot per hour.
19/5/08	Ordinary 3 burner Incandescent Gas	Clear	125·	225·	250·	10°	16·1	480· about	7·8	14·0	15·5
5/6/08	Keith Light	Double clear	380·	640·	720·	0° to 30°	23·3	—	16·3	27·5	30·9
6/6/08	—	—	425·	720·	780·	0° to 40°	22·8	—	18·6	31·6	34·0
11/6/08*	—	—	680·	1140·	1250·	0° to 40°	23·8	545·	28·6	48·0	52·5

* This test was made at Messrs. Keith & Blackman's Works, which are supplied by a different gas company. The apparatus used, however, was standardized in the Electrical Engineering Laboratories of the East London College.

The Mercury-Carbon Glow-Lamp.

By B. Duschnitz.

In the year 1900 Sinding-Larsen, of Frederiksvaern in Norway, obtained a German patent (No. 114,438) for an entirely new variety of glow-lamp, in which the glass bulb was filled with suitable gases and vapours under high pressure.

Now when a glow-lamp receives a current considerably in excess of that for which it was intended, its efficiency is increased, the increase in intensity so occasioned being proportional to the fifth power of the temperature of incandescence of the filament. The melting-point of the material of metallic filaments sets a limit to this method of increasing efficiency. In the case of carbon-filament lamps this difficulty does not arise, but here again a new limit is set by the increased tendency to volatilization of the carbon.

Alf. Sinding-Larsen, however, found that this increased tendency to volatilize could be restricted by considerably increasing the pressure of gases within the bulb of the lamp. For this purpose he utilized mercury-vapour, which has both the desirable chemical and physical inertia, not being absorbed by a carbon filament, and not exerting any chemical action upon it. The object of Sinding-Larsen was to compress the molecules of the glowing carbon, and thus to hinder the projection of particles from its incandescent surface. But naturally, as he discovered, this desired effect cannot be produced if the inert gas is allowed to penetrate into the interior of the filament.

In order to avoid the possibility of a short circuit such as might easily arise in the case of a bulb of the ordinary shape, an exhausted glass tube in the form of a U was utilized in the Sinding-Larsen lamp. A small globule of mercury contained in this tube was caused gradually to evaporate by the heat of the filament and the necessary high pressure of the inert atmosphere was produced by this means.

Nevertheless, Sinding-Larsen does not appear to have made very great progress with his invention, the patent for which was allowed to expire in 1903. Subsequently Fritz Dannert took out a German patent (No. 166,372 of 1904), on very similar lines. He noticed that when the device shown in Fig. 1, in which a U-tube is filled up to the level *d* with mercury, the latter tended to creep up each side of the tube until the level *e* was reached, when an explosion occurred, owing to the mercury spurting against the filament.

When a smaller quantity of mercury is used the mercury, even in the case of alternating current lamps, tends to collect at one pole. According to Dannert, a serviceable and continuously working lamp was only possible when the mercury vapour or other vapour-creating substance was unable to travel from pole to pole by an appreciably shorter path than the filament itself. He also stated that the weight of body to be vaporized must not weigh down the filament. The conduction of heat from the filament to the vaporized material should take place in the following manner :—

The filament should never actually touch the surface of the mercury, but be kept a very small distance above it, and this distance should be maintained constant as the mercury warmed up, expanded, and began to volatilize owing to the heat generated. These conditions are exemplified in Fig. 2, where it will be seen the mercury globule, in the cold state, just fails to touch the filament.

Dannert, however, did not proceed much further than Sinding-Larsen, for his patent was allowed to expire in the year 1906.

More recently, however, a lamp of this type has been developed with greater practical result, some hundreds being in actual use in Germany at the present time. The lamps burn at a consumption of 1·5–1·7 watts per H.K.—about the same as in the case of the Tantalum—with a life of 500–700 hours.

Being personally acquainted with the inventor of the new lamp, the writer is in a position to give some account of its progress, and the difficulties that have been overcome in its development. Some of these formed the basis of a recent paper read before the *Elektrotechnischer Verein* (May 26th, 1908). What follows, however, is based chiefly on the writer's personal experience and information furnished by the inventor, and the report of Dr. Lux of Berlin.

The German patent (No. 176,006) referring to this lamp was taken out by R. Hopfelt, of Schöneberg, near Berlin, According to this patent the previously employed U-tube arrangement was avoided, an ordinary glass bulb, in which the two leading-in wires are separated by a special glass diaphragm, being utilized. After the expiry of the Dannert patent, however, the inventor reverted to the U-tube device.

Hopfelt has found that the use of a U-tube does not alone suffice to secure the requisite conditions. It is desirable that the density of the vapour employed should be as high as possible, and in order to attain this result he finds it necessary to heat up the tube along its entire length; otherwise the vapour would condense on the cooler portions of the tube-surface. Since the sole source of heat that can conveniently be used is the glowing filament itself, it has also been found necessary to introduce an inert gas into the glass vessel. This principle first found practical application in patent No. 180,107, a gas being specified which is non-condensible and also capable of conducting the heat from the filament to the walls of the tube. Hopfelt states that the internal pressure in the lamp, in the cold state, must be exceedingly low; otherwise the mercury would volatilize with difficulty, owing to the expansion of the gas with the heat developed by the filament. In this lamp an ordinary carbon filament is employed, but under exceptional conditions. Owing to the greater cooling action of the surrounding nitrogen gas the temperature of the filament would

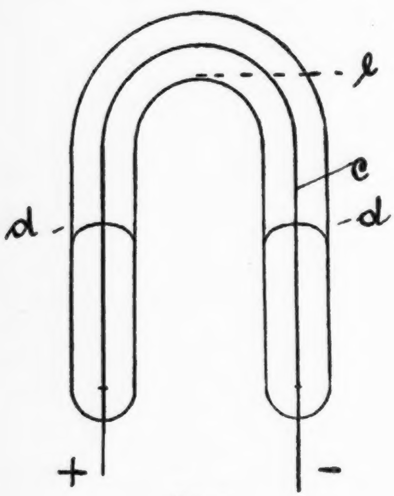


FIG. 1

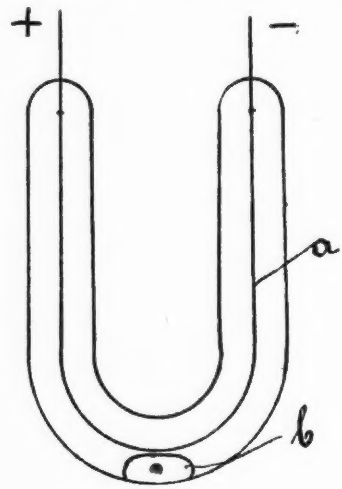


FIG. 2.

be lower than in the case of an ordinary glow-lamp receiving the same power when first lighted up. Afterwards, when the mercury has had time to volatilize, the conditions are changed.

Hopfelt demonstrated this by suddenly applying a small current to the lamp in its warmed-up state. Under these conditions the current necessary to just cause the filament to begin to glow was noted, and it was observed that whereas the ordinary lamp began to glow when it received 0·2 amperes and 17 volts, *i.e.*, 3·4 watts, the mercury lamp required 0·25 amperes and 21 volts, *i.e.* 5·2 watts—a difference of 55 per cent. When burning under normal conditions the mercury lamp received 36 per cent more power. The power given to a filament must therefore be somewhat increased in order to attain the same initial temperature, but the brightness of the light yielded by such a lamp is considerably greater when the lamp is burning in an atmosphere of mercury vapour under practical conditions. Hopfelt, for instance, found that an ordinary 65 - volt glow - lamp, not utilizing mercury, consumed 0·87 amperes and yielded 16 H.K. The same filament, however, when running in an atmosphere of mercury vapour to which was added a small quantity of nitrogen, consumed 76·5 volts and 1·02 amperes, and yielded 48 H.K.—*i.e.*, 1·625 watts per H.K. as compared with 5·534 in the first instance. According to Dr. Lux's experiments this is to be ascribed to the fact that the filament is then at a *higher* temperature than would be the case in vacuo. This point is referred to later on.

In the manufacture of these lamps Hopfelt does not proceed to complete exhaustion, but only until an internal pressure of 0·3 to 2 mm. of mercury is obtained. During the initial burning of the lamp a portion of the mercury vapour combines with the oxygen of the air remaining in the bulb, a small quantity of nitrogen being thus left behind.

In Fig. 3 is shown a special form of the Hopfelt lamp.

The U-shaped tube *r* contains the carbon filament *f* and the drop of mercury Hg. The actual lamp is surrounded by the outer bulb *b* and is attached to the cap S. In this case the filament is supported in four places at *a*, *a*, *a*, *a*; this, however, is only necessary in the case of high pressures, such as 220 volts. Lamps intended for 120 volts do not require any such supports.

Hopfelt submitted his lamps to the laboratory of Dr. Lux of Berlin, in order to solve the following questions:

1. What is the exact effect of the drop of mercury enclosed within the bulb upon the candle-power and efficiency of the lamp?
2. What is the exact explanation of the increase in the amount of light obtainable from an ordinary carbon filament?
3. How do the output of light and efficiency of a lamp change during its life?

Dr. Lux soon found that the behaviour of the lamp was quite different according as the lamp was hung vertically from the cap, or burned in a vertical upright position, the cap being at the base of the lamp, the drop of mercury being situated in the hottest or coldest regions of the tube respectively. If burnt in the latter position, the mercury does not readily volatilize, and the lamp behaves very similarly to an ordinary carbon filament lamp, burning, however, at a consumption of 2 to 3 watts per H.K. But when the lamp is inverted the drop of mercury is brought into the immediate neighbourhood of the hot filament, and soon begins to evaporate, and to recondense in the colder regions of the tube.

The lamp reaches a steady state in about five to ten minutes, the carbon filament then glowing in an atmosphere of mercury vapour. The intensity of the light is simultaneously increased and the consumption of power sinks to 1·5 to 1·7 watts per H.K. (horizontal).

Dr. Lux made a considerable number of photometrical observations of the light of these lamps, some of which are given in Table I.

It has been supposed that the greater efficiency of the Hopfelt lamp was attributable to the luminescence of the mercury vapour, and that the lamp thus formed a combination of the ordinary carbon and mercury vapour lamps. Dr. Lux, however, has remarked that if the vapour contributed any marked luminescence to the total light effect of the lamp, the characteristic line-spectrum of luminescent mercury vapour would be visible. Yet careful investigations of the spectrum, carried out with a spectroscope of great dispersive power, revealed no

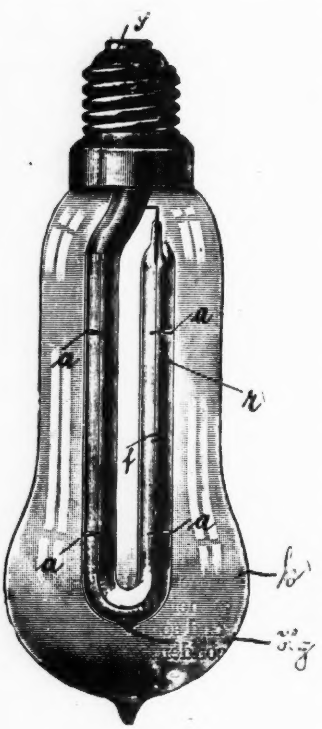


FIG. 3.

such lines. On the contrary, only a continuous spectrum, similar to that yielded by an incandescent solid, was observed.

Dr. Lux had also considered the possibility that the mercury vapour spectrum might have been masked by the considerably brighter continuous spectrum due to the filament. But this suggestion was proved to be incorrect by tipping the lamp so that a little of the mercury came in contact with one or other of the leading-in conductors. When this happened the lines appeared for the moment quite distinctly visible against the background of the continuous spectrum, only to vanish when this globule of mercury had evaporated.

Moreover, no dark *absorption lines*, due to the presence of mercury vapour, were ever discernible, as might have been expected. It is therefore legitimate to conclude that the mercury vapour in the tube does not luminesce, though it is still possible that the mercury vapour gives out light by being carried up to the temperature of incandescence. When actually looking at the lamp one observes a filament about 0·3 mm. in diameter, apparently surrounded by a luminous haze about 5 mm. in diameter. It must also be stated that the light from the Hopfelt lamp appears to the eye white, like that from the metallic filaments. Finally, the relatively small value of the current—about 0·7 amperes would not seem sufficient to cause any regular ionization of the mercury vapour, ionization being known to require a current of the order of 2 amperes.

On these grounds Dr. Lux comes to the conclusion that the mercury vapour does not contribute *directly* to the increased output of light, and explains its indirect action on the assumption that it forms a warm jacket round the filament, and so reduces its rate of radiation. As a result the temperature of the filament is increased, and, when it is remembered that the light is proportional to the *fifth power* of the temperature of incandescence, it will readily be understood that a relatively small increase in temperature may considerably increase the candle-power of the lamp.

In order to study this question Lux determined the temperature of the filament, both when surrounded by mercury vapour and when burning under ordinary conditions. By bolometric measurements the ratio of the light-energy to the total radiation from the filament were determined in the two cases.

When the Hopfelt lamp was supported by the cap in an upright position, so that no mercury vapour was created, the total radiation received upon a bolometric surface 1 sq. mm. in area and 1 metre distant from the lamp, proved to be $4{\cdot}02 \times 10^{-4}$ watts, while the light energy radiated under the same circumstances was $0{\cdot}13 \times 10^{-4}$ watts. The radiant efficiency was therefore about 3·2 per cent.

When, however, the lamp was inverted so that the influence of the mercury vapour came into play, the total radiation, and light-energy radiated were $4{\cdot}75 \times 10^{-4}$ watts and $0{\cdot}18 \times 10^{-4}$ watts respectively. The radiant efficiency in this case thus worked out to 3·72 per cent.

This increase in efficiency might be easily explained by an increase in the temperature of incandescence of the filament, and hence a shifting of the maximum of the curve of energy radiation nearer the visible range of the spectrum.

The direct determination of the absolute temperature of the filament was carried out by Dr. Lux with a spectrophotometer calibrated by observations of a "black body." By this means the "black body" temperature of the lamp in its upright position was determined as 2155° (absolute), and in its hanging position 2260° (absolute). The corresponding values of the light-intensity were 35 and 43·8 H.K., and this is in fair accordance with the theoretical result that :—

$$\frac{(2155)^5}{(2260)^5} \text{ should equal } \frac{35}{43{\cdot}8}$$

We are therefore led to suppose that the increased intensity of the Hopfelt lamp is simply a consequence of its higher absolute temperature.

In Table II. are shown the performances of a few sample experimental lamps as determined by Dr. Lux.

From these results it will be seen that the consumption of these lamps averaged about 1·7 watts per H.K., and that this consumption remained practically constant throughout the period of the tests. The efficiency of the Hopfelt lamp, as at present manufactured, is thus lower than that of the Osram, and about the same as that of the Tantalum lamp. The inventor, however, is not without hopes of obtaining yet more favourable results. He showed the writer of this article several lamps which burnt at about 0·5 watts per H.K., but admitted that the life of such efficient lamps would be at present only a few hours. On the other hand, an ordinary carbon filament, burned under these conditions, would probably give way in the course of minutes, while metallic filaments similar to those utilized in the tungsten lamps would melt outright. Meanwhile, Hopfelt hopes, with well-prepared carbon filaments, to produce lamps consuming only 1 watt per H.K. and with a life of 600 hours.

It may be inquired whether metallic filaments might not be advantageously employed in the Hopfelt lamp. The fact that these filaments melt at really high temperatures is, however, a disadvantage. Moreover, ionization might be set up between the neighbouring portions of a folded metallic filament, while a filament coiled into

TABLE I.

Lamp No.	P.D. Volts.	Current Amps.	Power Watts.	Lamp supported vertically upright. Intensity (H.K.)	Lamp supported vertically upright. Power Consumption per H.K. (Watts per H.K.)	Lamp hanging vertically. Intensity H.K.	Lamp hanging vertically. Power Consumption per H.K. (Watts per H.K.)
1	125	0·65	80·25	27·5 H.K.	2·9	60·0 H.K.	1·34
2	110	0·60	66·0	27·1 ,,	2·5	41·2 ,,	1·6
3	110	0·61	67·10	27·0 ,,	2·5	42·2 ,,	1·6
4	110	0·66	72·60	35·1 ,,	2·1	48·9 ,,	1·5
5	220	0·47	103·40	35·4 ,,	3·1	64·0 ,,	1·6
6	220	0·48	105·60	37·7 ,,	2·8	69.0 ,,	1·5

the U-tube form would necessitate a tube at least three times as long as that employed with a corresponding carbon one.

Also, although the mercury may rebound quite 5 cms from the wall of the tube when the lamp is briskly shaken, the elastic carbon filament is not broken thereby. This refers to the 120 volt unsupported filaments; the writer has observed that the supported high-pressure filaments can be broken by very violent shaking, owing to the fact that the natural period of the filament is shortened so that it cannot give way to the impact of the agitated drops of mercury. But if metallic filaments, with the exception of the tantalum, were subjected to vibration of this nature they would, of course, be immediately destroyed.

TABLE II.

Lamp.	Volts.	Watts.	Intensity (H.K.)	Watts per H.K.	Burning hours.
a	110	64·9	32·2	2·02	0 hours
	110	64·9	27·6	2·35	50 „
b	110	63·8	30·8	2·06	0 „
	110	64·9	30·9	2·13	58 „
c	110	62·7	31·7	2·03	0 „
	110	67·5	36·0	1·87	58 „
d	110	70·4	39·9	1·76	0 „
	110	71·5	34·4	1·82	120 „
e	110	73·2	46·2	1·58	0 „
	110	73·2	46·3	1·58	120 „
f	110	70·95	39·5	1·79	0 „
	110	72·05	45	1·61	48 „
g	110	70·8	42	1·68	0 „
	110	68·7	41·6	1·65	48 „
h	110	70·4	43·6	1·61	0 „
	110	71·5	44·1	1·62	48 „
i	220	101·2	59·5	1·70	0 „
	220	97·8	47	2·08	95 „
k	220	103·95	64	1·62	0 „
	220	103·5	64	1·62	40 „

Incandescent Glow-Lamps for Signalling Purposes.

GLOW-LAMPS have already often been utilized for signalling purposes, and there are always new possibilities opening out for their use in different directions. One such example is furnished by the new electric signs used on the underground railway to indicate the order of arrival of the next few trains.

Another more familiar example, of course, is the use of small glow-lamps in the telephone exchange.

Other very ingenious applications of the same principle occur in certain American hotels. Glow-lamps fixed in the manager's office must be turned on by employees working on a particular floor by switches in that region, so that the manager has a complete check of the whereabouts of all his staff, and can find any one at any minute should he or she be wanted.

In methods of signalling involving the rapid turning on and off of lamps, the meta'lic filament glow-lamps are at a certain advantage, because the filaments become heated and cool so much more quickly.

The Lighting of Pictures and Picture Galleries.

By G. A. T. Middleton, A.R.I.B.A.

The very important problem of the illumination of works of art, pictures, and picture galleries is one that presents peculiar difficulties and demands very careful consideration. Works of art are created primarily for the gratification of the eye, and it is only reasonable to expect that unique pictures, &c., which are purchased at considerable cost for the benefit of the nation, should afterwards be exhibited under the very best conditions, and illuminated in such a way as to render it a pleasure to look at them.

At present the possibility of extending artificial lighting to such galleries has, perhaps, hardly been sufficiently considered. There are many people interested in art who are rarely free to indulge their taste in the daytime, but would doubtless be glad to study pictures in the evening, if only adequate artificial illumination were provided. Moreover, any one who has had experience of designing facilities for daylight illumination knows how difficult it is to ensure sufficient lighting at all parts of a big building and under varying atmospheric conditions, and on dull days the illumination in certain regions of many of our picture galleries will not unfrequently be found to be quite insufficient to do justice to the pictures exhibited.

Theoretically, artificial light, being under control, ought to enable the artist to secure special effects that he otherwise could not hope to attain. As a rule the appearance of a picture under artificial light is very different from that in the daytime. Many a picture which appears commonplace and dull in the daytime is rendered attractive by artificial lighting, while conversely a picture which is brilliantly effective by daylight often becomes vulgar and obtrusive when illuminated artificially. It is therefore necessary to consider the question scientifically, and to study the object which the artist had in view.

A painter is not bound by conventional rules nor practical considerations, and if, for the sake of composition, a shadow looks best when projected towards the light, so it will very probably be found. Architectural draughtsmen are even greater sinners in this respect than painters, as careful examination of their perspective drawings at the Academy or any other exhibition will show.

When artists attempt to depict artificial light and its effects they invariably treat of located lights, which they employ much as the stage manager of a theatre does his limelight. Their effort is to bring into prominence some particular part of their composition while throwing the rest into shadow. Startling effects are often thus created, and many an interior, if carefully analyzed, will be found to owe much of its effect to methods of lighting which are absolutely impossible in practice.

But when it comes to the actual lighting of pictures hung in a room or gallery the artist's ideal changes. He will probably demand a generally diffused illumination, rather than a centralized light, even though there are many cases in which the latter would be considered preferable from an artistic point of view. In so deciding he is guided by the fact that, unless such a system is adopted, it is almost impossible to avoid reflection of the sources of light off the surface of the picture. In the New Gallery, the Academy, and many others, clusters of incandescent lamps are so placed as to give an effect approximating to that obtained by the admission of daylight through glass skylights. It need hardly be said that it is absolutely essential in a picture gallery to prevent the possibility of the sources of light being so placed as to be troublesome to the eye, in order that the visitor may have nothing to distract him or interfere with his comfort.

In our national collections no artificial illumination at all is used at present, although the reason for this is probably to be found in the deterioration of paintings when exposed to the fumes of combustion emitted by certain illuminants, and also the serious consequences of a fire, rather than in the mere mechanical difficulties involved. At the present time there may be said to be a number of methods by which an approximately uniformly diffused artificial illumination may be obtained. We may, for instance, imitate daylight conditions by suitably grouping our sources of light above diffusing glass roofs, or we may utilize inverted lamps and reflection off a white ceiling. The new Moore vapour tube lamp (see *Illuminating Engineer*, January, 1908) is also said to provide both a very soft and uniform illumination, combined with good colour definition.

On the other hand there are often pictures which require special local lighting by concealed lights in order to show to the best advantage, and one would imagine that the intensity of illumination desirable under these circumstances would depend very greatly upon the nature of the picture. The method adopted in the case of the portraits of past presidents in the meeting room of the Royal Institute of British Architects is an excellent example of this type of lighting.

One question, however, which goes to the very root of picture gallery illumination is that of correct revealing of colour—by "correctness" being generally understood their appearance in diffused daylight. As a rule pictures are painted with the object of being exhibited in daylight, and when their charm depends upon the assembling of harmonious and delicate shades of colour, it will readily be understood that the distorting effect of some artificial illuminants is often anything but pleasant. At the present time there cannot be said to be any general and definite agreement as to which of the existing sources of light most closely resembles daylight, although the enclosed arc lamp, acetylene, the carbon dioxide Moore light, and other illuminants, have all been claimed to be advantageous in this respect.

But perhaps the most important qualities which must be exacted from an illuminant for picture galleries are those affecting the wellbeing and safety of the often priceless and unique pictures exhibited.

The possibility of fire must be reduced to a minimum. An objection that has been urged against gas-lighting is that the products of combustion may gradually affect the pictures. Certainly electricity is free from this suspicion; yet if adequate provision is made for ventilation, including means of carrying away the injurious gases *immediately* they are created, it is probable that gas can be used without serious risk. It is true that gas-lighting has, in several instances in the past, proved to be injurious both to oil and water-colours, but in these cases the lighting was carried out by the old flat-flame burners, and without adequate ventilation. Probably the best plan of all, if gas is used, is to keep the lamp entirely outside the enclosure containing the pictures—to place it outside and above a diffusing skylight, for instance.

There are also many country houses where collections of valuable pictures have been gathered together, and in many such cases neither gas nor electricity is available. Under these conditions, either a small electrical plant will be installed or recourse will be had to self-contained systems of lighting, such as acetylene or petrol-air gas. Here again questions of ventilation and security from fire must be given careful consideration.

When we bear in mind the desirability of keeping historic paintings intact for centuries without their fading or losing their attractive appearance in any way, we can readily understand how small and almost inappreciable changes may gradually take place and eventually cause great mischief. In this connexion the possibility of certain kinds of light causing the colours of pictures to fade must not be lost sight of. It has been proved, for instance, that ultra-violet light is particularly effective in this way, and we should therefore avoid sources of light rich in such rays, or at least take precautions to render them innocuous. It is, of course, also possible that even visible rays exert the same influence to some degree. This is therefore one other aspect of the question on which further information is required, before we can definitely decide on the best variety of illumination for use in picture galleries.

The Illumination of the Galerie Heinemann, Munich.

In the above article Mr. Middleton has emphasized the value of diffused illumination in picture galleries. The illustration shown below, representing one method of achieving this result, may therefore be of interest. It represents the lighting of the Heinemann Picture Gallery at Munich by screened "Regina" arc lamps. We understand that this system of illumination was specially selected with the object of representing the colours as correctly as possible.

The Production and Utilization of Light.

Luminous Efficiency and the Mechanical Equivalent of Light.

By Dr. C. V. Drysdale.

(*Continued from p.* 546.)

In order to find the amount of heat lost by convection a calorimeter was made (Fig. 11), having a hollow conical bottom and a long spiral worm extending to the top, the base being blackened. This was suspended over the lamp under test so that the convection currents would collect in the cone as shown, and heat the calorimeter in their progress along the worm. If then R is the total radiation, and C the convection from the lamp, we have :—

$$R + C = 4{\cdot}18\ W$$

$\frac{\Omega}{4\pi} R + C = \omega \frac{\delta\theta}{\delta t}$ where Ω is the solid angle which the base of the calorimeter subtends at the lamp: ω the total water value of the calorimeter, and $\frac{\delta\theta}{\delta t}$ the rate of rise of temperaure. Tests made in this way appeared to show that the convection loss was not more than 2 or 3 per cent of the total power, and could be neglected in view of the accuracy which could be obtained. Conduction was reduced by having long, heavily insulated leads to the lamp, and was neglected.

The method of forming the spectrum requires a little consideration. As we are not making measurements upon the source A, any absorption in the spectrum-forming devices is of little importance. We have, however, the possibility of anomalous dispersion in a prism or of overlapping spectra with a grating. It has been shown by Nichols that carbon bisulphide, besides being remarkably diathermanous, obeys Cauchy's dispersion formula as far as $\lambda = 2\mu$ or more, and that moreover since its refractive index is closely equal to the square root of its specific inductive capacity, there is no reason to suspect any serious departures from this law in the longer wave lengths. On this account probably the best means of forming the spectrum is by a bisulphide prism, though it would be more satisfactory to have determinations with gratings as well.

The greater number of the observations were made in the yellow-green which was judged by eye to be in the neighbourhood $\lambda = {\cdot}54\mu$ proposed by Guilleaume. Having regard to the fact that the mounting hardly justified accurate determinations of wave length, that the point $\lambda = {\cdot}54\mu$ can hardly be said to have been definitely determined as the point of maximum efficiency, that in the region of maximum efficiency the variation would not probably be great, as was confirmed by test, and lastly, that in order to avoid trouble owing to the Purkinge effect it was considered advisable to work at illuminations not exceeding two or three candle-feet, in which case the bolometer sensitiveness was not very great, it was considered superfluous to determine the wave length with greater accuracy. It may be said that the sensitiveness of the arrangement seemed to allow of the definite detection of half a watt at a distance of about 2 metres.

In making determinations on white light the slit was broadened considerably, and by covering it up from each side successively it could be adjusted so that light passing one edge of the slit gave a very dark red light on the photometer screen, while that from the other edge gave a deep violet light on it. In this case the result produced

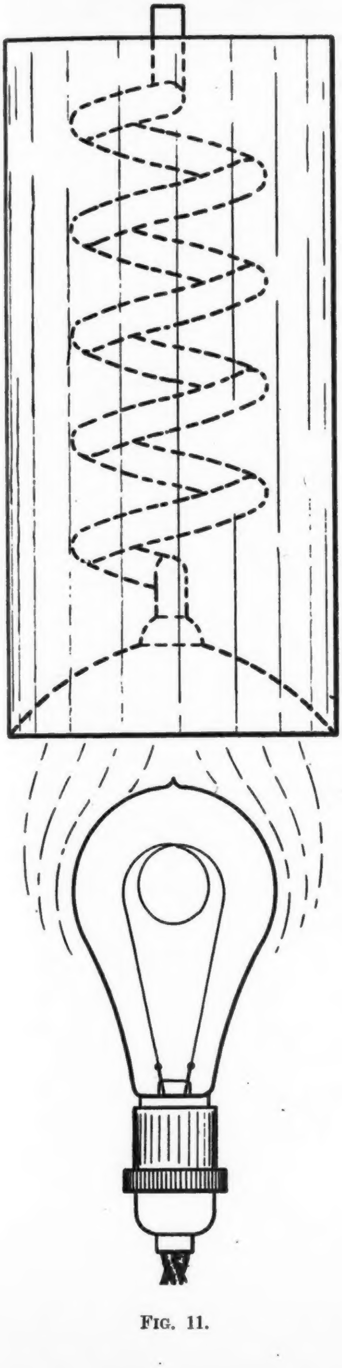


FIG. 11.

by the whole slit was of a pure white light from which all the invisible radiation was cut off.

A number of preliminary observations were taken with arc and Nernst lamps as sources of light, and reversing the photometer box, &c. Considerable trouble was, however, found with drifting of the galvanometer, and this was traced to the presence of the observer. The mean result, however, from 24 observations was ·08 watt per c.-p. After this the whole of the apparatus was removed, the photometer bench, sliding screen, &c., being set up in a dark room through the wall of which an aperture was made for the projection of the spectrum, and a second small aperture for the observation of the photometer. In this way the whole of the observations could be taken without entering the room, and the readings were much more satisfactory.

In Table II. are given the results which were taken in this manner. The observations extended over several days, and changes were made in the intensity of the beam, position of standard, &c., so as to eliminate as far as possible any constant source of error.

The most noticeable feature of the results in Table III. is the progressive decline in the value of the mechanical equivalent. This is due in part to the increasing care which has been taken by observers in defining the limits of the radiation, and also probably to the fact that some of the later values have been take on sources at a higher temperature, in which the dominant wave-length more nearly approached the most efficient value. It is worthy of note that the results obtained in the present investigation for white light from the Nernst lamp agree very approximately with the value given by Angström, while those taken with the arc give a somewhat lower value. The further reduction of the equivalent for the monochromatic source is, of course, what would be expected; in fact, one would rather perhaps have anticipated a lower value, in view of the great inefficiency of the red end of the spectrum. It should be mentioned that during the preliminary observations a few values were successively obtained on one occasion as low as those given by Russner, but there were many disturbing elements present. The value of ·06 for the mechanical equivalent found by us may probably be accepted as a fairly close one, although small sources of error such as convection, scattering, &c., if eliminated, would tend to reduce the value. It would appear of great importance that the investigation should be repeated, using exactly the same method, but with more refined apparatus, and the writer hopes to be able to do this shortly. In the meantime, however, we may conclude that an ideal source of white light should give us at least 10 candles per watt, while if monochromatic, nearly 17 candles per watt should be obtained. At the present time, therefore, the carbon filament glow-lamp, taking 4 watts per candle, has an efficiency of about 2·5 per cent in terms of the ideal white light, or about 1·5 per cent as compared with the monochromatic

TABLE II.—OBSERVATIONS ON THE MECHANICAL EQUIVALENT OF LIGHT.

(a) *Light approximately monochromatic, yellow green.*

Standard Lamp.		Comparison Lamp.				Mechanical Equivalent.
Distance. d.	Candle Power. K.	Distance. D.	Current. Amps.	P.D. Volts.	Watts. W.	$M=\frac{W}{\cdot 78K}\left(\frac{d}{D}\right)^2$
80	24·5	116·7	·145	31·8	4·61	·0555
80	24·5	166·7	·13	29·0	3·77	·0455
70·6	24·5	165·5	·15	32·6	4·9	·0468
78·0	20·6	165·5	·145	31·8	4·48	·0620
78·0	20·6	165·5	·16	34·5	5·52	·0765
78·0	24·5	165·5	·17	36·2	6·15	·0715
85·0	24·5	165·5	·15	32·4	4·85	·0670
76·3	24·5	165·5	·155	33·2	5·15	·0573
76·3	20·6	165·5	·145	31·6	4·58	·0605
76·3	24·5	165·5	·15	32·2	4·83	·0536
57·4	24·5	165·5	·23	45	9·9	·0622
121	24·5	165·5	·095	32·2	2·11	·0590
					Mean.	·0598

(b) *White Light from Wide Slit.*

Standard Lamp.		Comparison Lamp.				Mechanical Equivalent.	
Distance. d.	Candle Power. K.	Distance. D.	Current. Amps.	P.D. Volts.	Watts. W.	$M=\frac{W}{\cdot 78K}\left(\frac{d}{D}\right)^2$	
149	16·0	206	·115	26·3	3·03	·127	Nernst filament
86	13·0	263	·225	47·0	16·6	·1115	
					Mean.	·1193	
76·1	16	263·5	·23	47·5	10·9	·073	Arc.
75·0	16	263·5	·25	50·5	12·6	·082	
89·6	24·5	166·5	·16	34·4	5·5	·0835	
89·6	24·5	166·5	·16	34·4	5·5	·0835	
					Mean.	·0805	

Table III.

Mechanical Equivalent of Light.

From Observations on Luminous Efficiencies.

Source.	Mechanical Equivalent. (Watts per Hefner.) E. Merritt.	J. Russner.	W. Wedding.	H. Lux.
Hefner Lamp				·108
Petroleum Lamp			·0289	·105
Alcohol Lamp			·001155	
Acetylene Flame				·103
Incandescent Gas Light			·00226	·037
Hydropressgaslicht }				
Lucas Light }			·00715	
Millenium light }				
Carbon Filament Lamps	A. ·18	I. ·018	·0104	·085
,,	·252	II. ·020		
,,	·171			
,,	B. ·4405			
,,	C. ·271			
,,	D. ·324			
Nernst Lamp			·016	·073
Tantalum Lamp		·029		·080
Osmium Lamp		·035	·00967	
Osram Lamp		·033		·075
Arc Lamps, D.C.			·00161	·047
,, D.C. enclosed				·021
,, A.C.				·038
Flame Arc, yellow				·041
,, white				·031
Uviol Mercury Vapour				·015
Quartz Lamp				·014

Mechanical Equivalent of Light.—Collected Values.

Observer.	Date.	Method.	Source.	Unit.	Mechanical equivalent. Calories per second. Per Hefner.	Calories per second. Per C.P.	Watts. Per Hefner.	Watts. Per C.P.
J. Thomsen...	1863	A.	Sperm candle	Sperm candle, 8·2 grammes per hour	0·065	0·0733	0·276	0·3075
	,,	,,	Moderator lamp...		0·0585	0·065	0·245	0·272
	,,	,,			0·0615	0·0683	0·257	0·286
	,,	,,	Gas flame...........		0·063	0·070	0·264	0·293
	,,	,,			0·0553	0·0615	0·232	0·258
O. Tumlirz and Krug	1888	A.	Incandescent platinum wire	Hefner	0·041	0·0455	0·1715	0·19
O. Tumlirz...	1889	A.	Hefner lamp.........	Hefner	0·0455	0·0505	0·191	0·212
K. Ångström	1903	C.	Hefner lamp.........	Hefner	0·0259	0·0288	0·1085	0·121
Writer and A.C. Jolley	1907	C.	Nernst filament ...	Candle	0·0256	0·0284	0·107	0·119
	,,	,,	Arc	,, ...	0·0173	0·0192	0·0725	0·0805
	,,	,,	Monochromatic, yellow-green......	,, ...	0·01285	0·0143	0·0538	0·0598

Method A.—Thermopile and absorptive screens.

Method C.—Direct measurement of energy in spectrum.

In this table the Hefner has been taken as 0·90 C.P. See Paterson, 'Proc. Inst. E. E.,' vol. xxxviii. p. 286, and Fleming, p. 311.

source. The Tungsten lamp, which may be taken as having a power consumption of about 1·25 watts per candle has an efficiency of 8 per cent in terms of white light, or of 5 per cent in comparison with the monochromatic source. It is hardly probable that very much better results than this will be obtained by incandescence methods, unless bodies can be found having a very selective emission.

In conclusion, it is of some interest to deduce from this result the amount of power required to stimulate the sensation of vision. If we take a candle at a distance of a kilometer this corresponds to an intensity of radiation of $\frac{6 \times 10^5}{4\pi \times 10^{10}} = 5 \times 10^{-6}$ ergs per sq. cm. per sec. approximately. Taking an equivalent pupillary diameter of 5 mm., or about ·19 sq. cm., this gives $9{\cdot}5 \times 10^{-7}$, or about one millionth of an erg per second, or 10^{-13} watts as the amount of power received by the retina. Similarly the amount of power per sq. cm. of an illuminated surface, required to render it visible, could be calculated. Drude* states that a star of the sixth magnitude is equivalent to a Hefner at a distance of 11 k.m. This gives $\cdot 7 \times 10^{-8}$ ergs per second as the minimum stimulus for vision.

* 'Theory of Optics,' p. 486.

(*To be continued*).

The Bureau of Illuminating Engineering of New York.

We have received a letter from Mr. A. J. Marshall, well known as an illuminating engineer in the United States, informing us of his appointment as the Consulting and Chief Designing Illuminating Engineer to the Bureau referred to above,

Although the Bureau has been in existence for about two years, yet its wide and impartial method of treating problems of illumination has won wide recognition, including that of the United States Government, who have availed themselves of the services of the Bureau in the lighting of some of the Federal buildings.

Development of the Helion Lamp.

Mr. Walter Clark, in a recent letter to *The Illuminating Engineer*, mentions that considerable progress has been made by Prof. H. C. Parker and himself in the development of the helion lamp. This lamp, it will be recalled, utilizes a filament composed of a carbon core coated with a deposit of silicon, &c., by a special process, and is intended to burn at about 1 watt per c.-p.

We understand that it has now been found possible to burn these filaments in the open air without any enclosing globe whatever. Mr. Clark has kindly promised to send us a special communication on the subject very shortly, and we postpone reference to these interesting results until further details are available.

The Visit of the Société Technique du Gaz.

In our last number we referred to the visit of some of the gas engineers of this country to Berlin, where they were entertained by the Deutscher Verein von Gas- und Wasserfachmännern.

More recently about eighty of the members of the corresponding French society, including M. Coze, the president, paid a visit to this country, and were received and welcomed by representatives of the British gas industry. International greetings of this kind are becoming more and more common, and we need only again express our conviction of the immense value of these opportunities of meeting on the part of those representing different nations, and the feeling of good-fellowship to which they give rise, quite apart from the valuable information which those taking part are bound to receive.

The Development and Present State of Stage-Illumination

ONE would naturally be inclined to suppose that the modern cultured individual, living in an age of steam and electricity, and having at his disposal many sources of light of many different kinds, would apply this light with the object of enabling surrounding objects to be seen as they really are. An illustration that this is not invariably so is afforded by the objects and application of artificial light in theatres. Now, in this case light is mainly employed with the deliberate intention of creating illusions, and of presenting them in a complete fashion that would be impossible by ordinary daylight illumination.

Theatres, complying with the high standard of the present day in the matter of scenic pictures, almost invariably utilize electric light. For electric light enables the countless and varied manifestations of natural daylight illumination to be imitated with a completeness that can be attained by no other artificial illuminant. Indeed, electricity is now so invariably utilized for stage illumination that it is hardly necessary, in what follows, to dwell upon the claims of other systems of lighting.

The introduction of electricity on the stage not only led to a complete revolution in apparatus for illuminating, but also in all other existing stage implements. We may therefore take this stage in the progress of theatre-lighting as a starting-point in the present discussion. When we consider what enormous labour was necessary in order to secure even the simplest and most necessary illumination effects previous to the introduction of electric light, it seems almost incredible that there should still exist at the present day theatres in which no use is made of electric illumination on the stage.

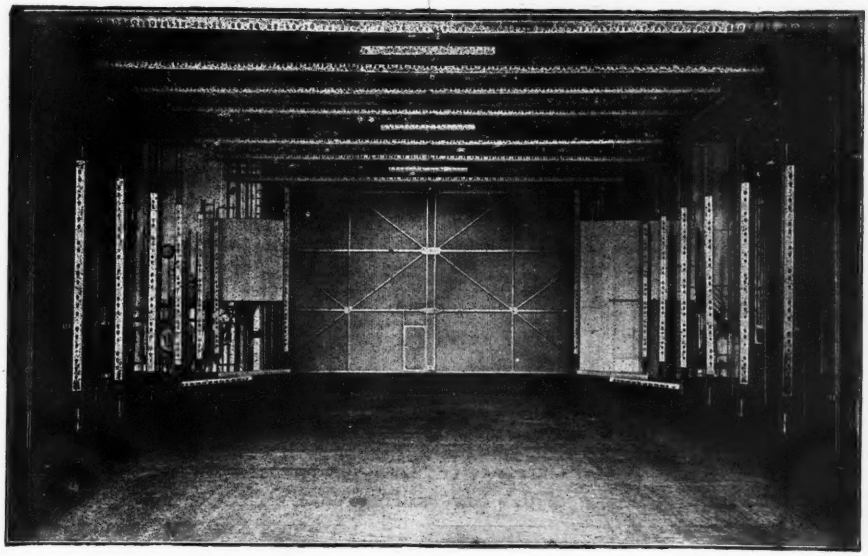


FIG. 1.

Previous to the introduction of gas

lighting, which found common application for stage purposes about the year 1830, it was usual to illuminate both stage and auditorium by means of oil lamps; we can therefore readily understand what difficulty was experienced in satisfying even the modest expectations of the public of that day.

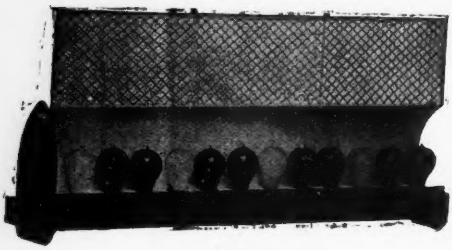


FIG. 2.

The functions of the arc light were then carried out by means of the Drummond limelight. Although the inconvenient and occasional dangerous nature of this illuminant were realized, it was only abandoned in the year 1880, when Siemens and Halske brought upon the market the first arc-lamp adapted to stage requirements. Subsequently the combination of arc and gas lighting was looked upon as the ideal method of stage-lighting. It was only in 1882, when the electric incandescent lamp came into use, that the disadvantages of gas lighting on the stage (development of heat, danger of fire, lack of flexibility and ease of regulation), were fully realized, and it was abandoned in favour of the new illuminant in all the larger theatres. From this point onwards a new era in stage illumination may be said to have commenced.

Stage lighting by electricity may be divided into two chief groups, namely:

1. *Glowlamp Illumination.*—In this category may be placed the footlights, the fixed lights in foreground, sides, and wings of the stage, and also the various portable fittings.

2. *Arc-light Illumination.*—In this class are included the searchlights ("limelight" as it is still usually termed), and many lamps for producing special effects, such as artificial lighting, &c.

1. GLOW-LAMP LIGHTING.

The illumination of most stages is, in the main, carried out by means of glow-lamps, which are utilized either in one, or in two, three, or four colours according to the size of the stage. The unicolour system, according to which only white lights are used, only comes in for consideration in the case of small or special stages and in amateur performances. In the case of all large or even medium-sized theatres, in which great demands upon the apparatus for producing scenic effects are made, three or four colour systems are invariably installed. In the former case there are four sets of fixtures which are equipped with white, red, blue, and green lamps respectively in equal numbers; in the latter yellow lamps are installed in addition. The different systems employed are subject to separate control, all the lamps, however, having a common return lead.

In considering the various types of fixtures employed on the stage we may distinguish between: foreground lights, which are utilized in the front portions of the stage; overhead lights, which are mounted in suitable reflectors, throwing the light downward, above the stage; side lights and lights in the wings. There are also a number of portable systems of lights which may

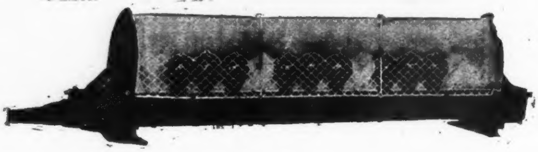


FIG. 3.

be stood on the stage in any desired position. Fig. 1 will enable a clear idea to be formed of the arrangement of some of these fixtures. It represents the general appearance of the stage seen from the extreme back, behind the curtain, of one of the largest German theatres.

The foreground lights are either built in the form of a permanent fixture, as is shown in Fig. 2, or take the form of portable arrangements of the kind shown in Figs. 3, 4, and 5.

The footlights, of course, form the boundary between the stage and the auditorium, and are distributed on either side of the prompt box. The footlights are intended to produce an evenly distributed light such that all persons and objects on the stage within a height of 2 metres are illuminated. In the interests of the actor an extravagant use of footlight illumination is to be deprecated. Light striking the eye from below in this way is very injurious. The author is inclined to think that irritation of the eyes of actors is more often to be attributed to this cause than to the effects of high general illumination, which is inevitable on the stage. Moreover, illumination by means of footlights may give rise to stripes and shadows, which cause effects which are often inconvenient and even comical. For instance, it may happen that shadows are cast on the actor's face by the ends of his false beard, with the result that he appears to the spectator to be equipped with two beards.

The overhead lights (Fig. 6), are mounted in such a way as to be capable of rotation about a horizontal axis, and can be fixed at any desired angle. The side lights (Figs. 7 and 8) are capable of a similar adjustment, and the light from them may be directed into the wings at any desired angle. For the production of bright sunlight glow-lamps of specially high candle-power are sometimes mounted over each side light; by this means a suitably high uniform illumination is produced over the entire stage, which can be strengthened or weakened between the desired limits.

The portable lights are arranged in various ways, some in the same form as the side lights shown in Figs. 2 and 3, others on suitable tripod stands of the

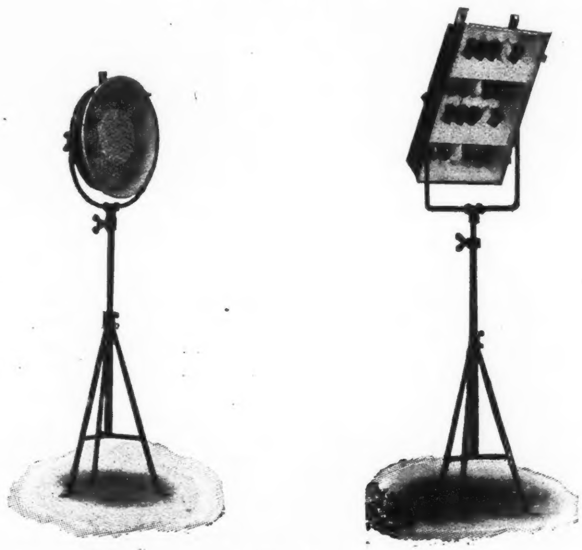


Fig. 4.

kind shown in Fig. 4. Here again a distinction is drawn between stands provided with lights of one colour and stands in which lamps in groups of three or four colours are mounted. Such a stand can be placed anywhere on the stage, the connexion to mains

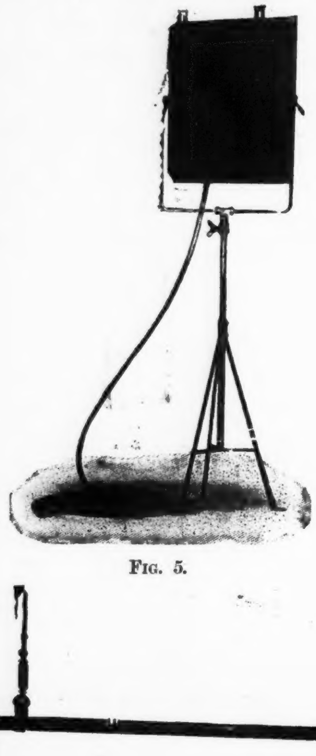


FIG. 5.

require individual illumination, in order to achieve some special effect.

An example of the total lamp equipment of a modern theatre is furnished by the table at the conclusion of this article, which refers to the Opera House at Frankfort-on-Main. The sum total of the intensities of the glow-lamps used on the stage alone amounts to 74,502 H.K.

ARC-LAMPS AND APPARATUS FOR THE PRODUCTION OF SPECIAL EFFECTS.

By "effects" we usually understand the production of illusions by special means, and the imitation of special natural phenomena. Strictly speaking, the moonshine, sunrise, dusk, &c., should be included among these. As, however, these latter effects are mainly dependent upon the use of suitable rheostats and regulating devices, also used for the general illumination of the stage, the arrangements for their production are not considered as belonging to the apparatus for furnishing special effects.

This "effect lighting," in contradistinction to the main lighting of the stage, is chiefly accomplished by the use of arc-lights. Scenic effects commonly involve the use of searchlights and projectors. Notable instances of

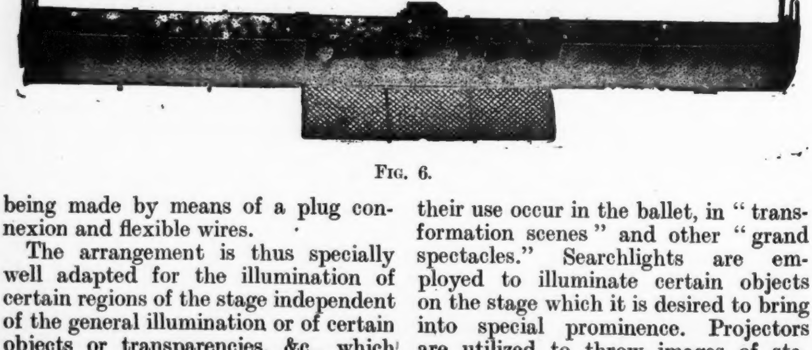


FIG. 6.

being made by means of a plug connexion and flexible wires.

The arrangement is thus specially well adapted for the illumination of certain regions of the stage independent of the general illumination or of certain objects or transparencies, &c., which

their use occur in the ballet, in "transformation scenes" and other "grand spectacles." Searchlights are employed to illuminate certain objects on the stage which it is desired to bring into special prominence. Projectors are utilized to throw images of stationary and moving objects upon a screen, and so simulate the appearance of driving clouds, falling snow, rain, rolling waves, or the rising of the moon, &c. Besides being as freely movable as possible about vertical and horizontal axes, these pieces of apparatus must also be capable of standing firmly on a very narrow pedestal and of being fixed in certain positions on the stage that are not readily accessible by other means. By means of special clamps they can also be firmly attached to tables or other objects without requiring any additional under-support. An adjustable rheostat is introduced into the circuit for the purpose of controlling the light.

As a rule the searchlight and the projector are not in use simultaneously. Consequently an adjustable combined piece of apparatus is used which can serve either purpose, and really is equivalent to doubling the number of searchlights or projectors available.

Combined arrangements of this kind are shown in Figs. 9 to 12. For the purpose of modifying the colour of the light emitted screens of the four shades of colour commonly used on the stage are provided. When it is desired to change colours suddenly—in a snake dance, for instance—these coloured screens are mounted in suitable opaque supports, and are rotated by hand about a horizontal spindle in front of the objective of the instruments as shown in Fig. 9.

In order to simulate clouds, rain, &c., transparent screens, on the face of which the desired quality of clouds, &c., are painted, are used. These transparent screens are mounted in a cylindrical vessel and driven by clockwork.

Fig. 7.

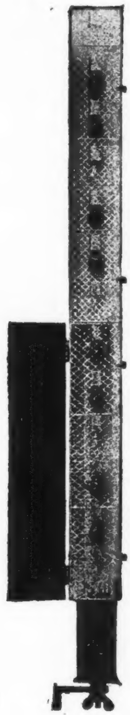


Fig. 8.

In this connexion reference may be made to a novel device, having for its object the exact imitation of daylight. The new method seems likely to effect a complete revolution in the previously employed methods of attaining this end.

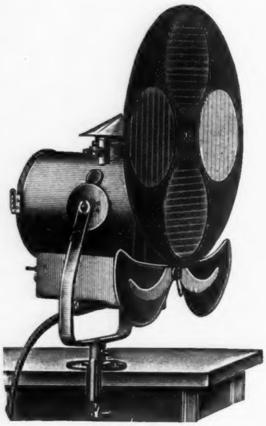


FIG. 9.

Hitherto it has been usual to utilize the light from glow-lamps for the purpose, which, however, are not entirely suitable on account of the fact that the yellow tint of the light yielded by them differs considerably from the whiter sunlight. Hence it has recently become customary to use the arc-light for this

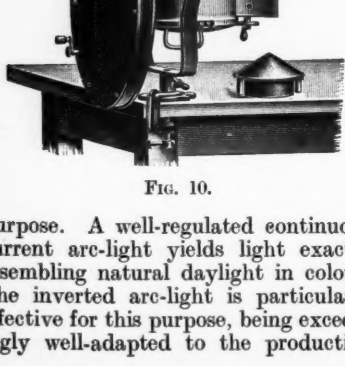


FIG. 10.

purpose. A well-regulated continuous current arc-light yields light exactly resembling natural daylight in colour. The inverted arc-light is particularly effective for this purpose, being exceedingly well-adapted to the production of delicate shades of colour. According to the Fortuny system, the light from the arc-light is thrown upon suitably coloured silk surfaces, and thence reflected on to the stage. A further advantage of the system is that, with an arc-lamp one can, owing to the economy of arc-lamps, with the same current-consumption obtain about two to three times the intensity that is possible in the case of carbon filament glow-lamps.

We must not forget to mention the special arrangement of lamps for the production of lightning. To produce

FIG. 11.

this effect a series of arc-lamps are spaced in the gaps among the overhead lights, and can be lighted up one after another in rapid succession by the use of a special quick break switch. Portable "lightning lamps" are also sometimes placed in different positions on the stage, with the object of accentuating the illusion.

Stage Regulating Resistances.

The regulation of the entire lighting of a theatre, both as regards colour and brightness, is accomplished by special regulating resistance—one of the most important pieces of apparatus used on the stage. In this resistance the control of all the various groups of lamps is centralized, so that any group can be dimmed or extinguished at will. In order to render this result possible separate resistances are placed in series with each individual group of lamps, and the steps by which the resistance can be varied are so finely divided as to enable an infinite series of gradations between darkness and complete brightness to be produced.

Fig. 12.

Space does not allow of a complete description of this piece of apparatus, but an idea of the size of the whole arrangement will be gathered from Fig. 13. Very complete control over the whole effect is obtained by utilizing a large number of separate systems of lamps spaced about the stage and all separately adjustable. As a result it is possible to vary not only the intensity, but also the colour of the light from each, and not only to gradually alter the general illumination, but to secure any desired shade of colour, and a very gradual transition from one colour to another.

The position of this regulating resistance must be such as to enable the operator to view the entire stage, and, possibly, the auditorium, so as to observe the exact effect of any alteration in the illumination on which he is engaged. It will be seen that the position of the resistance in Fig. 13 allows this to be done.

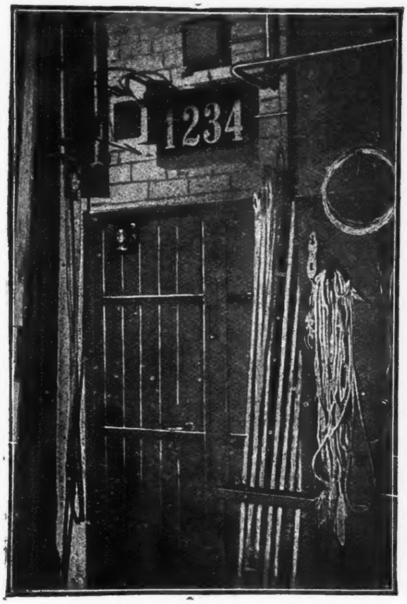


Fig. 14.

Signalling Lights and Apparatus.

Special importance attaches to the methods of signalling employed in a modern theatre. Such signals are commonly conveyed by the lighting up or extinguishing of white or coloured glow-lamps, by which instructions as to lowering or raising of pieces of scenery, trap-doors, curtains, &c., are given or messages from the stage manager, conductor of the orchestra, or prompter communicated.

Among these may be mentioned an electrical device for beating time by the aid of which the conductor can give the time to those standing in many different positions of the stage. A number of glow-lamps—two, three, or four as the time may demand, are utilized to illuminate certain parts of a screen, visible to all the performers. This arrangement is shown in Fig. 14. The lamps are controlled by the conductor, being lighted and extinguished as he presses or releases certain

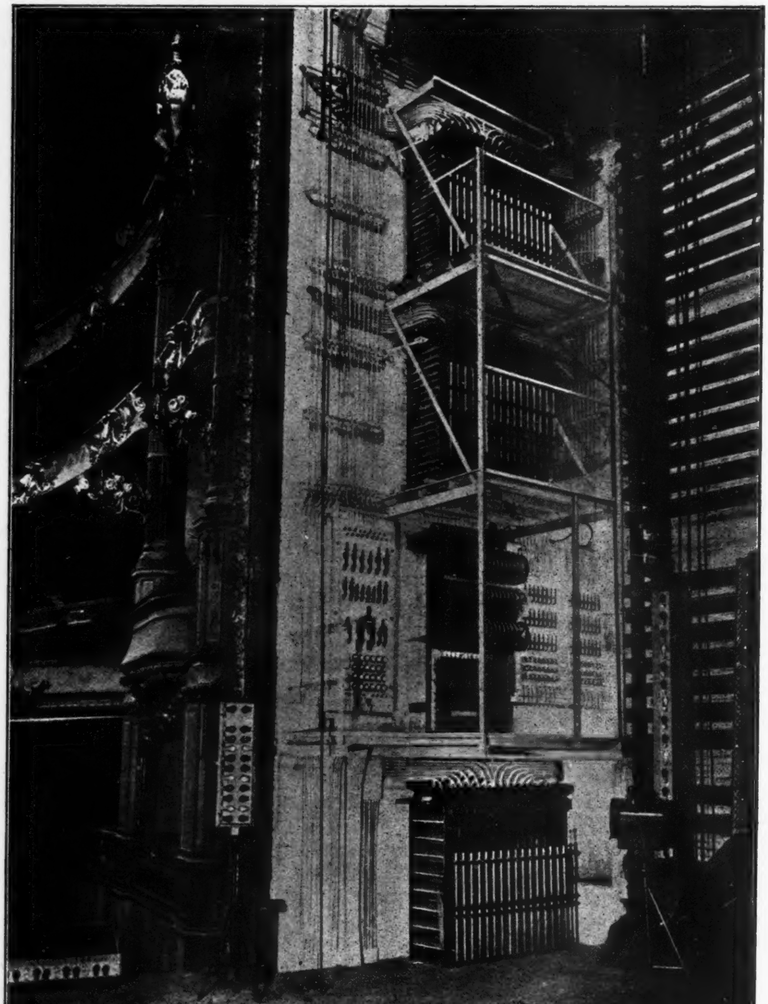


FIG. 13.

TABLE I.

Showing the number of glow-lamps in use for various purposes on the stage of the Opera House at Frankfort-on-Main

Number.	Nature of Fitting.	Length of each Reflector m.	Number of Lamps.				
			White 32 c.-p.	White 25 c.-p.	Red 25 c.-p.	Blue 25 c.-p.	Yellow 25 c.-p.
1	Foreground ...	12	26	—	26	26	26
6	Wings	16	—	144ea=864	—	—	—
6	,, ...	16	—	—	52ea. =312	52ea. =312	52ea. =312
1	Wing	10	—	86	—	—	—
1	,, ...	10	—	—	32	32	32
2	Front Side-Lights	5	22ea. =44		22ea. =44	22ea. =44	22ea. =44
1	Rehearsal Lights ...	2	20	—	—	—	—
12	Portable Front Side-Lights	1	10ea. =120	—	—	—	—
12	Portable Front Side-Lights	3	7ea. =84	—	7ea. =84	7ea. =84	7ea. =84
2	Portable Lights with Conical Reflector	—	10ea. =20	—	—	—	—
2	Portable Lights with Conical Reflector	—	19ea. =38	—	—	—	—
2	Portable Lights (4 colours) ..	—	7ea. =14	—	7ea. =14	7ea. =14	7ea. =14
2	Portable Lights (1 colour)	—	10ea. =20	—	—	—	—
			386	950	512	512	512

Total Number of Lamps, 2,872.

keys. On account of the rapidity with which such lamps light up and go out again, metal-filament lamps are specially adapted for this purpose.

In this article, which deals exclusively with stage illumination, no attempt has been made to describe the many other interesting applications of electricity to the stage. In conclusion the author wishes to express his acknowledgment of the courtesy of Messrs. Siemens Bros., Ltd., who kindly furnished blocks for the illustration of this article, and gave information on many points of interest.

F. S.

The Methods of the Stage Applied to Shop Lighting.

THERE are many practical cases in which the salesman would do well to take a leaf from the book of stage-craft in arranging the goods he is trying to induce the public to buy.

He is not, of course, expected to devise mechanically driven moons, snowstorms, or moonlight. But yet he is faced with a similar problem to that met with in stage lighting—namely to arrange his windows so as to attract and hold the attention of the passer-by who constitutes his "house." Therefore his display must be at once striking and pleasing to look at.

Some of the best methods of shop lighting involve the use of lights in a manner analogous to footlights on the stage, and there is room for endless possibilities in the way of directing the light so as to call attention to certain exhibits, and in the judicious use of transparencies and other luminous devices.

On Shades and Reflectors and the Diffusion of Light.

THE last few years have led to remarkable progress in the efficiency of artificial illuminants, and the attention which is now being bestowed on methods of using and distributing light is leading to, at least, equally valuable results.

Naturally it is of little use to be able to produce light efficiently if the light we have been at such pains to produce is wasted in an inefficient globe or fixture, or is allowed to cause actual injury or inconvenience to those whom it is intended to benefit. From this point of view the design of the actual lighting fixture in which the lamp is installed may be seen to be very important indeed. The increasing intrinsic brilliancy of the new illuminants almost compels the consideration of the proper placing and screening of sources, and their greater efficiency also enable us to make some economical sacrifice, in order to obtain pleasant working conditions.

In arranging lights in a room, and in designing shades and fixtures, we have usually a two-fold object in view. In the first place we wish to protect the eyes from the fierce brightness of the unshaded source of light. Secondly, we wish to concentrate our light in the directions in which it is most needed.

The use of diffusing globes, made of opal or frosted glass, &c., and reflectors, has certain definite advantages. Prof. Basquin has estimated the average brightness of the sky at about 2·5 candle-power per square inch, and Dr. Louis Bell has given 5 candle-power per square inch as the maximum permissible limit. Evidently, therefore, supposing that the light from the source is distributed evenly over the surrounding globe, there need be no difficulty in providing a shade of sufficient superficial area to bring its brightness per unit area below the permissible limit, at any rate, in the case of lights below 100 candle-power, such as are used in most interiors.

There are, however, other points to be considered which render the use of opal glass, frosted glass, &c., in itself hardly sufficient, though this method may be very useful in connexion with other devices. In the first place it is inevitable that if any such glass is sufficiently dense to cause the entire surface to be evenly illuminated it must absorb a considerable amount of light—it is known that very dense glasses of this kind may absorb upwards of 50 per cent. Researches by Hyde and Cady have likewise shown that the useful life of lamps with frosted globes is very

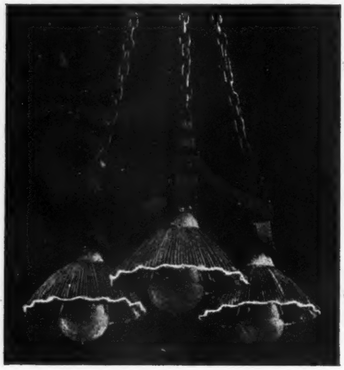


FIG. 1.

seriously diminished. Secondly, it is clear that in the case of shades of this description the *distribution* of light from the source is not under control. For the globe may become an illuminating source, radiating light evenly in all directions, or, if it is not sufficiently dense to appear evenly illuminated all over, we merely obtain a polar curve of distribution intermediate between that corresponding to the above conditions and that of the source of light itself.

A more perfectly scientific method of diffusing and distributing light lies in the development of globes and reflectors made of cut glass.

Cut-glass shades, which are not contrived on scientific principles, are objectionable in many ways. They are often of very little real service in diffusing the light, only breaking it up into irregular bright patches which annoy the eye almost as much as the bright surfaces they are intended to screen. In addition to this the thickness of the glass, and the fact that the cut edges, being placed hapazard, often reflect the light to and fro within the globe instead of allowing it to escape, are often responsible for a considerable loss of light.

For the scientific development of glassware of this description great credit is due to the Holophane Co., who have put on the market an extraordinary variety of shades and reflectors, all intended to produce certain specific effects. We do not propose, in the present article, to enter into a detailed description of the scientific principles underlying fixtures of this class. Briefly their object is attained by the use of ribbed or prismatic glass, in which these ribs or prisms are so shaped as either to bend and transmit the light in any desired direction, or to totally reflect it. Glass made on these principles may, therefore, either be utilized as a reflector or as a transmitting shade. In either case the light can be either evenly diffused or concentrated in any direction, according to the nature of the shade or reflector employed, and the loss of light has been found to be a minimum, being, under favourable conditions, as low as 10 per cent.

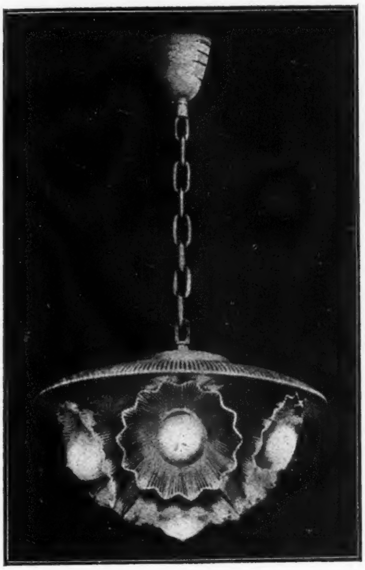


Fig. 2.

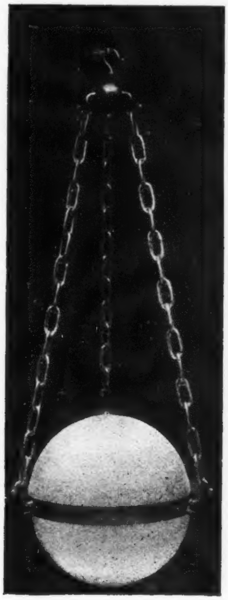


Fig. 3.

In Fig. 1 is shown an illustration of the use of these reflectors with frosted tungsten lamps, in order to concentrate the light in a downward direction. Fig. 2 shows a similar arrangement applied to a cluster of tungsten lamps, and termed a "holophane arc."

An entirely different type of fixture is the diffusing globe shown in Fig. 3. These globes are made in various sizes, so as to include one or more lamps of different candle-power. When in use they appear evenly illuminated all over; they may, however, be so constructed as either to throw most of the light downwards, or upwards on to the ceiling, as may be required.

A verandah illuminated by a series of globes of this kind is shown in Fig. 4.

In choosing these holophane globes and reflectors special attention should be paid to the exact purpose for which they are intended, and the type of lamp with which they are to be used. For example, standard types of shades and reflectors are designed for use with tantalum or osram lamps, incandescent mantles, &c., and can be arranged either to distribute the light or to concentrate it immediately below the lamp, as required.

One feature of the development of shades and reflectors in the United States, which is worthy of special mention, is the standardization of certain "units," that is, the design of a certain diffusing globe or reflector only supplied in conjunction with a certain type of lamp—fixture, shade, and lamp complete.

The result of establishing a system of this kind is that naked filament lamps fall out of fashion, and it becomes a recognized and accepted fact that a lamp must always be provided with a suitable shade so as to diffuse and distribute its light to the best advantage.

In this article we have only attempted to touch in a general fashion on the subject of reflectors, diffusing globes, and fixtures generally. The subject is now an exceeding important and wide one, and we propose to publish a series of articles dealing with various aspects in greater detail in the near future.

Fig. 4.

The Illumination of Railways by Acetylene.

In the course of this article we propose to study two entirely distinct questions, namely :—

The illumination of railway stations by acetylene.

The illumination of railway carriages by acetylene.

These two problems are really quite distinct, and present different difficulties. In the first case we have to provide illumination for the buildings, platforms, &c., without being obliged to make very exceptional provision for the nature of the place the lights are intended to illuminate, or being greatly concerned with the length of time during which the sources of light will burn without attention. In the second case, on the other hand, we must endeavour to secure above all things that the lights shall burn continuously throughout the entire run of the train, and also to avoid fixtures and apparatus of a cumbersome nature.

The Illumination of Railway Carriages by means of Acetylene.

In the first place it may be understood that acetylene will probably not find application for the purpose of lighting stations, &c., near to large towns, as these will naturally be provided for by gas or electricity. But when we come to consider small country stations, and small towns, which it does not pay to illuminate either by gas or electricity, acetylene finds a useful field of application.

As a matter of fact one finds that many such stations are commonly illuminated by petroleum lamps. However, not only does such lighting cost more than acetylene, but it also entails a large staff to be kept up in order to keep these lamps in proper working condition. As a result it not infrequently happens that small stations are equipped with petroleum lamps which might burn well if properly looked after, but actually go out, smoke, or smell disagreeably because it is impracticable to keep the necessarily small staff of the station constantly engaged upon the wearisome duty of attending to them.

In the case of acetylene, on the other hand, there is no trouble of the kind. All that is necessary is to attend to the apparatus once a day at most, and to change the burner occasionally, in order to secure as bright an illumination as any one could desire. In such a case it is understood that all the lights are fed from the same central generator.

Either acetylene flames or incandescent mantles may be used. The first method is possibly the simpler of of the two ; the second is undoubtedly the cheaper. Both methods are equally applicable to the lighting of the interiors of buildings and to the illumination of platforms.

The progress of acetylene lighting applied to railway stations has been most remarkable in Austria, being generally adopted by the Northern Railway. In France several railways are illuminated by acetylene, and the State railways utilize incandescent acetylene lighting by means of burners of small consumption. In America, acetylene has been adopted not only in stations, but also for signal-lights ; in the latter case dissolved acetylene is preferably employed.

The Lighting of Railway Carriages by Acetylene.

Although the problem of train-illumination is an exceptionally interesting one, and in spite of the fact that a number of experiments in the subject have been carried out by railway companies of recent years, it is only recently that any really practical solutions of the problem have suggested themselves. On the other hand, it is a fact that the methods of lighting in use in trains have hardly kept pace with the great progress that has recently been made in artificial lighting, and for the simple reason that they cannot be easily applied under the particular circumstances called into play.

Leaving out of account acetylene, what other illuminants are applicable for this purpose ? Electricity and gas at once suggest themselves.

It would seem simple enough to apply electricity to train lighting. What is easier than to utilize the engine driving the train to drive a dynamo in addition ? Unfortunately, however, trains are not invariably in movement, and light is still a necessity to travellers even when the train is standing still. Hence it becomes necessary to utilize accumulators to take up the load when the dynamo is not running. Unluckily, again, accumulators are very fragile things.

As usually arranged, the accumulators are charged when the train is running at full speed, and the P.D. of the dynamo rises above that of the cells ; on the other hand, when the train is still, or running comparatively slowly, the cells discharge Thus, owing to the general irregularity in the treatment to which such accumulators are subjected, the plates tend to buckle, and very rapidly deteriorate.

One may, of course, utilize a separate special engine to drive the dynamo. The running of the dynamo, however, would be affected by the vibration and shock of the motion of the train, and also variations in the pressure in the boiler would result in a very fluctuating light.

Fig. 1.—Interior of Railway Carriage Illuminated by Acetylene.

A third possibility would be to light the lamps of the train solely by means of a group of accumulators which are completely charged before the train starts, and recharged when the journey is ended. But accumulators are very heavy, their capacity for a given weight is limited, and it requires a considerable length of time to recharge them. It is also hardly worth while to adopt the laborious plan of replacing the battery which has run down by one newly charged. On the whole it may be urged that electricity is hardly adapted to train lighting.

Coal-gas, burnt by means of flat-flame burners, may also be employed. In order to obtain enough light in the case of a carriage divided into six compartments, we should require ten burners, each burning about 100 litres of gas per hour, or one cubic metre per hour in all. During the winter an ordinary carriage in a night train would, therefore, require about 15 cubic metres of gas. Therefore if we imagine the gas to be compressed under a pressure of ten atmospheres, it becomes evident that each carriage must be furnished with a gas-carrying vessel of one and a half cubic metre capacity, if we wish to avoid being obliged to recharge *en route*. This enormous bulk might be reduced to 300 litres at a pressure of 10 atmospheres, or 3 cubic metres at ordinary pressures, by utilizing incandescent mantles, and would, of course, also constitute a saving in consumption of gas.

But here again incandescent mantles are very fragile, and come to pieces very easily when subjected to the continual jar and shock of the train. The continual renewal adds to the cost of the lighting, but, worse still, the mantles may break during the journey at a time when it is very inconvenient to replace them, and, as the flames used with them give practically no light, the carriage is plunged into sudden darkness.

Four distinct methods of utilizing acetylene for train lighting are in use :

1. Lighting by acetylene gas in the ordinary way, several burners being employed, fixed at convenient positions in the carriage to be illuminated, and supplied from a generating system.

2. Lighting by means of a mixture of acetylene and rich gas (the Pintsch mixture).

3. Lighting by compressed acetylene.

4. Lighting by means of acetylene dissolved in acetone.

We will consider each of these methods in turn.

1. Ordinary acetylene lighting is scarcely used except in American trains. The method, while very convenient for the purpose of lighting a vehicle furnished with four or five burners or more, to be illuminated for six or seven hours at a stretch, is less easy to apply in the case of a railway carriage, in which the great number of burners to be fed and the long time during which they are needed necessitates the use of an apparatus of considerable size for each carriage. Thus, in the case of a carriage lighted by ten burners, each consuming 20 litres of gas per hour, we require 3 cubic metres of gas to last through a winter night. This corresponds to a charge of 10 kilos of carbide, which means a generator inconveniently large. In such a case it would almost be necessary to reserve a special compartment for the generator. However, this method, as we have stated previously, has only been used to any extent in America, where it was considered necessary, cost what it might, to provide each carriage with exceptionally good illumination ; it is no worse than any other method of lighting, but presents no special advantage.

2. Pintsch gas consists of a mixture of 25 per cent acetylene and 75 per cent of a rich quality of gas obtained by the distillation of "boghead," a variety of bituminous shale found in Scotland, France, and Australia. It would be out of place in this article to enter into the qualities of this Pintsch gas. It may, however, be mentioned that the rich gas and the acetylene are manufactured separately at the works, mixed in the desired proportion, and then compressed at 10 atmospheres in enclosing vessels similar to those used for compressed illuminating gas of the ordinary variety. It has been found that, in the case of the Pintsch gas, this pressure is quite safe.

These reservoirs are used to fill suitable vessels placed in each carriage. The pressure in this latter case is 7 atmospheres, the gas being, however, supplied to the burner at a convenient pressure of 55 millimetres of water. The capacity of the vessels employed for the lighting of a single carriage varies considerably, but, as a rule, contain sufficient gas at 7 atmospheres to light all the burners in the carriage for 35 hours. The burners themselves consume 25 litres per hour, and yield a light of about 12 to 13 candles. In France the cost of one " bougie "-hour in the case of Pintsch gas amounts to 0·0017fr., less costly than the rich gas alone, but dearer than acetylene.

Pintsch gas has long been one of the most practical methods of train lighting. It was first employed in Germany, especially upon the Prussian railways. It has also been used in France, on the lines of the Paris, Lyons, and Mediterranean Railway, and in America there are also a number of companies who make use of the method.

However, the Pintsch gas can only be regarded as an intermediate step from rich gas to acetylene. It was a long time before any practical method of reducing acetylene gas to small bulk was devised. Nowadays it is not only possible to compress acetylene, but also to dissolve it and extract it from solution as required. Now that these methods have been brought to a practical stage the Pintsch gas has no longer any valid reason for existence. By the advice of the inventor himself, it has been abandoned in almost all the cases in which it was formerly employed.

3. The apparatus used for lighting by Pintsch gas may also be employed with compressed, but not dissolved acetylene.

Although there is no particular difficulty in compressing acetylene, it is only a few years since this method has found practical application. First of all it would be unwise to propose to store compressed acetylene, as is done in the case of the Pintsch gas, in a vessel containing no solid matter. Under these circumstances acetylene could not be used without danger. In order to compress acetylene with impunity some porous substance is included in the containing vessel, and the pressure is carried up to 10 atmospheres. By taking the precaution to introduce this porous matter, it is possible to use acetylene gas with the old Pintsch apparatus, and thus avoid the expense of total renewal. The change to acetylene carries a double advantage. Not only is the illumination more satisfactory, but, for the same intensity of illumination, the vessel which formerly contained enough Pintsch gas to enable the carriage to be lighted for 35 hours, will hold enough acetylene to last for 175 hours. We may therefore either elect to increase the illumination or to enable the reservoirs to remain for a longer time without recharging.

The storage of acetylene in these vessels is accomplished in exactly the same way as in the case of the Pintsch gas. All that is necessary is to put the vessel in communication with a supply at a pressure slightly in excess of that which will be actually employed.

For this purpose the works are usually provided with reservoirs containing acetone. The possibility of rapid storage is the sole advantage of compressed over dissolved acetylene.

4. Dissolved acetylene is, in the writer's opinion, best suited for the illumination of railway carriages. It may be well to explain briefly in what this process consists. Acetone, a comparatively cheap liquid, possesses the remarkable property of dissolving about 240 times its own volume of acetylene, at a pressure of 10 atmospheres and a temperature of 15 degrees. At atmospheric pressure acetone will only dissolve about 25 times its own volume. Therefore a vessel of acetone, saturated with acetylene gas at a pressure of 10 atmospheres, will liberate 215 times its own volume when the pressure is reduced to ordinary atmospheric value.

In order to avoid danger, acetylene is dissolved in acetone contained in tubes filled with a special extremely light, porous material which absorbs the acetone freely. In such tubes of 1 litre capacity it is possible to imprison 100 litres of acetylene. Therefore we are able to compress very great reserves of acetylene in an exceedingly small pace, which, of course, is exactly what is required in train-lighting.

For long journeys, which are very frequent in America, tubes of great capacity are employed. These tubes are supplied with acetylene at the works, or from portable cisterns sent to various stations on the railway for the purpose. During the process of charging the vessels may remain in position on the train. The charging, however, takes a comparatively long time, and it is, therefore, necessary to arrange to make stoppages at the works or at feeding centres. In the case of short voyages one uses by preference tubes of relatively small capacity, replacing them, as soon as they are empty, by others filled at the works.

Acetylene is burnt in burners of the ordinary variety, consuming 15 to 20 litres of gas per hour. Since the open flame itself has a considerable illuminating power, it is hardly advisable to employ incandescent mantles, on account of their fragility. The mantles are, however, much stronger than those used with ordinary gas.

Lastly, a few interesting instances may be given of the performances of acetylene lighting in trains.

In 1902 the American Lackawanna, and Western Railway Co. decided to equip their carriages with dissolved acetylene. The reservoir containing acetylene was to feed 13 burners. The charging was carried out on March 4th, 1902, and the lighting was assured until May 12th in the same year before it became necessary to recharge. The actual lighting hours were in this case 260.

A train, lighted by dissolved acetylene, which was blocked in a snowdrift on the North-West Line, was able to supply light without interruption for 12 days.

In the year 1902 a very important experiment was undertaken by the following 13 companies: The Delaware Lackawanna Railway Co., Erie Co., Cincinnati Co., Richmond and Muncie Co., Atlanta and West Point Co., Chicago, Rock Island, and Pacific Co., St. Joseph and Grand Island Co., Western Maryland Co., St. Louis South-Western Co., Missouri Railway Co., Kansas and Texas Railway Co., Atchison, Topeka and Santa Fé Railway Co., and the Canadian Pacific Co.

A carriage 21 metres in length was to travel over the lines of these railways. The carriage was to receive a total amount of light of 450 candle-power, furnished by a tube of dissolved acetylene 3 metres long and 0·50 m. in diameter, containing dissolved acetylene at a pressure of 16 atmospheres.

The carriage departed on May 25th from Chicago for Denver, and accomplished the go and return journey 35 times, *i.e.*, a total distance of 137,000 kilometres. The tube was first recharged on Jan. 5th, 1903, and a second time on March 10th. It had furnished light for 140 complete nights; a single charge thus supplied the carriage with light for 70 nights. In consequence of this record several of the companies decided to adopt dissolved acetylene, and all the companies are gradually following suit. At the present time 3,000 carriages are thus lighted in America.

Among other countries in which dissolved acetylene is used on trains we may mention Austria, Italy, and Russia. Most other countries, including France, are at present undertaking tests of the method. R. G.

The Acetylene Convention in Chicago.

THE Eleventh Annual Meeting of the International Acetylene Association will be held in Chicago on August 10th–12th of this year. We understand that some papers of special interest will be read before the meeting, and that there will be visits and social entertainments arranged.

The Meeting of the Societe Technique de l'Industrie du Gaz.

At the thirty-fifth annual meeting of the above society, which took place in Paris from June 23rd to 26th of this year, a number of papers dealing with subjects more or less closely related to illumination were read. **M. Vautier,** well known as the chairman of the International Photometrical Commission which met at Zürich last year, briefly summarized the proceedings of the last Congress, and drew attention to the table connecting the relative VALUES OF THE CARCEL, HEFNER, PENTANE, AND BOUGIE-DECIMALE.

M. Denayrouze described his method of utilizing certain HYDRO-CARBON PRODUCTS from coal-tar FOR INCANDESCENT LIGHTING. Such liquids had previously been utilized in conjunction with alcohol, and more recently pure benzol has been used for the purpose in the form of the Lusol lamps now in use in Paris. M. Danayrouze's system seems to have consisted mainly in the utilization of other liquid derivatives, which are claimed to be exceedingly easy and cheap to manufacture.

M. C. Bachelay gave an account of a form of SAFETY DEVICE FOR SUSPENDED FITTINGS.

M. Berthelon described the SECURITAS APPARATUS, which enabled the gas to be cut off at the meter during the night from a switch in the bedroom by means of pneumatic arrangement. This apparatus is, of course, intended as a boon to nervous people who are afraid of escaping gas in the bedroom, and like to have the gas turned off completely before retiring to rest.

M. Henri Roger explained a form of GAS-LIGHTED LUMINOUS ADVERTISEMENT, in which the gas from the mains was caused to light up and extinguish the sign at regular intervals; the method could also be applied to illuminated signs working in two colours.

M. Meker gave some details of IMPROVEMENTS IN GAS-BURNERS, chiefly centring about the design of the mixing tube, and resulting in a gain in efficiency of about 20 per cent.

M. Laforgue described a number of NOVELTIES IN GAS-LIGHTING. These included some details of the Esperanto mantles, which, it is claimed, yield 120 candle-power initially, and still give 100 after 1,000 hours' burning. Tests by Dr. Bunte were also quoted to the effect that a maximum light was obtained in thirty hours, and retained undiminished for about 150 hours afterwards.

M. A. A. Defoy described the method of LIGHTING RAILWAYS BY INVERTED INCANDESCENT GAS-MANTLES on the compressed oil-gas system used on the lines of the West of France railway. The mantles were stated to have given excellent results, special precautions being taken to reduce the shaking to a minimum, and it was further stated that the method will be extended to all the trains of the company very shortly. The southern and northern railways are also experimenting with the same system, with a view to its adoption.

M. M. E. Thomine read a short paper dealing with HIGH-PRESSURE LIGHTING, and in doing so referred to the progress that had been made in England in this direction, as exemplified by the installations in various streets in London and the Keith lighting, now on exhibition at the Franco-British Exhibition.

M. R. H. Gaulis gave an account of the AUTOMATIC EXTINGUISHING APPARATUS constructed by his own firm in Switzerland, including a distance-extinguisher actuated by waves of pressure from the gas supply.

Economical Aspects of the Various Illuminants.

A RECENT article by A. A. Wohlauer in *The Electrical World* (N.Y.) contains an exceedingly complete and up-to-date review of the relative economies of the various modern electrical illuminants.

The difficulty of deciding upon the best illuminant to be used under certain circumstances is accentuated by the great number of different lamps now at the consumer's disposal. Probably no one would think of utilizing a flame arc for indoor illumination, or a mercury arc in a ballroom. In the same way there are certain qualifications, possessed by certain illuminants, which render them specially adapted to some situation, and might result in the cost being regarded as comparatively unimportant. For instance, incandescent glow lamps might often be utilized to produce some desired decorative effect, on account of their adaptability and the ease with which they can be fitted into any required position, notwithstanding the fact that some other illuminant could produce the same amount of light at a lower cost. Again, we can readily understand that the architect concerned with the illumination of some building of great historic associations might frequently feel that mere efficiency could be disregarded in view of the greater importance of attaining sympathy with the traditions of the past. Subject to

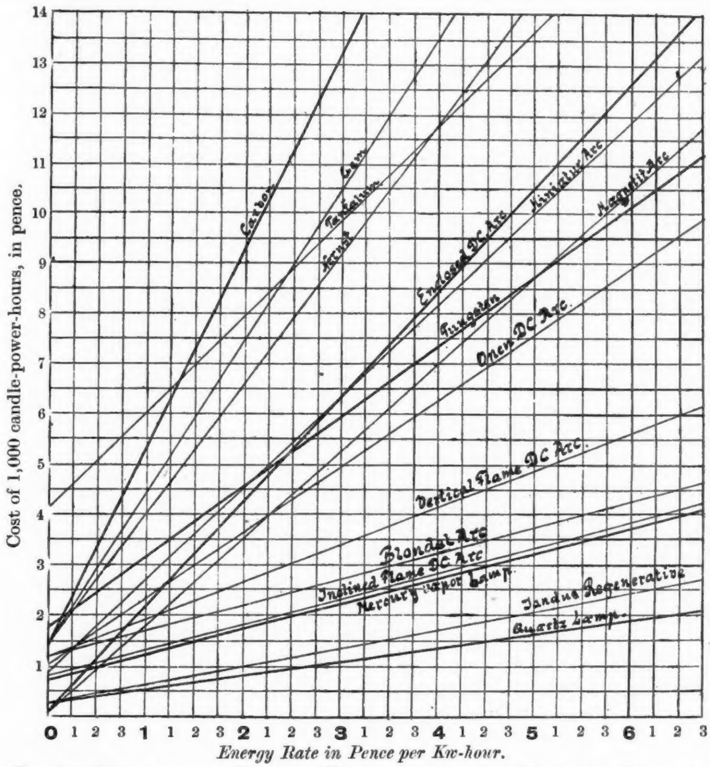


FIG. 1.—CURVE SHOWING RELATIVE ECONOMY OF VARIOUS ELECTRICAL ILLUMINANTS.

certain limitations, however, it may be said that the deciding factor in many practical cases is the question of cost, including both renewals and maintenance and the cost of energy.

Furthermore, the author points out, recent developments have distinctly disarranged and shifted the relative territories of the various lamps. The enclosed arc now finds a formidable competitor in the high candle-power tungsten lamp; the flame arc may prove to have a similar competitor in the quartz-tube mercury lamp, &c.

The author does not consider depreciation and interest on invested capital, as these do not materially influence the cost per candle-power hour, and are, in addition, so dependent on special circumstances as to be outside the scope of general rules.

In the table are shown the relative costs per candle-power hour, reckoning different rates per unit of energy. The results are worked out in terms of the mean spherical intensity of the sources, which the writer regards as, on the whole, the best basis of comparison. It is true that occasionally the mean hemispherical candle-power is most important in an illuminant; but this again involves the reflecting qualities of different reflectors, which vary among themselves very greatly.

The cost of renewal and maintenanee is taken as $\frac{P \times 1000}{l \times L_s}$, where L_s means the mean spherical candle-power,

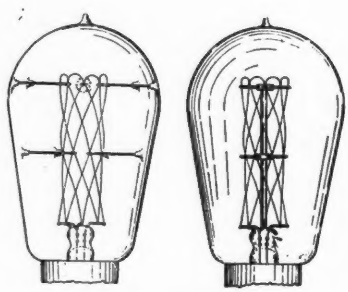
l, life of *lamp* in the case of incandescent lamps; *glower* in the case of Nernst lamps; *electrode* in the case of arc lamps; *vapour-tube* in the case of vapour-tube lamps.

P, price of *bulb* in the case of incandescent lamps; *renewal of glower and ballast* in the case of Nernst lamps; renewal of *electrodes* and *trimming* for arc lamps; *tube* for vapour lamps.

A Recent Patent Referring to Metallic Filament Lamps.

(From *The Electrical World*, May 16.)

A DISADVANTAGE encountered in electric lamps of the metallic filament type resides in the extreme fineness of the filament, which renders them liable to breakage. Mr. Hans Kuzel, of Baden, Austria-Hungary, on May 5 obtained a United States patent for a method of supporting the filaments so as to eliminate the liability to breakage, and to prevent such deformation of the loops of the filaments when hot as to cause short circuits. The filaments are supported from a central stem or from the walls of the bulb by eyelets which are so arranged that the filaments are wound helically, as shown in the diagram.



KUZEL INCANDESCENT LAMP.

SPECIAL SECTION.

Some Notes on Illumination at the Franco-British Exhibition.

The arrangements at the Franco-British Exhibition, though still not quite complete, afford an excellent illustration of the different methods of interior and outside lighting now available. It is not often that the public have an opportunity of seeing so many different systems of lighting collected together under such pleasant conditions, and in the present case the interest is heightened by the exhibition of several of the most recently introduced lamps, and the scale on which the general illumination is carried out.

Another aspect of the exhibition of this class that may be dwelt upon is that the buildings erected, &c., do not impose the restrictions under which ordinary every - day illumination is carried out, while the special nature of the exhibits naturally calls for and deserves a degree of ingenuity in the matter of lighting that would not be bestowed on the contents of an ordinary shop window.

In order to give an idea of the different methods of lighting in use in the grounds of the exhibition we reproduce in Fig. 1 a rough plan of the exhibition in which the systems of lighting adopted in the case of the various portions of the exhibition are diagrammatically indicated. Broadly, we may divide the outside lighting into two sections, that lighted by gas and electricity respectively. Arc-lighting is, of course, largely in evidence, various types of open and enclosed arcs being utilized for the lighting of the avenues, and in some cases for the outside of the buildings also. Thus flame-arcs are used to line the Avenue of Progress and the Stadium Avenue, and also for the lighting of the outside of the Canadian Palace, *The Daily Mail* kiosk, and the Court of Arts, while the space adjoining the Elite Gardens are lighted by enclosed arcs, and the new Jandus enclosed flame arc-lamps are used in the Wood Lane Station. Naturally the traditional system of outline lighting is very generally used for the illumination of the outside of the various buildings, white and coloured glow-lamps being exclusively used for this purpose, and on a scale that is probably unique in this country.

In Fig. 2, for instance, is to be seen a view of the Court of Honour illuminated by night, the lighting being carried out by electric glow lamps. Messrs. Furse & Co., of Nottingham, who are responsible for the illumination of the Court of Honour, inform us that as many as 20,000 lamps are here employed, while over 5,000 are used in the Palace of Music, as shown in Fig. 3. This system of exterior illumination is employed in the case of the majority of the buildings distributed throughout the Exhibition, and it is estimated that well over 100,000 lamps are used for the entire display.

The most recent developments in gas lighting are exemplified in the new Keith high-pressure gas lamps, burning on a gas pressure of 55 to 60 inches, and, though only utilizing a single mantle, stated to yield 1,500 c.-p. each. These lamps are spaced about 50 feet apart, and illuminate the portion of the Exhibition beyond the central, eastern, and western circuses.

It will be remembered that, according to the recent tests of Mr. W. R. Herring (*Illuminating Engineer*, June, 1908), these lamps were found to give 60 to

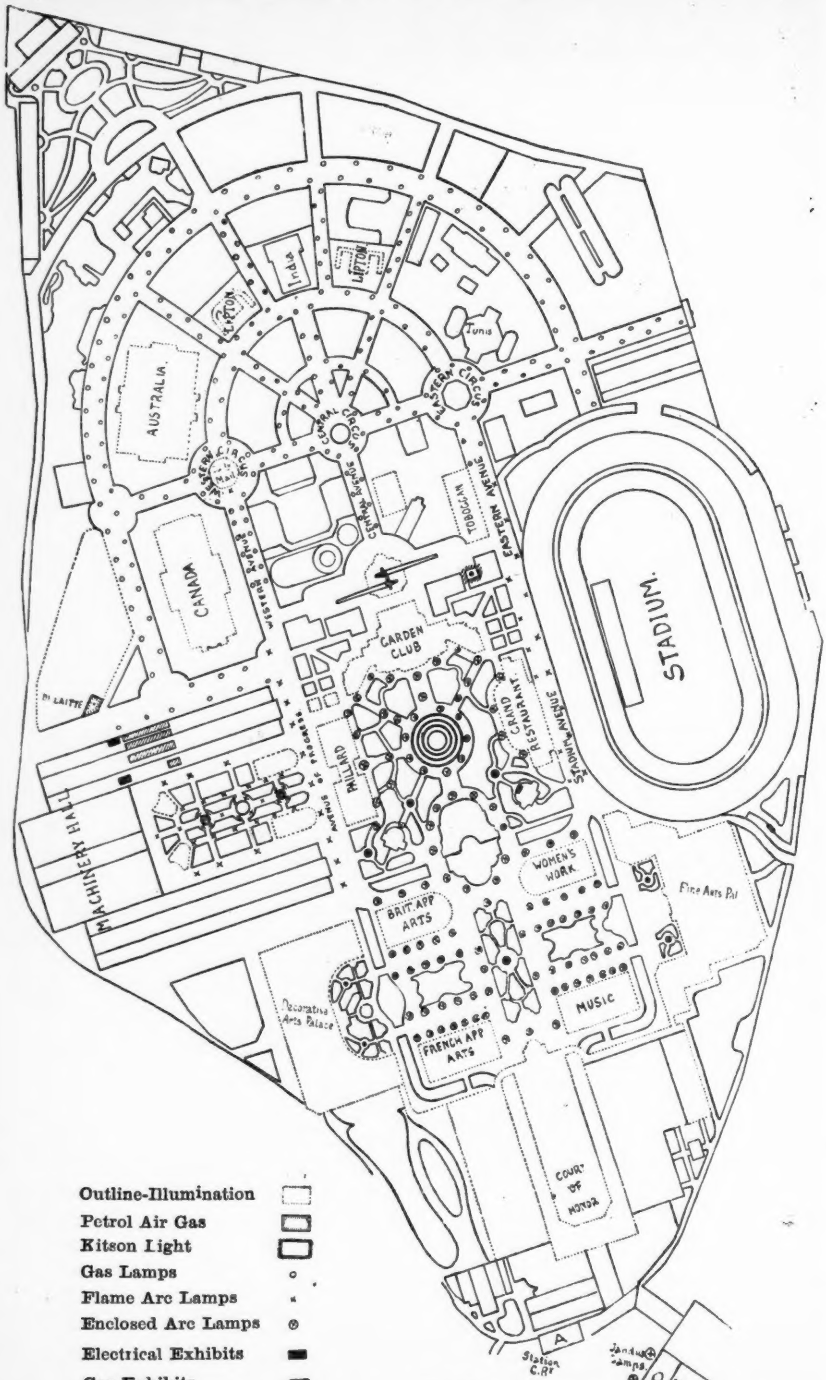

India
LIPTON
LIPTON
Tunis
AUSTRALIA
CENTRAL CIRCUS
EASTERN CIRCUS
WESTERN CIRCUS
CENTRAL AVENUE
WESTERN AVENUE
TOBOGGAN
EASTERN AVENUE
CANADA
STADIUM.
GARDEN CLUB
GRAND RESTAURANT
STADIUM AVENUE
AVENUE OF PROGRESS
PAILLARD
MACHINERY HALL
WOMEN'S WORK
Fine Arts Pal
BRIT. APP ARTS
MUSIC
Decorative Arts Palace
FRENCH APP ARTS
COURT OF HONOR
A
Station C.R.
Station C.L.R.
Outline-Illumination
Petrol Air Gas
Kitson Light
Gas Lamps
Flame Arc Lamps
Enclosed Arc Lamps
Electrical Exhibits
Gas Exhibits

FIG. 1.

70 candle-power of per cubic foot of gas per hour—a notable advance over anything previously attained. In Fig. 4 is shown a view of the Indian Pavilion and the adjoining grounds so illuminated.

Oil and petrol-air gas incandescent lighting also find representation in the exhibits of the Kitson, the De Laitte, and other exhibits. The variety of the lighting of the grounds of the exhibition, therefore, presents a considerable field for discussion. On the present occasion we do not propose to enter into detailed discussion of the many interesting points in illuminating engineering that suggest themselves, though we hope to deal with certain sections of the exhibit more fully in a subsequent number. In the article that follows, however, will be found some impressions of exhibition lighting in general.

Meanwhile we cannot refrain from commenting upon the striking divergence in the views expressed in different quarters not only as regards matters of detail, but on the fundamental objects and aims of exhibition and spectacular lighting. As an illustration of such sharp contrasts in opinion, mention may be made of the appearance of the Court of Honour. If one were to judge from the general expressions of opinion of visitors to the exhibition, one would no doubt assume the results of the traditional scheme of "outline-lighting" to be in this case eminently satisfactory. Most of those present seemed to feel that the general effect surpassed anything that had been presented to them before, and, indeed, that the general appearance of the Court by night was tasteful and—to use a very generally specified term of approval—"fairy-like." It does not follow, of course, that such a consensus of opinion, even if it could be shown to exist, is final; naturally the public taste in these matters is based solely upon what has previously been presented to them, and the general method of lighting here adopted, is that hitherto almost exclusively employed in exhibitions and on festive occasions generally. The public might, however, be willing to recognize a quite different method as incontestably superior from the æsthetic standpoint, were it presented to them.

On the other hand, we find the same difference of opinion as to the results achieved expressed in the press, and in quarters in which the criteria as to what is good lighting and what is bad are more generally understood and more sharply defined. The same effect is described as a fairyland of beauty in some instances, while in others it is termed glaring and vulgar, and extremely wearisome to the eye. Such extreme diversity of opinion, even if in part attributable to the partiality in favour of the particular system of lighting or the reverse, is still remarkable, and shows that æsthetic illumination is still very debatable ground to many of those in the lighting profession.

Very instructive, too, are the impressions created by passing from one section of the exhibition to an adjacent portion illuminated by some different system. If mere ocular demonstration were to be relied upon in deciding the merits of methods of lighting to be seen side by side, some very conflicting results could be reached. This is well illustrated by the appearance of the adjacent regions of the grounds lighted by flame-arcs and high pressure gas lamps respectively. For one thing the impression of the observer depends very greatly upon whether he stands on the borderland between the two systems, or takes up his position among the lamps lighting one of the two sections. Again, the opinions of many of those visiting the grounds in his company are probably based mainly on the actual apparent brightness of the sources of light themselves rather than upon the ground illumination. Clearly this is quite a different matter to illuminating power. An incandescent gas lamp, for example, naturally tends to appear brighter to any one approaching it from a distance than does an arc-lamp with inclined carbons in which nearly all the light is deliberately projected downwards. It may be urged that for spectacular lighting the apparent brightness of a source seen from a distance is a point to be considered,

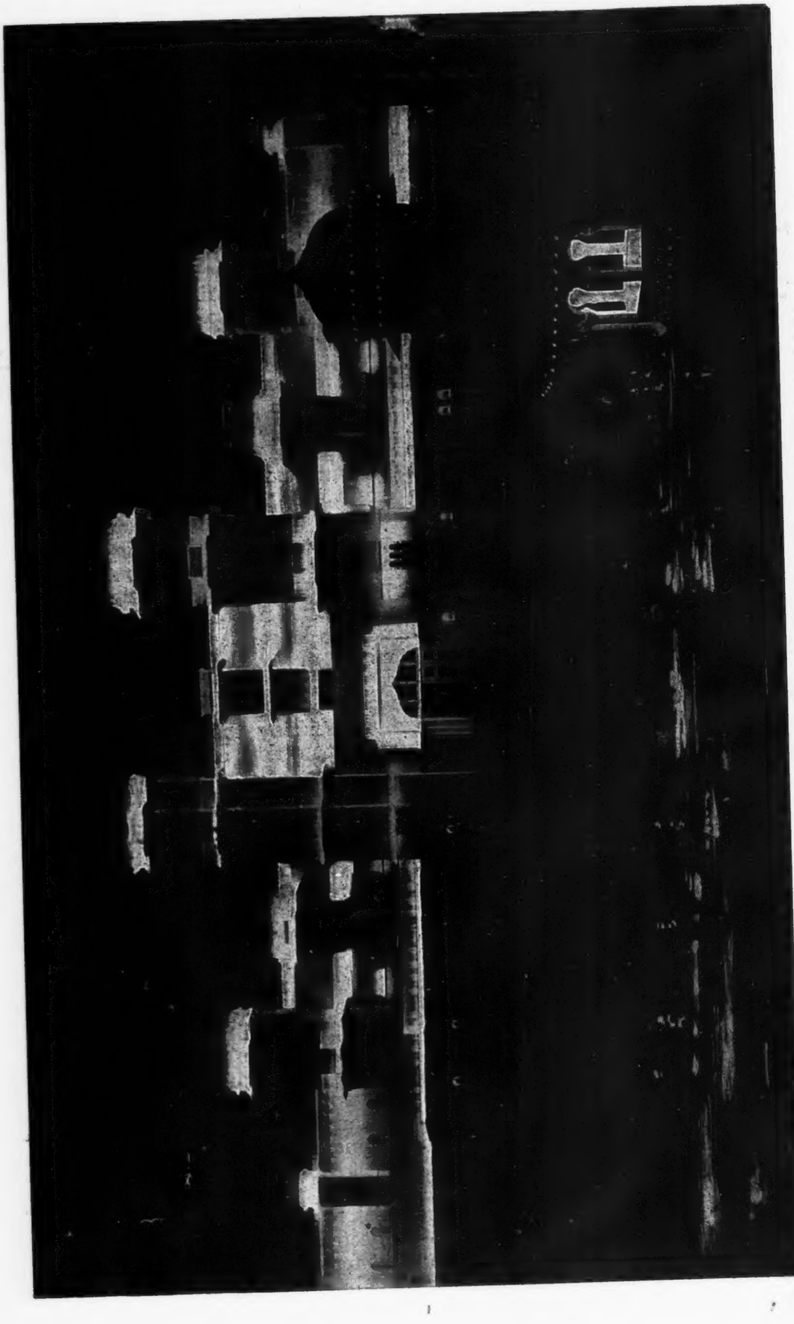


Fig. 2.—The Court of Honour, Franco-British Exhibition, Illuminated by Night.

and an asset of value. This may be possibly the case, but such a use of an illuminant ought to be kept quite distinct from its power of illuminating. We ought to modify the polar curve

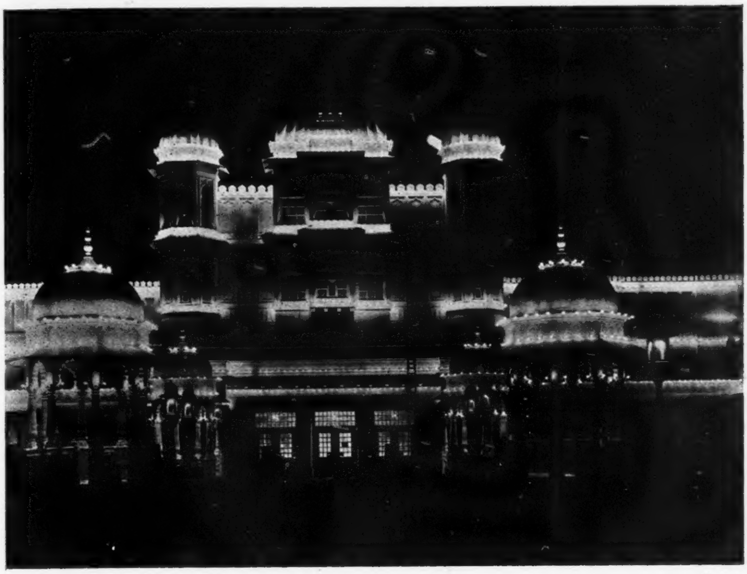


FIG. 3.—Palace of Music, Franco-British Exhibition, Illuminated by Distributed Glow-Lamps.

FIG. 4.—Indian Pavilion, and Adjoining Avenues, Illuminated by High-Pressure Gas.

of distribution of light of a source in such a way as to render it valuable for whichever of these two distinct uses was most important in the particular case to be considered.

Another factor which is not without influence upon the observer is the frame of mind in which he makes his visit. In one case that came before the writer's notice, the effect produced by the lighting of one section of the exhibition was entirely discounted by the glowing account which the visitor had previously received. As often happens in such circumstances,

FIG. 5.—Kitchen

FIG. 6.—Bedroom.

Views of the Electrically-Lighted "Model Home" in the Machinery Hall at the Franco-British Exhibition.

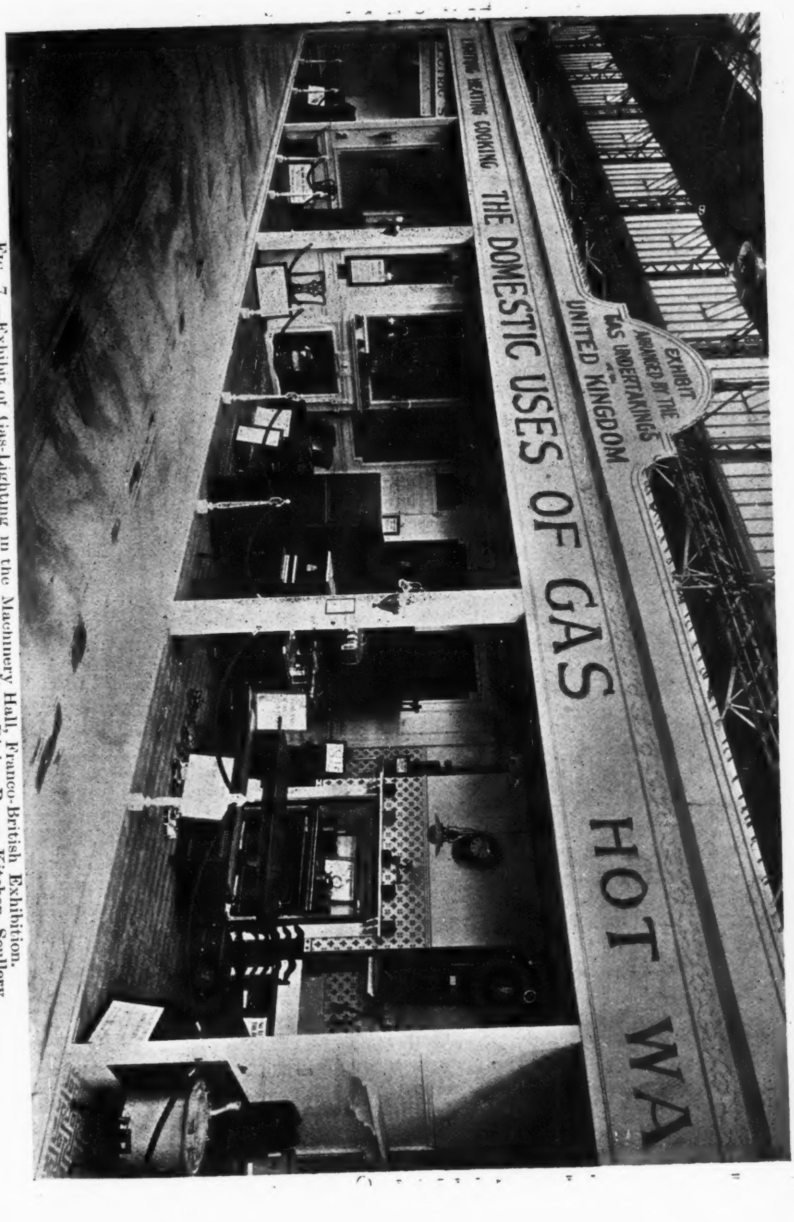


FIG. 7.—Exhibit of Gas-Lighting in the Machinery Hall, Franco-British Exhibition.
From left to right the rooms are:—Billiard Room, Boudoir, Dining Room, Kitchen, Scullery.

he found that the reality did not come up to his expectations, and he departed from the exhibition with a totally opposite impression from that pictured in his state of mind before his visit. Such considerations only serve to make it clear that, although general impressions of this kind ought to be taken into account they cannot serve as a valid system of comparison unless supported by actual tests with instruments which can be referred to a constant standard and are not entirely at the mercy of fluctuating mental impressions.

Among the actual exhibits connected with lighting and illumination, reference may first be made to the exhibition of gas and electric lighting in the Machinery Hall. Here we have the interesting situation of two adjacent sets of rooms, tastefully furnished and got-up with the object of displaying the merits of gas and electric lighting respectively. The electric exhibit takes the form of a model house, entirely illuminated within by electricity and completely furnished by Messrs. Waring & Gillow. Through the series of rooms ranging from the drawing and dining room to the kitchen the visitors make a circular tour, and are given an opportunity of seeing a number of different lighting fixtures employing both direct and indirect diffused illumination.

Heating and cooking also receive attention. The visitor finds electrically heated hair-curlers, bed-warmers, &c., in the bedrooms, demonstrations in cooking in progress in the kitchen, and ventilating fans blowing a small gale as he passes from one room to the other.

The furnishing of the house is stated to cost £200, and the cost of electric lighting is given as £6 a year. Needless to say placards emphasizing the merits of electric lighting are duly presented to the notice of all entering or leaving the house, and make interesting reading for those who linger to peruse them.

Immediately adjacent to the electrical exhibit the visitor has an opportunity of learning what gas has to say for itself, and if he occasionally finds the contents of the notices commending its use somewhat unsettling, if not a positive shock, after the impression derived from the notices next door, he will not fail to be interested in the attractive suite of rooms, some of which are shown in Fig. 7. In this case, it will be seen, the gas exhibitors have elected to use an open form of room, readily available to the public.

In the suite of rooms which include drawing-room, library, two bedrooms, bathroom, nursery, billiard room, boudoir, dining-room, kitchen, scullery, and laundry, a number of different types of burners, both upright and inverted, are to be seen, while the laundry is illuminated by Keith high-pressure lights. Some of the 1500 candle-power lights likewise serve to advertise the whereabouts of the display, flame arc-lamps performing a similar function for the electrical display. The display is brought thoroughly up-to-date by the instalment of several types of pneumatic distance-lighting apparatus, by the aid of which any light may be turned on at will by merely turning a switch. Needless to say cooking and heating by gas are to be found in evidence in all the rooms, especially in the kitchen and laundry ; it is also interesting to note that the dining-room contains an electrically operated pianola supplied with electricity generated by the adjacent compressor plant.

It is curious to observe that the usual positions of gas and electric lighting are in this case, to some extent, reversed. In the past it has frequently been contended that gas was the cheaper, but that electricity offered special conveniences that commended its adoption to the man to whom expense was of relatively small importance. In the present instance, however, the main object of the gas exhibit appears to be to show that gas-lighting is acceptable even when utilized to illuminate costly and luxurious surroundings, while the electrical exhibit is intended to illustrate the fact that artistic electric lighting is open to those of very modest means.

Yet another illustration of indoor-lighting is afforded by the exhibit of the De Laitte Petrol-Air Gas Co., which, however, is not in the Machinery

Hall, but occupies a separate position in the grounds of the exhibition near the Scenic Railway. The exhibit consists of an easily accessible demonstration of the automatic apparatus for generating the gas, and a series of tastefully got-up rooms illuminated by various types of fixtures from the gas generated outside in the open air.

In Fig. 8 we reproduce a photograph of one of these rooms.

The central inverted fixture is exceptionally attractive. The demonstration of the working of the system, in which the automatic process of generation is set in motion by a weight which afterwards slowly descends as the gas is used up and has to be replaced in the reservoir, is calculated to give the impression that the generating apparatus is exceedingly simple to operate.

Other examples of petrol-air gas illumination are furnished by the exhibit of the Pitner Invetrol Lighting Co. and the Oetzmann Country Home lighted by the Cox air-gas system.

Those visiting the exhibition have, therefore, ample opportunity to study the claims of different illuminants, and if they occasionally find themselves confronted by apparently conflicting statements, put forward side by side, this only serves to show the difficulty of obtaining reliable information on all illuminants, and the necessity for expert and impartial outside judgment.

FIG. 8.—Room Illuminated by Petrol-Air Gas. The De Laitte Model Installation, Franco-British Exhibition.

Naturally there are many other features in the Exhibition of considerable interest to the illuminating engineer. The special efforts made in the present instance serve to give an idea of the immense field for enterprise in the employment of the principles of illuminating engineering in order to secure the special spectacular and attractive effects. An exhibition of this kind presents endless opportunities of using light in such a way as to attract the attention of passers-by to certain exhibits, and also of showing them off to the best advantage. This is the more true, because the importance of the occasion justifies the exhibitor in expending an amount of money and thought that would be grudged under ordinary circumstances.

One feature that is especially prominent in the present Exhibition is the predominance of scenic effects, usually accentuated by special illumination. For instance, we encounter a striking example of such a scene in the effective illuminated pictures representing the vineyards of the Gilbey Distilleries at the very entrance to the Court of Honour.

Other, perhaps, even more interesting efforts in this direction are to be seen in the Canadian exhibit. Here are a number of beautiful and striking tableaux explaining certain aspects of Canadian life and industries. A specially interesting feature of this exhibit is the frequent use of transmitted light to illuminate scenery and portraits, &c. Naturally this method can be utilized to make certain objects stand out and attract the eye in a way that could hardly be secured otherwise.

In the present instance, however, one feels that the high general illumination from the flame arcs used to illuminate the interior of this building, excellent as it may be considered to be from an ordinary practical standpoint, rather weakens the effect of all but the brightest of the transparencies, and that a higher local illumination could be profitably employed in some cases. Nevertheless, the general nature of the scheme in this hall constitutes an important development in scenic exhibition lighting, and in a very legitimate and desirable direction.

Needless to say, countless interesting problems in shop-window lighting are to be found. Some excellent examples occur to the left of the Court of Honour on entry, where a number of the latest Parisian fashions are displayed.

In one case an effective display is obtained by concealing the glow-lamps behind linen bands, and using others as foot-lights. The general effect is, at any rate, much more in accordance with sound principles of illumination than much of the window-lighting we see in the streets of London, though it is quite possible that the same results might be obtained more cheaply if necessary by the use of more effective reflecting devices.

Among the examples of special illuminating devices for attracting attention may be mentioned that in use in the exhibit of one of the tobacconists. A number of tins of the standard type are piled up in the window, and all to the eye look alike. Some of the tins, however, are really made of semi-transparent material, and contain a glow-lamp. By means of a mechanically-operated switch certain tins are caused to appear brightly illuminated at different intervals, and then to relapse into comparative darkness and to resemble their companions.

A few of the exhibits in the Science Section merit special notice. Sir Joseph Swan has contributed an exhibit of early forms of glow-lamps, including one that is said to be the first actually exhibited in public in this country.

The National Physical Laboratory exhibit a series of large bulb Fleming-Ediswan standard glow-lamps, and an arrangement used by Mr. Patterson to secure that all of a number of glow-lamps undergoing a life-test shall burn at exactly the same watts per candle-power.

There are also some interesting particulars of coloured gelatine films supplied to the laboratory by Messrs. Watton & Wainright, including curves illustrating the percentage of light transmitted throughout the spectrum in each case.

Finally, we wish to express our indebtedness to the De Laitte Petrol-Air Gas Co., Messrs. Waring & Gillow, *The Gas World*, and *The World's Work*, for the use of some of the blocks and photographs employed in this article.

The Lighting of the Grounds and Buildings of Exhibitions, &c., with Special Reference to the Franco-British Exhibition.

BY AN ENGINEERING CORRESPONDENT.

ONE of the most interesting aspects of the lighting of an exhibition from the standpoint of an illuminating engineer is certainly the problem of producing attractive effects in the grounds—"landscape-illumination" one might almost term it.

The possibilities of securing specially successful results in this direction depend very greatly on the variety of the buildings distributed about the grounds, and upon the method of illuminating them. In almost all cases in which illumination has been used for spectacular effects of this kind in the past the method of "outline-lighting" has been adopted. It may, indeed, be said that this method of lighting has almost become a tradition.

Outline-lighting consists essentially in so distributing glow-lamps as to follow the lines of a building, and so to sketch its outlines in a luminous form. Regarded from the pictorial standpoint, therefore, in genuine outline lighting, we approximate to the efforts of the artist or the draughtsman when he sketches an object in outline merely. By this method, therefore, we may hope, perhaps, to preserve the beauty of line of a building, but we cannot hope easily to reproduce the alternation of light and shade which play a great part in the appearance of all buildings having any claims to architectural distinction. In such a case as the Franco-British Exhibition, in which buildings of admitted beauty from the architectural standpoint have been put up, the illumination of the buildings by night becomes an important consideration.

In the Franco-British Exhibition, however, the traditional method of outline-lighting has been followed almost throughout, and a few of the buildings which are not yet illuminated in this way appear to be about to be treated in the same way as the others.

Strange to say, the opinions that have been expressed on this point differ very greatly. Many people seem to regard this method of lighting as the natural and ultimate goal of exhibition-lighting. Others consider the multiplication of small bright sources only bewildering and trying to the eyes. The writer feels obliged to confess that, up to a certain point, he shares the latter impression. The effect of small but very bright sources on the eye is too well known to require elaboration. In the case of large buildings the effect is lessened by the comparatively great distance of the lamps from the eye. Moreover, in the case of the very white buildings used in the exhibition we see not only the filaments of the glow-lamps themselves, but also a vast amount of reflected light. This reflected light enables us to see the form of the building as a whole, and the moderate general illumination to which this circumstance gives rise helps to tone down the otherwise disagreeably bright outline-lighting. The value of the Court of Honour as a decoration by night would seem to be attributable as much to this reflected light as to the outline-effect. Even so the author personally finds the multiplication of small bright spots of light objectionable.

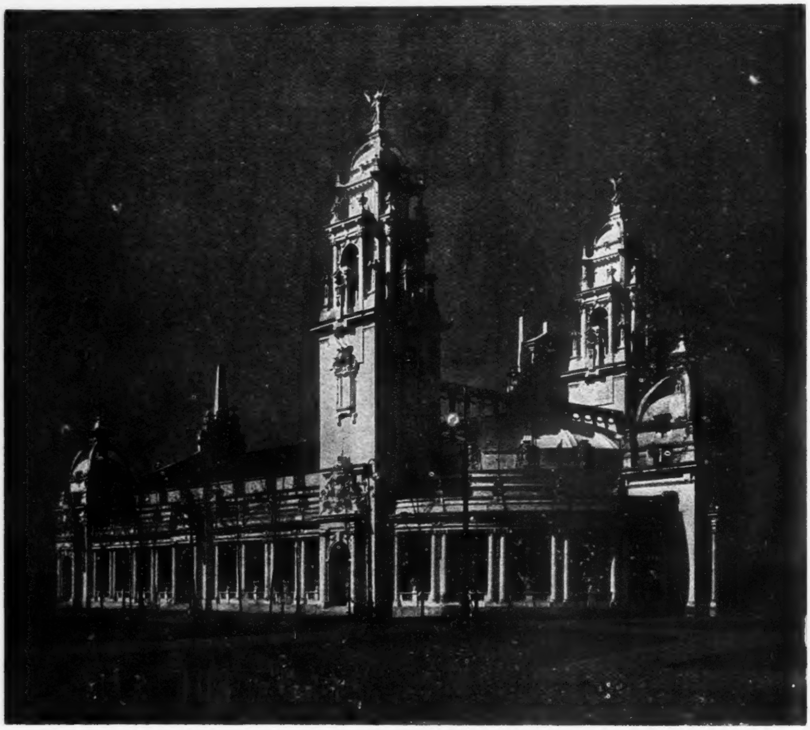
As has been suggested above, outline-lighting depicts the lines of a building. In cases in which the lamps are merely strung about a building haphazard, without respect to its true outline and projections, it loses even this value; but in any case the effect is impaired from an artistic point of view, by our being compelled to draw such bright, disjointed spotty lines. Possibly the use of such a source as the Moore tube might lead to the artistic possibilities of this method being greatly extended.

We see, however, that if we really

wish to show off the features of a building as it appears by daylight, line-lighting is ineffectual. It is true that the building does receive a certain amount of general diffused lighting by this means; yet this light strikes the faces of the building in a haphazard manner, and cannot be expected to bring out the shadows of artistic mouldings and projections as they appear in daylight. To illustrate this point of view observe the appearance of the British Palace of Applied Arts, as shown in Fig. 1.

The light falls upon the building from a certain angle, bringing out all its lines, projections, and depressions, and the effect is pleasing. Moreover, the general effect depends upon broad masses of light and shadow—there is no wearisome speckly pattern of light and shade and no glare. The author would therefore suggest that this is the condition of things which we ought to imitate by means of artificial light rather than the previous method of outline effects.

This view appears the more reasonable because the white surface of the buildings erected in the Franco-British Exhibition are singularly favourable to illumination from without. As it is, the amount of diffused light about the exhibition is quite exceptionally great compared with outside street conditions, while in sunlight the reflected light is sometimes so strong as to be distressing to many people.



Reproduced by permission of 'The World's Work.'

FIG. 1.—British Palace of Applied Arts, Franco-British Exhibition.

Another example of the attempted use of artificial light in the desired direction is presented by Fig. 2, which is taken from a photograph of the lighting at the Düsseldorf Industrial Exhibition of 1902.

In this case the white exteriors of the buildings are illuminated by arc-lamps of the Regina type, by the Regina Arc-Lamp Co., of Cöln-Sülz. Fig. 2 is interesting on account of the fact that it illustrates an attempt to specially illuminate a fresco on the outside of the building.

While it cannot be contended that the particular case cited above represents the best that could possibly be done in this way, the author personally very greatly prefers even the comparatively simple method which it represents to the wearisome outline-lighting effects. There is, however, no reason why we should confine ourselves to the use of sources of light on the tops of long posts, &c., in order to produce the pleasant diffused lighting referred to. The real essentials of the method are that we should see broad masses of illuminated surface rather than concentrated bright points. An absolute uniform illumination is obviously undesirable on æsthetic grounds, but it is easy to avoid this result; it would, indeed, be far from easy to produce it, though it may be pointed out that, in the case of outline lighting with glow-lamps, we approach it, owing to the distribution of light over the entire white surface.

Probably the most effective results are to be secured by hiding the lamp behind some projection on the face of the building, so that the surfaces illuminated by it are visible, but not the light itself. An attempt in this direction seems to be made in the case of the Palace of Women's Work, where arc-lamps are suspended beneath the open domes of the towers, so as to illuminate the adjacent surfaces and produce an interesting play of shadow, without themselves offending the eye. An effort in the same direction is made in the Indian Pavilion, where the gas-lamps suspended under the domes of each of the towers play the same part as the arc-lamps in the case just mentioned.

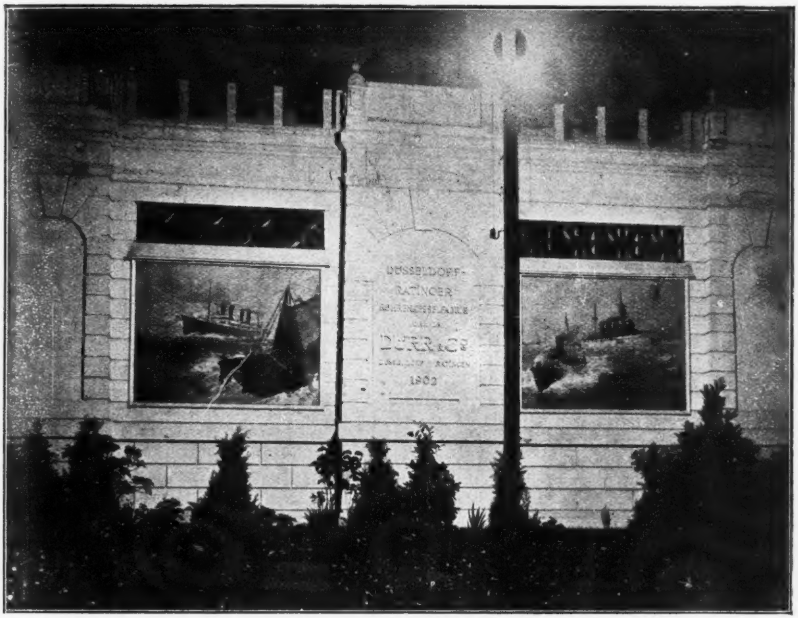


FIG. 2.—Illumination of Pictures on outside of Exhibition-Building (Düsseldorf Industrial Exhibition, 1902).

The open corridors surrounding some of the palaces at the exhibition also offer very great possibilities of illumination in this way. For instance, the covered walk seen in Fig. 3 might be illuminated by lamps placed on the ceiling and invisible to those outside. As a matter of fact in a number of cases very pleasing effects are produced involuntarily in this very manner. Some of the flame arc-lamps surrounding the Canadian Palace are cases in point; one frequently gets a charming glimpse of some portion of the building lighted up brighter than the rest, without the source itself beingapparent.

In short it seems reasonable to conclude that our main object in attaching lights to the exteriors of buildings of artistic and architectural value should be to exhibit its architectural characteristics in the same manner as occurs in daylight-illumination, and to try to conceal, as far as possible, the sources themselves when they are too intrinsically brilliant to be pleasant to the eye.

Just in the same way that sources of light are often mainly used to enable us to see the architectural features of buildings by night, so the sources used in the grounds are meant primarily to enable us to see our way about. Therefore we ought also to try and secure that the brilliancy of such sources is never sufficient to dazzle the eye when looking about. It is well known that in ordinary street-lighting it is almost impossible to secure the exact theoretical conditions, because there is no evident method of using lights to effectually illuminate the ground and yet to be invariably out of the line of sight of the pedestrian. The most we can do is to provide such sources with suitable diffusing shades so as to modify their brilliancy. Even so, it is probable that they will be

Reproduced by permission from 'The World's Work.'

FIG. 3.—Corridor, looking out on Court of Honour, at the Franco-British Exhibition.

inconvenient when the observer wishes to make out something in the background behind them.

It must also be remembered that the attention is involuntarily attracted by such bright patches of light. If we desire to draw general attention to a certain building or a stall we ought to make the local illumination in this neighbourhood higher than that of the surroundings. The illuminated kiosk in Fig. 4 is an illustration of what is legitimate in this way. The illumination due to the concealed lights is satisfactory, not only because it attracts attention to the correct point, but also because this method lends itself to artistic treatment.

At the White City the conditions are exceptionally favourable on account of the excellent reflecting character of the buildings and the large amount of general diffused illumination to which they give rise. Nevertheless it will probably be admitted by any one impressed with the dilemma referred to above that the lighting in the grounds has not escaped the common difficulty peculiar to all external lighting. The general illumination in the section of the exhibition lighted by gas, for instance, is unquestionably excellent in many ways, but one's approval of the performance of the high-pressure gas-lights is modified by a feeling that their great brilliancy becomes very inconvenient when one attempts to examine any object in their immediate neighbourhood. This feeling is probably intensified by the fact that the lamps seem to be placed exceptionally low considering their high candle-power. The same remarks apply to a greater or less degree to the general illumination by arc-lights.

Fig. 4.—Mattke & Sidow Pavillion (Görlitz Industrial Exhibition, Saxony). Lighted by "Regina" enclosed 5 amp. arcs.

Apart from the value of illumination for the purposes already referred to, one might suppose that there is scope for considerably more originality and ingenuity in devising methods of showing off certain features of the grounds or calling attention to certain objects. One is inclined to think that more might be done in the way of illuminating the tastefully arranged flower-beds in the gardens of the exhibition, for instance. In the daytime these are prominent objects, but in the night time they fail to receive the same attention, owing to the fact that they are illuminated so comparatively feebly. It is true that in one place in the Elite Gardens an attempt is now being made to surround the beds with a string of naked glow-lamps. But naked glow-lamps, whatever be their merits for other purposes, are not in themselves beautiful objects, especially at close range, and this continuation of the principle of outline lighting seems to the author in this instance particularly out of place. It would seem to be a greatly preferable plan to try to throw the light on to the beds from shaded lights, invisible to the observer, as is done on the stage. The same remarks apply to statuettes and other objects that are considered decorative in the daytime, but whose existence seems to be often disregarded by night.

Needless to say there are also great possibilities in the way of creating special colour-effects, &c., which artificial light enables us to do with comparative success. Practically the only example of the deliberate use of coloured light in this way, apart from the coloured glow-lamps outlining the buildings, lies in the illuminated cascade in the Court of Honour. The author, however, is inclined to suppose that the principle on which this illumination is contrived is incorrect. This cascade, it will be remembered, makes its way over a series of glass steps, illuminated from behind by means of transmitted light. As a matter of fact, the light in this case seems irregularly distributed, for only certain persons looking in a certain direction receive the full benefit of the coloured light coming through the water. Apart from any defects in the distribution of the light, however, it may be doubted whether running water can be very effectually illuminated by transmitted light at all. Certainly it will be observed that the charm of the cascade in the Court of Honour depends mainly on the light reflected to the eye from the flowing water, and the most striking effects in the way of fountain-illumination, &c., have, according to the writer's experience, always been obtained by means of reflected light.

Immense possibilities in the decorative way seem to lie in the illumination of the white buildings of an exhibition by means of coloured light, in such a way as to light up adjacent portions with harmonious shades of colour. Some of the most pleasing effects (in the writer's opinion once more) are produced in this very way. For instance, in several cases the outside of the building receives light of a bluish character from the enclosed arcs without, while sheltered flame arcs light up the porches and porticos and other portions of the interior of the building with a soft yellow light. In the Court of Honour, too, there are several cases in which an effect of this kind has been obtained, apparently without design, by the use of lights differing in colour from those of the surrounding illumination.

In throwing out the suggestions in this article the writer is conscious that to many they may appear impracticable, or even undesirable. He himself is convinced that there is an immense field for the application of artificial light to the production of spectacular effects, and especially to the illumination of the exteriors of buildings.

It is, at least, evident that if a building has any artistic pretensions at all, the method of illuminating its exterior ought to receive careful consideration both from the architect and the lighting engineer, so that its attractive features may be shown off to the best advantage. The dirtiness of most street buildings and the other considerations connected with traffic, &c., impose limitations under ordinary conditions which do not exist in the case of an exhibition. Even so, however, there cannot be much doubt that very much more might be done under proper artistic direction in this matter, even in the streets of London.

REVIEWS, ABSTRACTS, AND REPRODUCTIONS.

Liquid Gas.

(From the *Illustrierte Technische Umschau*, Zürich, June 20th.)

COAL-GAS, which can be used with such advantage in towns on account of the density of the supply area, cannot be employed in the country, as the consumption would bear no adequate comparison to the extent of the necessary mains. Electric light is too dear to permit its general introduction in all classes of society. Like its competitor, coal-gas, it can only be used in exceptional cases at a great distance from the source of supply. Lighting by petroleum, on the other hand, no longer satisfactorily meets the requirements of modern life, and consequently the demand for light is continually increasing. All this explains why, for a long time past, a lighting medium has been sought which should be at the same time practical, artistic, and economical, and serve for the lighting of residences which are situated at a distance from central sources of supply, and for villas, factories, country houses, hotels, &c., as well as for railway carriages, automobiles, &c.

The use of electric furnaces, which permit the manufacture on a large scale of calcium carbide, seemed, at least for a short time, to ensure a brilliant future for acetylene gas, especially as this gas can be transformed in a fairly simple manner into the liquid state, and it was thought that the important problem of obtaining a transportable lighting gas had been solved. Unfortunately, owing to the extraordinary explosiveness of this gas, especially in the liquid state, these hopes were quickly doomed to disappointment, the more so as in most towns liquid acetylene is classed as an explosive, and this regulation extends to the gas even when compressed to a few atmospheres' pressure.

The result of this regulation has been that at present, in order to utilize acetylene gas for lighting purposes, recourse has had to be made to private installations for the production of the gas.

These installations are, as is well known, complicated and very delicate, and danger is not entirely removed in this way. The problem of obtaining a transportable lighting gas, therefore, still remained unsolved.

A striking proof of the importance of this question is found in the great activity of all makers of the various apparatus for the production of air, alcohol, benzine, petroleum, and gasoline gases, &c. They all pursue the same object—to furnish isolated residences with their own supply of lighting gas; but none has succeeded in overcoming the general objection, viz., the preparation of the gas in the house itself.

Only after tedious research has Herr Wolf succeeded, *by a simple, convenient. and cheap process*, in producing what he terms "liquid gas." In liquid gas we have at last a product which no longer necessitates any producing - apparatus in the house, which is not poisonous, is less explosive than town-lighting gas, and possesses the maximum lighting and heating power.

Liquid gas is a gas obtained by the distillation in retorts of various raw materials, such as heavy oils, paraffin oils, raw petroleum, and all its products and residues. This gas is afterwards transferred into the liquid state by means of a special process, which forms the object of the patented invention, rendering possible its transport in steel cylinders to any required distance.

The following extracts from an analytical report of Prof. Bunte's laboratory in Carlsruhe, August, 1907, explain the composition and properties of this gas:—

"The 'liquid gas' is a mixture of carbo-hydrates which is gaseous at the ordinary air-pressure. When highly compressed the gas is liquefied, and is supplied in this state, the same as carbonic acid gas, in strong steel cylinders. When in use it is allowed to flow out of the cylinder, and by the decrease of pressure again assumes the gaseous form. After passing through suitable pressure reducing and regulating apparatus, it flows through the distributing pipes to the point where required, when it is used like coal-gas.

"The gas consists principally of ethylene and ethane, together with small quantities of methane and higher homologues of ethane and a little benzole.

"The specific gravity compared to air is 1·027, so that the average molecular weight of the gas corresponds almost exactly to that of ethane.

"The heating value per cubic meter of gas at 0° and 760 mm. pressure was determined as 15·595 T.U. It is therefore three times as great as ordinary coal-gas.

FIG. 1.

"By the use of an incandescent gas burner suitably arranged for this gas, with 85 mm. pressure of gas and a consumption of 28·5 litres per hour, an average horizontal lighting effect of 75 Hefner candles was obtained. In this test the volume of the gas was measured wet at 760 mm. pressure and 18°C. This corresponds to 26·1 litres of dry gas as 0°C. and 760 mm. pressure. This gives a consumption of 0·35 *litres of gas at* 0°C. *and* 760 *mm. pressure per Hefner candle-power-hour.*"

The gas, therefore, has a very high lighting and heating coefficient; it is moreover, free from carbonic oxide, and for this reason not dangerous. Its explosiveness is 13 *times less than that of acetylene, and* 3 *times less than that of coal-gas.*

The transport of this gas presents absolutely no difficulty. For instance, in Switzerland it is treated by the railways the same as liquid carbonic acid.

Figs. 1 and 2 will give an idea of the usual storing apparatus.

Its use is extremely simple, the whole installation for a house only taking up the space of a cupboard. This contains the entire apparatus, consisting of the steel cylinder with the liquid gas, and a small gasometer connected thereto. This cupboard, made of wood or metal plates, can also be situated outside the house, *as the liquid gas is not influenced in any way by the outside temperature*. The piping passes from the gasometer; such pipes are of very small diameter. If they already exist, the ordinary gas-pipes may be utilized.

This means, therefore, no more generators in the house, no more cleaning and drying of the gas, as in an acetylene plant, no more waste products of manufacture, and no more mechanical parts, motors, and counter-weight, as in gasifying plants.

In the lighting of carriages it accomplishes a great simplification as compared, for instance, with lighting by oil gas. No producing-houses are spaced along the line; no tank-carriages for carrying supplies; no reservoir under each carriage, taking up a great deal of space; a single apparatus, with its steel cylinder, which can be replaced immediately, even whilst running, suffices.

Figs. 3 and 4 are examples of convenient lighting-fixtures.

Liquid gas, however, not only possesses these exceptional properties for lighting, but is particularly suited, on account of its high heating value, for the heating of residences, cooking and ironing, as also for all forms of soldering, from plumbers' work to the autogene welding of metals requiring the highest temperatures.

This last application is at the present time of the utmost importance in the metal industry, where it is on the point of replacing the tedious and lengthy process of riveting.

It is interesting to consider the various processes which are employed to produce the necessary temperature for these operations. Electrical welding, although a temperature of about 3,000 degrees is obtained therein, cannot be used in practice, as the metal welded or soldered by this means becomes too brittle, its structure being altered by a form of crystallization.

Goldschmidt's alumino-thermal process certainly offers great advantages, but not only is it very dear, but its use is also extremely limited, as, however useful it may be for welding similarly shaped pieces, such as bars, tubes, &c., it is not practical for boiler-making and the repair of various parts. There remain therefore the two processes utilizing oxygen and hydrogen, and oxygen and acetylene respectively.

The oxy-hydrogen flame, which was for a long time almost exclusively used, has been replaced somewhat rapidly by the oxy-acetylene flame, and this for the following reasons :—

1. It is more expensive.

2. It is liable to produce oxidation of the metal.

3. It does not produce a sufficiently high temperature.

Furthermore, hydrogen is not only extremely explosive—a property it shares with acetylene—but is very poisonous to the human organism, as it decomposes the blood, and this property is the more dangerous because the gas has no smell, which would permit of an escape being detected.

As regards practical properties, it may be said that the oxy-hydrogen flame does not produce nearly as high a temperature as that obtained by the use of the oxy-acetylene process.

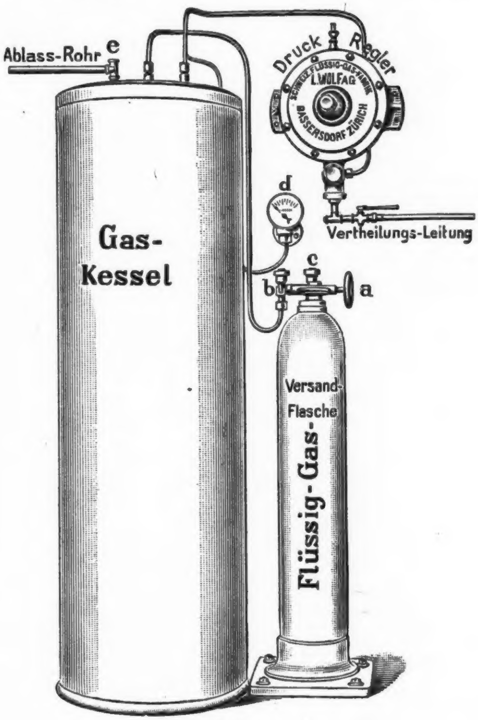


Fig. 2.

Fig. 5 shows an arrangement for welding by liquid gas.

As a matter of fact a cubic meter of hydrogen only gives out on burning 2,570 T.U., whilst the same volume of acetylene gives almost 13,000 T.U.

Furthermore the hydrogen flame is very wide, and for this reason the heat is very distributed. This results in a considerable loss of heat by radiation and a slower action at the welding point.

The oxy-acetylene flame, on the other hand, is short and pointed, and a very small cone may be observed in the centre, the temperature of which is estimated at about 3,500°, whilst that of the oxy-hydrogen flame does not exceed 2,600°. And if it is borne in mind that a *cubic meter of liquid gas developes* 15,500 *T.U., that is* 2,500 *T.U. more than acetylene; that this gas is very easily transportable* (compared with the acetylene generator, the whole apparatus, including the oxygen vessel, takes up but little space), it will be readily understood that by the mixture of oxygen and liquid gas, an ideal flame for autogene welding is obtained, by the use of which greater thicknesses can be welded with a simultaneous saving in both time and gas.

FIG. 3.

FIG. 4.

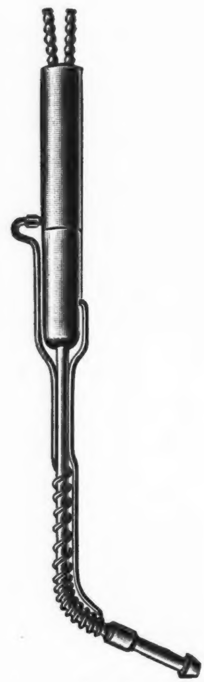


FIG. 5.

Comparison of the cost of various systems of lighting per 100 *Hefner candle-power hours :—*

Petroleum, according to burner used	10-12
Alcohol, according to burner used..	8
Acetylene	7–9
Coal-gas	4·5
Liquid gas	6·5

Daylight and Artificial Light.

BY DR. E. L. NICHOLS.

(Read before the New York Section of the Illuminating Engineering Society, on May 14th, 1908. See the *Transactions* for May, 1908.)

IN his interesting and valuable paper on the above subject, Dr. Nichols remarks that there is a general impression that daylight-illumination is the best of all varieties, and that claims on behalf of artificial illuminants are frequently based on their supposed resemblance to natural daylight conditions. Dr. Nichols therefore proceeds to consider in what exactly natural daylight consists, and exactly to what extent it is resembled by ordinary illuminants.

Daylight, of course, is derived from the sun's rays after their passage through the intervening atmosphere of the earth,

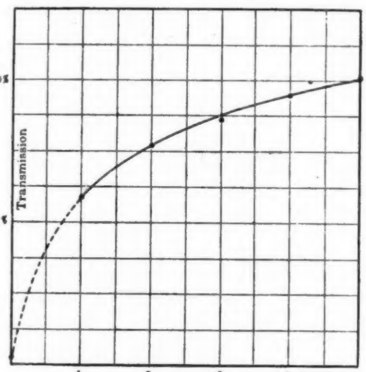


FIG. 1.

and its composition is therefore considerably modified by the depth of air through which this light passes and its varying turbidity, owing to the presence of varying degrees of moisture or of minute particles of dust, &c. The absorption of the atmosphere also affects different regions of the spectrum unequally.

Thus Fig. 1 represents the average transmission of light of different wavelengths through the earth's atmosphere, as determined by the records, extending over six months, of the Astrophysical Observatory of the Smithsonian Institute.

It will be seen that the violet end of the sun's spectrum is reduced to a greater extent than in the case of the rays of greater wave-length, while the ultraviolet element is known to be affected still more strongly. We now know, for instance, that the inflammation of the eyes which occurs in high altitudes is to be attributed to the action of these rays.

Thus it comes about that daylight under different conditions and in different countries varies considerably both in intensity and in spectral composition. Diffused daylight again differs from

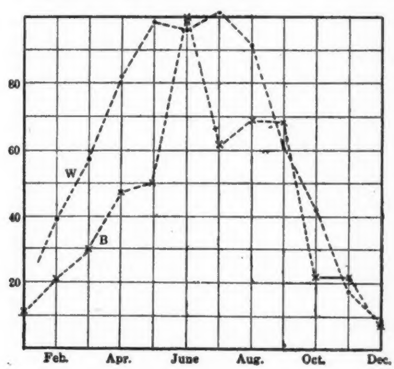


FIG. 2.

direct sunlight, especially as regards the blue and violet constituent. Table I. shows the result of comparing daylight in different localities with the acetylene flame.

In Fig. 2 are also shown some results obtained for the mean annual variation in the intensity of sunlight by L. Weber of Kiel in Germany, and Prof. Basquin of Chicago in the United States. These are marked " W " and " B " respectively. According to Weber the average illumination of the entire sky in July reaches about 100,000 hefner-metres. Dr. Vogel, under the same conditions, obtained 78,000 units.

In Fig. 3, which represents the variation in intensity during the normal day, are shown some results obtained by the author (N) in the Tyrol and Prof. Basquin in Chicago.

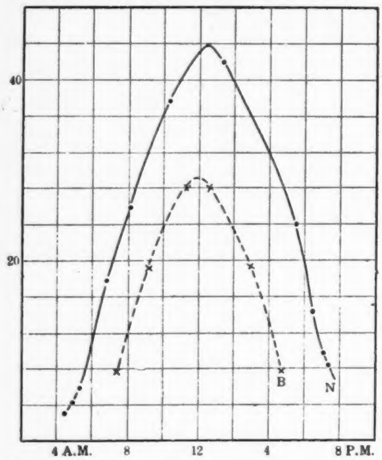
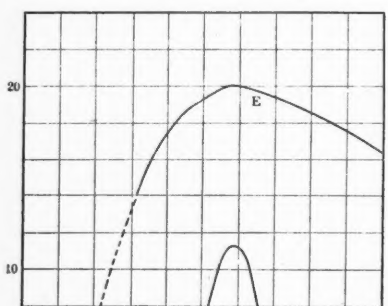
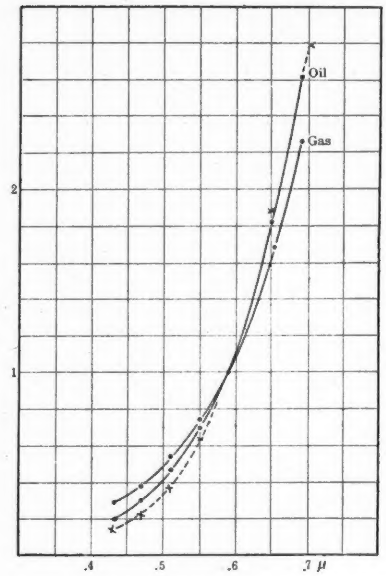


FIG. 3.

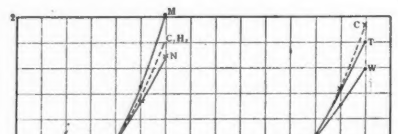


Wave-length.
E. Energy.
L. Luminous Intensity.
FIG. 4.

We see, therefore, that daylight conditions may vary considerably, but yet the general impression that daylight is physiologically the best of all illuminants has a logical scientific basis, for the eye has actually been developed through countless generations so as to utilize daylight to the best advantage. An interesting illustration of this fact is presented in Fig. 4, where it will be seen that the maximum of the energy-curve



Wave-length.
FIG. 5.



Wave-length.
FIG. 6.

of the solar spectrum E, and the curve of luminous intensity L, occur in exactly the same position, near $\lambda = 0{\cdot}58\mu$. This suggests that the eye has developed itself so as to be most sensitive to yellow light, simply because the energy happens to be mainly concentrated in this particular region of the solar spectrum.

In the second part of his paper Dr. Nichols takes up the comparison of artificial illuminants with daylight. In doing so he divides illuminants into three broad classes :—

1. Those which owe their luminosity to incandescent carbon.
2. Those in which the light-source consists of incandescent oxides.
3. Those in which the spectrum consists of isolated groups of bright lines.

The spectra of the majority of illuminants occurring in Class I. resemble each other fairly closely. Thus in Fig. 5 is shown a comparison between an ordinary flat-flame petroleum lamp and a gas-flame (Sugg standard burner) compared with the Hefner flame.

In Fig. 6 are shown the similar results for the tantalum (T), Nernst (N), and metallised carbon (M) lamps, all of which do not differ very greatly from that of the carbon filament, bearing, however, a closer resemblance to acetylene. It is probable that such differences as occur are not to be ascribed entirely to difference in temperature of incandescence, but also to a small extent to selective radiation.

Fig. 7 shows a comparison between the distribution of intensity in the spectra of the Hefner lamp and sunlight.

In Class II. we include such sources of light as the incandescent mantle, the Nernst filament and the magnesium light, in all of which there is evidence of selective radiation.

The quality of light from incandescent mantles, for instance, depends very greatly on their composition. The earlier mantles were very weak in the red, and showed marked selective radiation near $\lambda = 0{\cdot}65\mu$, as shown in Fig. 8. A newer mantle, of American make, measured one hour after incandescence, gave the results shown in the X curve in Fig. 8. Here the presence of selective radiation is much less noticeable. The change in the spectral composition of light given by many mantles, as they age, is often very marked.

The flame of burning magnesium is a well-marked instance of selective radiation. In Fig. 9 is to be seen a very steep rise in the curve due to luminescence in the violet, while yet higher regions in the ultra-violet occur.

In Class III. we number those sources of light which do not develope continuous

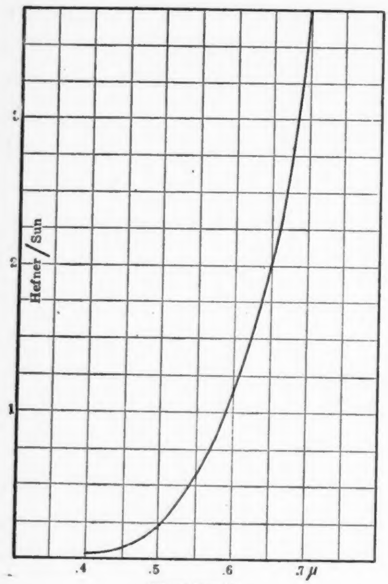
TABLE I.

Values for the ratio daylight/C_2H_2 averaged by groups and reduced to the basis of equal brightness of both spectra at wave-length of ·59 x 10^{-4} cm.

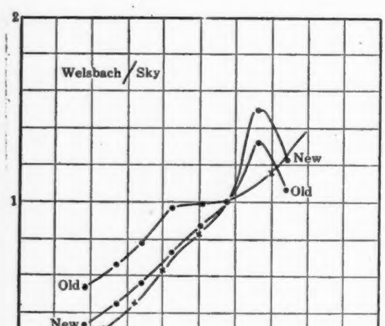
WAVE-LENGTHS IN 10^{-4} cm.

Stations	·725	·620	·590	·530	·460	·420	·390
At Sea	·367	·739	1·00	1·78	2·87	3·75	5·12
Algiers	·466	·764	1·00	1·47	2·37	2·97	2·96
Biskra	·538	·835	1·00	1·38	1·93	2·56	2·95
Naples	·444	·962	1·00	2·01	3·09	4·08	4·65
Palermo	·566	·873	1·00	1·24	1·85	2·52	2·81
Taormina	·423	·844	1·00	1·49	1·80	2·26	2·92
Bebek	·640	·928	1·00	1·17	1·52	1·84	2·03
Vienna	·562	·742	1·00	1·46	2·05	2·36	2·62
Zell	·528	·922	1·00	1·18	1·58	1·93	1·89
Sterzing	·468	·852	1·00	1·28	1·99	2·52	2·54
Trafoi	·358	·804	1·00	1·35	2·17	2·74	2·62
Brienz	·388	·848	1·00	1·33	2·96	3·43	3·23
Rothhorn	·334	·824	1·00	1·39	2·73	3·28	3·22
Misc. (Swiss)	·347	·850	1·00	1·42	2·17	2·70	2·57
Misc. (other)	·460	·900	1·00	1·33	2·39	2·77	2·83
Averages— Swiss, &c.	·420	·859	1·00	1·35	2·19	2·73	2·58
Averages— Lower Stations	·490	·866	1·00	1·31	1·87	2·34	2·67
Averages— All Stations	·450	·865	1·00	1·34	2·07	2·59	2·63

spectra, such as the mercury arc, the flame arcs, &c. It is extremely difficult to compare such sources with daylight, except when the lines in the spectrum are crowded close together and very



Wave-length.
FIG. 7.

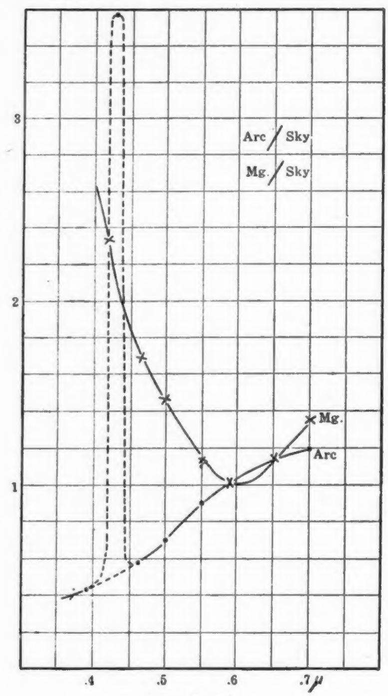


Wave-length.
FIG. 8.

uniformly distributed. But in such cases as that of the mercury arc, in which the light is practically concentrated in three bright groups of lines in the yellow, green, and violet respectively, exact comparison becomes impossible.

In the DISCUSSION PROF. HALLOCK remarked that the results shown in Fig. 4 illustrated our ultimate goal in illuminants. We could not easily hope to attain the enormous temperature of the sun, but might reach an even better result by some means analogous to those utilized by the firefly, the light from which yielded an energy-curve with its maximum within the visible spectrum.

MR. J. W. HOWELL said that the reason for the spectra of the various glow-lamps



Wave-length.
FIG. 9.

resembling each other so closely seemed to lie in the fact that, though their temperatures differed somewhat among themselves, they lay relatively near together, compared with the temperature of the sun.

MR. A. H. KELLOG drew attention to the claims made for some illuminants—for the tungsten lamps for instance—that the whiteness of their light enables the colours of illuminated objects to be more easily discriminated than in the case of other sources. In view of Dr.

Nichols's conclusions as to the similarity of the spectra of such illuminants, were we to regard these claims as unjustifiable ?

Mr. P. S. Millar remarked on the fact that in the case of artificial light the eye appeared to be satisfied with an illumination of about 3 foot-candles, in spite of the fact that daylight-illumination was usually so much higher. Was this in any way connected with the difference in colour of daylight and artificial illuminants ?

In reply Dr. Nichols said that the general character of the spectra of two illuminants might appear very similar, and yet colours, illuminated by the two sources, might present very different appearances. He thought that the difference in the intensities of the illumination desired in the case of daylight and artificial illumination might be partially attributed to the greater diffuseness of the former. He understood that it was an established fact that people expected a higher order of illumination to read by in rooms lighted by concealed sources.

It was improbable that temperatures very much higher than that of the carbon arc would ever be used for the production of light. There was still an almost untouched field for research in luminescence and phosphorescence effects. The difficulty, of course, was that in such cases a narrow band of light was almost invariably produced, instead of a continuous spectrum. Conceivably, by securing overlapping bands it might be possible to imitate natural daylight fairly well.

Bees and Ultra-Violet Light.

Lord Avebury, in the course of a lecture recently delivered at the Franco-British Exhibition, referred to the range of frequency of light-vibrations visible to bees. These insects, he thought, could certainly distinguish colour, though the range of colour that appealed to them might be different from that recognized by us. There was reason to believe, for instance, that ultra-violet light, which could not be detected in the form of light by our eyes, was visible to theirs.

A Novel Use for Incandescent Gas-lights.

A novel method of dealing with sewage gases has recently been proposed by the city engineer and bacteriologist of Winnipeg. The gases are led up the lamp-post to an incandescent gas-burner, where the bad air feeds the flame, and so becomes automatically sterilized.

It is stated that one lamp per 500 feet of sewer would be required, and that the expense would be at least no higher than that of existing systems of ventilation. The effectiveness of the method was tested by allowing the air to impinge upon glass plates containing suitable culture-media, both before and after passage through the burner. As a result it was found that a plate which was exposed to the gas *before* entry developed several hundred micro-organisms. In the case of the gas which had passed through the burner, however, not a single germ could be detected.—*The Acetylene Journal,* Chicago.

Light and Colour in Decoration.

By G. Leland Hunter.

(Abstracted from the *Transactions* of the Illuminating Engineering Society, March, 1908.)

Mr. Hunter dealt mainly with the value of lighting effects from the decorative standpoint. He commented upon the marvellous development in our methods of producing light, but remarked that we had yet to learn to employ our tools skilfully.

The author especially emphasized the necessity of avoiding violent contrasts either of light or colour, and drew attention to a common misconception that, in order to balance the effect of, say, a pronounced red-coloured wall-paper, a room ought to be illuminated by sources of light screened by means of green shades. The effect of this was that where the green light, coming through the semi-transparent shade, struck the wall, the latter appeared "muddy" and dark, while its red appearance was intensified by the bright patches of light from unshaded portions of the illuminant. The author contended that the correct course in such a case is to use a *red* shade, for naturally only red light is of any real service in illuminating such a background. In the same way the colour of a mercury lamp is less marked when used to illuminate green foliage, &c.

Mr. Hunter also put in a plea for the use of light in order to illuminate walls and ceilings. Many illuminating engineers were only content when they had arranged that the light was almost entirely cast in a downward direction upon the table, &c., that it was mainly intended to illuminate. Thisideawasincorrect, however, because the violent contrast of light and shade so caused was in itself distracting to the worker. Apart from this the walls and ceilings of a tastefully decorated room were in themselves deserving of illumination. Dark walls and ceilings should be avoided as far as possible from the point of view of successful illumination. When this was impossible the sources of light should be distributed, and, above all, should be enclosed in suitable globes so as to break the light up without the assistance of the reflecting power of surroundings.

The author also remarked upon the effect of different colours in causing the background to recede or advance; this, he seems to suggest, depends more upon difference in shade than difference in colour. The nature of the illumination adopted, and the amount of light that is to be allowed to fall upon the surroundings, also depends upon the dimensions of a room—on the height of a ceiling for instance. A light which would be dazzling to the eye three feet away is less so at nine. The decorator is often in a position to modify or accentuate the effects originally produced by the architect. For instance, if the ceiling of a small room gives the impression of being too high, this impression may be corrected by keeping the ceiling and floor dark and the walls bright. In general, however, floors should be dark in pattern, so as to give the impression of security. People frequently slip on parquet floors, not so much because the surface is slippery, as because it appears insecure.

In the discussion that followed the paper, Mr. H. F. Huber pointed out how the decorator could assist the scheme intended by the architect, and the illuminating engineer could assist the decorator. In order to secure a harmonious result all the trades interested must co-operate and learn to appreciate each other's point of view.

Mr. E. Y. Porter questioned the suggestion of Mr. Hunter that a glaring source became less troublesome to the eye as the distance of the eye was increased. Roughly speaking, the brightness per unit area of the image formed upon the retina is independent of the distance. Dr. Louis Bell pointed out that the colours of ordinary decorative papers were rarely pure. Mr. A. J. Marshall said that for all ordinary purposes it was really most essential to throw the majority of the light downwards. If one relied upon the reflected light from walls and ceilings for this purpose it certainly became very expensive. On the other hand, he agreed that the upper part of the room ought not to be in actual darkness.

In replying, Mr. Hunter said that, with reference to the point raised by Mr. Porter, one undoubtedly did find in practice that the nearer the eye to a bright source the more trying the effect. This became very evident if one placed a naked filament lamp a few inches from the eye.

REVIEWS OF BOOKS.

Les Nouveaux Modes d'Eclairage Electrique.

BY A. BERTHIER.

(*H. Dunod et E. Pinat, Paris.*)

THE main object of this book is to furnish an up-to-date description of the most modern methods of electric lighting. The chapters devoted to definitions of terms used in illumination and photometry, while mentioning instances of the most recent progress in photometers, &c., hardly serve to do more than afford an indication of the scope of this subject.

Chapter iii., however, contains an interesting and readable discussion of the scientific basis underlying the production of light, including a résumé of the recent developments in the theory of radiation.

The main portion of the book, occupying rather over 200 pages, is devoted to a résumé of the three methods of electric lighting by arc-lamps, glow-lamps; and vapour-lamps respectively. The description of the various lamps and the scientific principles involved is readable and up to date. We find, for instance, reference to such sources of light as the magnetite arc, the Küch mercury vapour lamp, and the Moore tube, and the section dealing with glow-lamps contains a brief summary of the recent work in attempting the manufacture of filaments of zirconium, niobium, silicon, &c. We notice a few misprints, of which "Hollfreund" for *Hollefreund*, "Zernig" for *Zerning*, and "Wittmann" for *Whitman* are examples.

The contents of the book are presented in an attractive and readable form, and it should be of service to those anxious to form some conception of the recent developments in electric lighting. Without detracting from the value of the book, we might suggest that fuller details of the exact references from which the author is quoting would sometimes be desirable. In some instances the references are given in full; in others, however, the journal quoted from is mentioned without date, and in others again only the authority is cited. This is the more to be regretted because the author seems to be in touch with international literature dealing with his subject, and makes many references which the casual reader would probably wish to follow up in detail.

Traité Théorique et Pratique de la Fabrication du Gaz.

BY E. BORIAS.

Second Edition, revised by E. BORIAS and M. FRÉCHOU.

(*Librairie Polytechnique ch. Béranger, Paris.*)

SOME idea of the extent of the ground covered in this book will be gathered from the fact that it consists of exactly 600 pages. As its title suggests, the book deals mainly with problems of generation and distribution of gas, although there are also chapters included on its application to heating and lighting purposes in practice.

The first two chapters are given up to a review of combustible minerals and apparatus for distillation, the process of distillation, refinement, and storage being considered more completely in chapters vii. to xii.

Chapters iii., iv., and xviii. deal with the application of gas for heating purposes, chapter iv. containing a scientific discussion of flame temperature and calorific values and their measurement. Other portions of the book deal with the design and management of retorts, chimneys, and the production and analysis of ammoniacal liquors. Of chief interest from our point of view are chapters xvi. and xvii., which deal with the use of gas for lighting and photometry respectively. We feel, however, that, though the avowed object of this book is to deal with problems of generation rather than with illumination, it would be well if, in future editions, a little more attention were bestowed on this subject in a chapter specifically devoted to gas lighting. Actually the chapter deals with theories of combustion, illuminating power, burners, and ventilation, but hardly touches on the subject of illumination proper. The chapter on photometry also hardly seems to contain as full treatment as we should expect to find in a book of the size and scientific scope of that undertaken by M. Borias. The single page devoted to standards of light (p. 456) seems to convey the impression that England and Germany still rely upon candles as photometric standards, and that the Vernon Harcourt and Hefner standards have merely been suggested and never came into actual use, and the only standard described is the Carcel lamp.

However, bearing in mind the main objects of the book and the extent of the ground to be covered, we do not doubt that this will be found a very useful book of reference to the gas engineer interested mainly in this aspect of the subject. Matters more closely connected with problems of generation are referred to from a scientific standpoint, and with greater detail. One feature of the book which should be found of special value is the exceptionally generous use of tables giving data of analyses, &c., often of a nature not easily found when wanted.

The contents of the 88 pages devoted to the initial tables constitute an interesting illustration of the amount of scientific information with which the expert gas engineer of the present day is expected to be acquainted.

Publications Received.

[We mention below a few of the books and pamphlets which have reached us during the present month, to some of which we mean to refer in greater detail in a subsequent number.]

Le Nuove Lampade Ellettriche ad Incandescenza. By G. Mantica. (Milan, Biblioteca dell' Associazone Utenti Energia Ellettrica d'Italia.)
A text-book devoted to the incandescent lamp, and including a review of the most recent developments in graphitized and metallic filaments.

Lichtstrahlung und Beleuchtung. By Paul Högner. (Brunswick, Friedr. Vieweg & Sohn.)
A treatise on illumination and the distribution of light, including particulars of the polar-curves of various illuminants and their application to the calculation of ground illumination, &c., under practical conditions.

Indirekte Beleuchtung von Schul- und Zeichen Sälen mit Gas und elektrischem Bogenlicht. (Berlin and Münich, R. Oldenbourg.)
A very complete account of the researches carried out by the commission appointed by the Deutscher Verein von Gas- und Wasserfachmännern, on the lighting of various schools in Münich.

Vorschriften für die Lichtmessung an Glühlampen nebst Photometrischen Einheiten. (Berlin, Julius Springer.)
A copy of the regulations relating to the photometry of glow-lamps, and the photometric units as prescribed by the Verband deutscher Elektrotechniker.

Über Schaufensterbeleuchtung mit Pharos-Licht.
A reprint from the *Journal für Gasbeleuchtung* containing particulars of some examples of shop lighting by gas at the recent Augur exhibition in Berlin.

We have also to acknowledge the receipt of an excellently got-up series of bulletins and papers on various matters connected with gas-lighting published by the Welsbach Co., Gloucester, New Jersey, U.S.A.

CORRESPONDENCE.

The City Lighting.

To the Editor of ' The Illuminating Engineer.'

SIR,—from the Report of Mr. Voysey on the Public Lighting of the City of London, which you printed in full in your last number, I am glad to see that he has "formed the opinion from observation and testing that the minimum illumination is the most important factor in good lighting." As you are aware, I have advocated for several years that comparisons of street illumination should be based on the minimum illumination obtained in any part of the road or pavement; but as there are still those who believe that such comparisons should be based on the average illumination, it is gratifying to note that Mr. Voysey, with his wide experience, both of testing and adjudicating on various methods of street illumination, has come to the same conclusion.

I sincerely trust Mr. Voysey will be permitted to carry out the whole of the scheme he proposes, namely, to erect large units of light in the main streets in such positions as to also illuminate the smaller branch streets for a certain distance, combined with smaller units of lights for the remainder of the side streets, which could be lighted and extinguished automatically at the same time as the large units, as such a scheme would result in the City being probably the best and most economically illuminated capital in the world. Yours, &c.,

HADYN T. HARRISON, M.I.E.E.

To the Editor of ' The Illuminating Engineer.'

July 17th, 1908.

DEAR SIR,—I have followed Mr. Voysey's remarks on street lighting with great interest.

Though the report deals mainly with matters of fact and observation, rather than of opinion, there is one point, it seems to me, which Mr. Voysey might have insisted on more rigidly, namely, the importance of uniformity of illumination. A dull, uniform illumination is much better than a bright, patchy one, at any rate from the physiological standpoint; and from this point of view flame arcs with inclined carbons are unsatisfactory.

The lighting of Holborn Circus appeared to me, during my visit last winter, to be a case in point. The illumination, on the whole, seemed to be brighter than in the adjacent streets, but the irregularity of the ground illumination rendered the result less effective than it should have been.

I hope that in street illumination projects of the future some form of vertical carbon flame lamp will be used, so that the illumination of the surface may be as complete as possible.

I am, yours very truly,

E. W. MARCHANT.

DEAR SIR,—Referring to the Editorial in your last issue, I think the establishment of an independent authority for photometric measurements would have much to recommend it. Such an arrangement would probably be most satisfactory to those electrical engineers who, like myself, believe that modern arc-lamps have nothing to fear from any system of gas-lighting.

The street-lighting in Manchester is already under observation by a department independent of both the gas and electric lighting concerns, and photometric tests are constantly made on the various lamps installed in the streets. Unfortunately it is, at present, extremely difficult to obtain a basis of comparison that would be mutually satisfactory to everybody concerned.

I think most authorities are agreed that for the best results the following conditions would have to be fulfilled :

1. High average illumination.
2. The smallest possible difference between the highest and lowest illumination.
3. A few powerful lights placed high up, as far as possible above the line of sight, giving illumination curves with long gentle gradients.

I believe that the ratio between the highest illumination and the lowest illumination is as important as the minimum illumination. Patchiness of illumination, particularly where a large number of small points of light are distributed over the surface, is most confusing to the traffic and trying to the eyes.

Few realize the sensitiveness of the eye undisturbed by patches of brilliant light. An interesting experiment of Sir William Huggins was to place an observer in a room from which all light was as far as possible excluded, and the window blocked by one inch boards covered by several thicknesses of dark brown paper. Bright summer sunlight was shining upon the exterior brick wall of the room, and although absolute darkness was the impression given when first entering the room, it was found that after the stay of half-an-hour or so, the observer could distinguish objects, and see his way dimly about the room.

The colour of the light is also an important factor in giving good visual illumination apart from what I may term photometric illumination.

The interesting article by Dr. Louis Bell in your June issue deals with this very clearly, and I believe it is now generally admitted that a slightly yellowish light is more comfortable to work by than a white, greenish, or bluish light. This, at any rate, holds good after sunset hours.

There is no doubt that for any comparisons of two systems of lighting, each system should be installed in the manner deemed best by its advocates, with due regard to traffic obstruction, &c., but I fear that even then the best photometric experts might not come to conclusions satisfactory to everybody.

It is possible that a 'bus driver, for instance, would have different views on the matter. I have frequently listened to their criticisms of lighting with great interest.

After all, rivalry is very essential for progress, and gas probably owes as much to electric lighting as electric lighting owes to the incandescent gas-mantle.

I remain, Sir,
Yours faithfully,
A. DENMAN JONES.

Acetylene v. Petrol-Air Gas.

To the Editor of 'The Illuminating Engineer.'

DEAR SIR,—I beg to enclose herewith a reply to Mr. Bingham's paper on 'Acetylene *versus* Petrol-Gas' as follows.

ECONOMY.

1. *Cost of Apparatus.*—With regard to the first cost of the plant for the rival systems, the advantage in the smaller sizes is with the "acetylene," but for larger sizes such as 150 up to 1,000 lights this advantage entirely disappears, and is rather on the other side. The comparisons given on p. 548 are, as far as the De Laitte plant is concerned, erroneous. For instance, this states that a 20-light De Laitte plant costs 48*l*. 10*s*., whereas that is the price of a 30-light machine. 70*l*. is stated to be the cost of a 50-light plant, whereas that is the catalogue price of the 70-light plant, and 90*l*. the price for a 100.

Moreover, whereas the Acetylene Gas Plant Manufacturers rate their machines upon the 30 C.P. basis, we rate ours on a 50 C.P. basis, so that, light for light, our 30-light machine is equal to an acetylene plant of 50-light capacity, and so on in proportion, so that on the 30 C.P. basis for the 90*l*. mentioned on p. 548 a "De Laitte" plant of 166-light capacity may be obtained.

2. *Cost of Piping*.—In this country very small piping is generally used for acetylene; this small piping is more economical than the ordinary size gas-piping such as is used with coal gas and the De Laitte gas also. It is more easily concealed in mouldings, &c., but experience has proved that the deposit from acetylene comparatively soon chokes these small-diameter pipes, with the result that considerable expense is incurred in cleaning them out, or they have to be renewed entirely.

In Australia, where acetylene is very largely used, this difficulty caused by the stoppage of pipes has long been recognized, with the result that large-size pipes are invariably used, the advantage claimed under this head in the first instance being thereby eliminated.

3. *Cost of Burners*.—It is true that the first cost of an acetylene burner is very considerably cheaper than that of a burner specially designed for use with petrol gas; but it must not be forgotten that whilst the life of a petrol gas burner is anything from 4 to 8 years, owing to the deposit caused by the gas, the former becomes choked in a few months.

4. *Fittings*.—The cost of these would be the same for either gas, but the choice of upright or inverted burners gives to petrol gas a distinct advantage as far as design is concerned.

5. *Cost of Running*.—Careful tests have shown that the costs for maintaining a 40 to 60 candle-power burner with petrol at 1*s*. 4*d*. per gallon to be one-fourteenth of a penny. These figures can be proved at any time with comparatively little trouble by any one sufficiently interested.

SAFETY.

Safety in the Dwelling.—It is well known and admitted by Mr. Bingham in his paper that there is no record of any explosion having taken place through the escape of petrol-gas in the building, but a glance through the files of our newspapers reveals many such explosions caused by acetylene.

Safety of Plant.—As regards the gas-generating plant, many of the leading fire insurance companies now recognize the absolute safety of the De Laitte plant, and have removed all restrictions.

Safety of Raw Material.—With regard to the raw material itself, this in the case of the De Laitte system is stored in patent storage tanks of such absolute safety that whether they are full, half full, or nearly empty, a lighted match even can be dropped into the tank and the resultant flame extinguished by means of a piece of paper, such a thing as an explosion being absolutely impossible.

From the extract of the *Revue des Éclairages* of January 15th last an erroneous conclusion is drawn, the thirty-seven accidents reported as having been caused by petrol refer to the motor industry and not petrol-lighting, whilst it is admitted that two at least were caused by acetylene.

HEALTH.

(*a*) *Effect on the Eyesight*.—As it is an indisputable fact that the petrol gas light is practically the only lighting in which the ultra-violet rays are absent, further comment on this subject is unnecessary.

(*b*) *Effect on the Atmosphere of the Room*.—With the properly regulated petrol gas burner no additional oxygen is taken from the air of the room.

Many unbiassed users of acetylene light admit the feeling of lassitude which attacks them after remaining an hour in a room which is lighted by that means.

CONVENIENCE.

I am glad to see the admission made that it is easier to fill the petrol tank with liquid than to fill the trays of an acetylene generator with carbide and remove the "sludge," which is a particularly appropriate name for the offensive residue.

An additional advantage which has been lost sight of by Mr. Bingham is that with the petrol gas plant the supply can be renewed whilst the machine is working.

My answers to the alleged disadvantages of petrol gas are as follows :

1. Petrol gas as manufactured by the De Laitte system cannot, at any rate in the inhabited parts of the world, revert to a liquid, since the vapour of any liquid will only revert to its former liquid form when the same temperature or a lower is attained as that at which it is given off, a temperature which in the case of De Laitte gas is minus 14 Fahrenheit, hence the imposibiity of condensation of the petrol, and as the air with which the petrol vapours are (in the case of the De Laitte machines) intimately mixed, is anhydrous, there is no possibility of condensation of the natural moisture, which would otherwise be present in the air.

2. With the De Laitte plant no hot air motor is used, no more attention or need of a " fairly clever mechanic to look after it," is necessary than is the case with an ordinary grandfather's clock, and where water pressure is available even this winding-up is done away with, and the plant will require attention only once in eight or ten weeks for the purpose of renewing the petrolsupply. So much cannot, I think, be said for acetylene.

The Objection to the Blackening and Bursting of Mantles, when the gas is first turned on, is entirely removed in the De Laitte plant owing to the intimate mixture of the gas when first made. There being no natural moisture in the air the vapour of the petrol is held in suspense.

GENERAL APPEARANCE.

It is admitted on all hands that, owing to the entire absence of ultra-violet rays, petrol light is the only light which shows persons and objects in their true colours, and a prettily and artistically decorated room is never seen to better advantage than when illuminated by petrol light in conjunction with inverted fittings and tastily designed shades.

CONCLUSION.

Throughout the whole of Mr. Bingham's paper I fail to find any reference made to the obnoxious smell inseparable from the charging of the acetylene retorts, the disposal of the " sludge," or, above all, from an escape owing to a leak in the pipe or the accidental turning on of a burner. Neither has Mr. Bingham called attention to the very great difference between the space required for a plant capable of supplying 100 lights, and this becomes more pronounced as the size of the plant increases.

I remain, yours faithfully,

J. Williams

(The De Laitte Gas Machine Syndicate, Ltd.)

The Temperature of the Sun.

Sir,—I notice in your abstract of Herr K. Sartori's recent paper on the temperature of incandescence of glow lamps, what seems to be an erroneous method of estimating the temperature of the sun.

The author applies Wien's law $\lambda_{max}.T = \text{constant}$, to the energy curve of the spectrum of sunlight *as it reaches us*. Probably, however, the maximum of the energy curve of solar radiation, in the condition in which it starts from the sun, would be very much displaced into the ultra-violet. We know from S. P. Langley's researches how influential is the effect of the earth's atmosphere in absorbing these rays, and how the energy maximum of solar radiation moves towards the blue end of the spectrum as we ascend a mountain.

Whether we are justified in applying Wien's law to solar radiation on general grounds or no, it seems highly probable that any result deduced from the energy curve, as obtained on this earth, must be too low.

I am yours truly,

I. Wanterno.

The Second Annual Convention of the Illuminating Engineering Society.

We have received a notice of the above Convention, which is to be held in Philadelphia, U.S.A., on Monday and Tuesday, Oct. 5th and 6th of this year. We wish to draw special attention to the extremely wide range of attractive subjects covered by the papers to be presented at the Convention. In order to facilitate discussion, it is proposed to circulate advance copies of these papers among the members of the Society attending the Convention, and then to read the various contributions in abstract or by title only.

Programme of Papers.

President's Address. By Dr. Louis Bell.

Architecture and Illumination. By Mr. Emil G. Perrot, Philadelphia.

Modern Gas Lighting Conveniences. By Mr. T. J. Litle, Jun., Philadelphia.

Railway Car Lighting. By Mr. H. M. Davies, Philadelphia.

Relation between Candle Power, Voltage and Watts of Different Types of Incandescent Lamps. By Dr. F. E. Cady, Washington, D. C.

Illuminating Value of Petroleum Oil. By Dr. A. H. Elliot, New York.

Structural Difficulties in Installation Work. By Mr. J. R. Strong, New York.

Street Lighting Fixtures, Gas and Electric. By Mr. H. Thurston Owens, New York.

Oil Burners. By Mr. W. T. Sterling, New York.

Design of the Illumination of the New York City Carnegie Libraries. By Mr. L. B. Marks, New York.

Intensity of Natural Illumination throughout the Day. By Mr. L. J. Lewinson, New York.

Calculation of Illumination by Flux of Light Method. By Messrs. J. R. Cravath, Chicago, and V. R. Lansingh, New York.

Specific Intensity of Lighting Sources. By Mr. J. E. Woodwell, Washington.

Design of Reflectors for Uniform Illumination. By Mr. A. A. Wohlauer, New York.

The Ives Colormeter in Illuminating Engineering. By Dr. H. E. Ives, Washington, D.C.

International Unit of Light. By. Dr. E. P. Hyde, Washington, D.C.

Some Experiments on Reflections from Walls, Ceiling, and Floors. By Messrs. V. R. Lansingh and T. W. Rolph, New York.

The International Electrotechnical Commission.

The first meeting of the International Electrotechnical Commission is to be held in London on Oct. 19th, and probably at the new home of the Institution of Electrical Engineers. It is expected that delegates from all the chief countries concerned will be present.

Review of the Technical Press.

ILLUMINATION.

AMONG the most important papers that have recently appeared bearing on this subject mention must be made of that of A. Broca and F. Laporte on the hygienic aspects of the principal illuminants from the point of view of eyesight (*Bull. Soc. Int. des Electriciens*, June). The authors have carried out an extensive series of tests on the effect of the mercury-vapour lamp and the carbon filament lamp on the eye, including experiments on the effect on visual acuity, speed of reading, and the contraction of the pupil orifice. On the whole, their results appear to suggest that no marked difference due to the colour of these two sources of light could be detected.

The authors also study the effect of varying the illumination on acuity, and come to the conclusion that a value of 20 to 40 lux suffices. They also condemn the placing of bright sources of light in such a way as to be visible to the eye, if only obliquely, as a prevalent cause of eye fatigue. Curiously enough they appear to have found that a bright source of light that was visible out of the tail of the eye increased acuity in some cases —possibly by causing the pupil orifice to contract—but the effect was also very fatiguing.

Schanz and Stockhausen have recently delivered a paper before the Verband Deutscher Elektrotechniker on the injury that may be caused to the eyes by ultraviolet light. They allude to the effect of these illustrated by cataract, inflammation of the eyelids, and snow-blindness. It is pointed out that ordinary glass does not provide a complete screen against these rays, letting through those between 0·4 and 0·3 μ, which the authors consider to be amongst the most injurious. They then proceed to describe a type of glass termed "Euphos," which, they claim, has the property of absorbing the most obnoxious rays completely.

Cravath and Lansingh (*Elec. World*, July 11) contribute an article giving some approximate data for the predetermination of illumination. A table is also provided specifying the approximate number of watts per square foot of floor area that must be allowed in order to secure an illumination of one foot-candle in the case of a series of different illuminants and different arrangements of them. The results refer to a plane 30 inches from the floor. Two values are quoted in each case, corresponding to a room with light and dark wall-papers and decoration respectively.

The Electrical Review of New York (June 11th) contains an article by Lansingh on illumination from the contractor's point of view. Here the necessity for attention on the part of the modern contractor to illumination problems, as distinct from the study of matters of wiring only, is insisted upon.

Wohlauer (*Elec. World*, July 4th) again discusses the problem of securing a perfectly uniform horizontal ground illumination. He deduces the form of polar curve necessary in order to obtain a given intensity of uniform illumination, and works out some formulæ connecting the distance between the lamps, the height of suspension, and the degree of illumination required. Assuming certain premises, he shows how to calculate the number of lamps required by means of a simple formula.

A recent number of *The Electrical World* also contains an account of the illumination of the Singer tower by a somewhat novel method, involving the lighting up of the exterior by means of shielded glow-lamps and search lights; the article is accompanied by several interesting photographs and diagrams showing the general effect and the number of lamps required throughout the building.

PHOTOMETRY.

The report of the Committee on Photometry of the Verein von Gas- und Wasserfachmännern has now been published.

The Committee have been considering the possibility of adopting the regulations of the Verband Deutscher Elektrotechniker, designed for the photometry of electric lights, in the case of gas-lamps. They adopt the mean lower hemispherical candle-power of the source of light as the best basis of comparison, though they insert a caution against the application of this factor too rigidly, without due regard to the special circumstances of the case under consideration. They also discuss the applicability of the Ulbricht globe to the photometry of gas - lights. The main consideration in this case is the possibility that the confined space in which the source is enclosed might cause the air-supply to differ from that occurring when the lamp is in actual use. It is known that a very small difference in this respect may very seriously affect the performances of inverted burners. The Committee, however, decide to make further researches on this point. Other matters dealt with in the report include details of gas-testing and the effect of transmission for long distances under pressure, on the calorific and illuminating power of the gas ultimately delivered. Both these quantities appear to be but slightly affected.

Krüss (*J.f.G.*, July 4th) describes a new form of integrating photometer of the mirror type. He points out that in photometers of this class it is necessary to introduce the factor "cos a" referring to the angle a at which the ray strikes the mirrors, and explains how this was attained by Blondel, Matthews, &c. He himself utilizes a series of lenses to concentrate the individual beams and introduces the required correction for "cos a" by placing suitably graded stops in front of them.

Paulus completes his article on different methods of measuring the mean horizontal candle-power of glow - lamps (*Z. f. B.*, June 30th). He comes to the conclusion that neither measurement in a single direction nor measurement with a mirror can yield correct results in the case of metallic filament lamps, because both these methods demand an approximately uniform distribution of light.

The rotation method, which is not open to this objection, was found to yield much better results, the author recommending a frequency of rotation of from 40 to 80 per minute. Under these circumstances the centrifrugal force does not suffice to produce any marked deformation, and it is stated that no lamps were broken in the rotating holder, notwithstanding the fact that many were smashed in transport. The author also quotes figures to show that the "flicker" at this speed did not seriously interfere with the accuracy of observation. The portable photometer of Siemens and Halske is described in the *Zeitschrift für Beleuchtungswesen* (June 30th); it will be remembered that this was dealt with in the review for June (*Illuminating Engineer*, June, p. 523).

Electric Lighting.

Several interesting papers were read at the annual meeting of the Verband Deutscher Elektrotechniker last month, but they have only been shortly referred to as yet, and we still await complete publication. Special interest attaches to that by Wedding on recent progress in electric illuminants, and Remané on the effect of overrunning metallic filament lamps, and a comparison between the upkeep of small arc-lamps and high candle-power osram lamps. Remané has also contributed an article on the subject of the 1 watt per H.K. glow-lamp to a recent number of the *E.T.Z.* He quotes a number of data on the relative costs of lighting by metallic filament lamps and gas, and seeks to show that the 1 watt per H.K., 16 candle-power, 220 volt lamp will not really be desired either by supply companies or the consumer, because electricity can now compete with gas even when lamps of 25 or even 35 H.K. are available. Moreover, he points out that the gas companies have habitually used units of 50 to 60 H.K., and would ridicule the use of 16 H.K. units. In reality, therefore, the coming of the 1 watt per H.K. glow-lamp only enables the consumer to secure an amount of light he ought by rights to demand, but could not hitherto obtain cheap enough.

In opposition to this view it is interesting to note that Wedding, in the article above referred to, speaks of the 220 volt 16 H.K. lamp as the ultimate goal of the lighting industry.

Remané, however, also expresses the hope that the lamp-makers will not be forced to supply high voltage and low candle-power lamps, because he feels that there is no prospect of producing such lamps to give as good results as those obtainable for low voltage ones. This has already been their experience in the case of the carbon lamps, and is yet more true of the metallic filament ones.

Another interesting comment on this question is furnished by some tests, pub lished in the *Elektrotechnische Zeitschrit* for June 4th, on the 220 volt Just-Wolf ram lamps, according to which the lamps gave excellent results both on direct and alternating current running, however, at an efficiency of about 1·25 watts per H.K.

The prospects of the tungsten lamp also form the subject of a recent paper by Tweedy (*Elec. World* and *Elec. Review* of New York, July 4th).

A reference has also appeared in several of the American papers of a somewhat remarkable development of the Helion lamps; it is now claimed that these lamps can be run in the open-air instead of in an exhausted globe, as was formerly found to be necessary.

Mention may be made of a contribution by Duschnitz (*Elek. Anz.*, July 5 and 16), and the serial contribution in the *Zeitschrift für Beleuchtungwesen*, which have just been brought to a conclusion. Both these articles deal with recent developments in the manufacture of glow-lamp filaments, and contain references to the patent literature on the subject.

Schmidt (*Elek. Anz.*, July 23rd and 26th) contributes an interesting discussion of street-lighting by electrical methods. The article is especially interesting, in that it brings out the number of factors on which the relative economy of different systems depends. For instance, in addition to the cost of energy and maintenance of a given light we must bear in mind the number of lights that can be run in series off the supply and the system of supply adopted. A wide field for economy is also afforded by the choice of the method of grouping lamps, the number that are allowed to burn all night or half-nightly, &c. In this connexion the author gives a table showing the time that such lamps may be expected to have to burn in the different months in the year.

Finally, we may refer to a device that has been described in several of the German technical papers, its object being to draw attention to the behaviour of any distant arc-lamp, out of the observer's sight, that is not burning satisfactorily. This is accomplished by placing a number of glow-lamps on a central board visible to the observer, each of these being on a parallel with the particular lamp it is desired to study. Any abnormality in the behaviour of an arc-lamp and resulting fluctuations in the P.D. across it, is immediately indicated by the glow-lamp in parallel.

Gas, Oil, and Acetylene Lighting.

At the annual meeting of the Société Technique de l'Industrie du Gaz a number of short papers dealing with subjects of more or less interest to the illuminating engineer were read; these have been briefly reported in recent numbers of the leading English gas journals. One of the most interesting subjects brought up was the use of hydrocarbons derived from coal-tar for incandescent lighting. Portable lamps using derivatives of this nature have already been used in France and elsewhere with very satisfactory results, and it is stated that it is now possible to get half as much light from the coal-tar remaining after distillation as could formerly be obtained from the entire bulk of gas generated.

At the recent annual meeting of the corresponding German society Drehschmidt described the public lighting in Berlin, his address being briefly reported in the *Journal für Gas*, &c. (June 27th).

In a recent number of the *Journal of Gaslighting* some interesting particulars are given of a simple method of increasing the lighting efficiency of a burner. This consists in merely slipping a solid refractory conical body over the crutch on which the mantle is supported. The effect of this heated body is beneficial in directing the flame on to the mantle, and also, possibly, in raising the temperature. At any rate, it is stated that an increase in efficiency of 20 per cent is gained.

It is also stated that the wear and tear of the mantles is reduced, partly because the flame is steadied and the mantle does not rattle to and fro through draughts, and partly because the rapid heating and cooling that is supposed to be injurious to the ordinary mantle is modified by the presence of the heated body.

Grey (*Amer. Gaslight Journal*, July 6th) contributes a discussion of the hygienic aspects of gas-lighting. He puts forward the plea that gas-lights in general improve the ventilation, by causing an ascent of heated air, and adds a number of useful references on the subject at the conclusion of the article.

Among other articles on the subject of gas-lighting mention may be made of those occurring in the *Zeitschrift für Beleuchtungswesen* bearing upon new processes of treating incandescent mantles. The article by Monasch on the photometry of portable oil-lamps, occurring in the *Journal für Gasbeleuchtung* some time ago, has now been translated in *The Progressive Age* (July 15th).

Finally, attention may be called to some tests by Wedding on the Keith high-pressure inverted lamp, published in *The Journal of Gaslighting* (July 14th).

List of References:—

ILLUMINATION.

Broca, A. and Laporte F. Etude des Principales Sources de Lumière au point de vue de l'Hygiene de l'Oeil (*Bull. Soc. Int. des Electriciens*, June, 1908, p. 277).
Cravath, T. R. and Lansingh, V. R. Helps in Rapid Preliminary Calculation of Illumination (*Elec. World*, July 11).
Dagget, H. M. High Efficiency Illuminants (paper read before the Illuminating Engineering Soc., June 19).
Lansingh, V. R. The Contractor and Illumination (*Elec. Rev.*, N.Y., June 11).
Marshall, A. J. and Rolph, T. W. Artificial Lighting of Schoolrooms (*Illum. Eng.*, N.Y., July).
Schanz and Stockhausen. Die Schädigung des Auges durch die Einwirkung des ultravioletten Lichtes (paper read before the Verband Deutscher Elektrotechniker, abstr. *E. T. Z.*, June 25).
Wohlauer, A. A. The number of Lamps for uniform illumination (*Elec. World*, July 4).
The Boston Finance Committee and Street-lighting (*Elec. World*, June 27).
The Illumination of the Singer Building Tower (*Elec. World*, July 4).

PHOTOMETRY.

Krüss, H. Integrierendes Photometer (*J. f. G.*, July 4).
Morton, F. W. The History of Photometric Standards (*J. G. L.*, June 30 and July 7, abstr. from *T. I. E. S.*).
Paulus, C. Vergleich der verschiedenen technischen Methoden zur Bestimmung der mittleren Horizontallichtstärke von Metallfadenlampen (*Z. f. B.*, June 30).
Bericht der Lichtmesskommission (Report of Committee on Photometry appointed by the Deutscher Verein von Gas-, &c., abstr. *J. f. G.*, June 20).
Neues tragbares Photometer für elektrische Glühlampen (*Z. f. B.*, June 30, see also Schweiz., *E. T. Z.*, April 25, mentioned *Illum. Eng.*, June).

ELECTRIC LIGHTING.

Duschnitz, B. Metallische Leuchtfäden und Metallfadenlampen in der Fabrikation und in der Praxis (*Elek. Anz.* July 5 and 16).
Remane, H. Beitrag zur Klärung der Frage betreffend die kunftige Entwickelung der einwattigen Lampe und der elektrischen Beleuchtung (*E. T. Z.*, June 11).
Der Einfluss von Uberspannungen auf die Lebensdauer von Metallfadengluhlampen.
Vergleich von Betriebskosten kleiner Bogenlampen und hochkerziger Osramlampen (two papers read at meeting of the Verband Deutscher Elektrotechniker, abstr. *E. T. Z.*, June 25).
Schmidt, J. Ueber elektrische Strassenbeleuchtung, deren Systeme, und ihre Rationellität (*Elek. Anz.*, July 23).
Tweedy, E. F. The Tungsten Lamp (*Elec. Rev.*, N.Y., and *Elec. World*, N.Y., July 4).
Wedding, W. Uber neuere Errungenschaften der elektrischen Beleuchtung (paper read before the Verband Deutscher Elektrotechniker, abstr. *E. T. Z.*, June 25).
Die Just Wolfram Lampe für 220 volt (*E. T. Z.*, June 4, 1908).
Bogenlampen-Indikator (*E. T. Z.*, July 2, *Elek. Anz.*, July 9).
The Helion incandescent Lamp (*Elec. World*, N.Y., June 27).
Street-lighting in St. Louis (*Elec. World*, N.Y., July 4).
Fortschritte in der Glühlampen-Industrie (*Z. f. B.*, July 10).
Fortschritte in der Beleuchtungswesen des Bergwerksbetriebes (*Z. f. B.*, July 20).

GAS LIGHTING, OIL, AND ACETYLENE LIGHTING, &c.

Denayrouze. Use of Hydrocarbons derived from Coal-tar for incandescent lighting (*J. G. L.*, July 7).
Drehschmidt. Uber die öffentliche Beleuchtung in Berlin (paper read before the Deutscher Verein von Gas-, &c., reported *J. f. G.*, June 27).
Editorials. Electric Competition (*Progressive Age*, July 1).
Street lighting in the City of London (*G. W.*, July 11).
Grey, J. C. The Hygiene of Burning Gas (*Am. Gaslight Jour.*, July 6).
Monasch, B. The Photometry of Portable Oil Lamps (*Progressive Age*, July 15, trans. *J. f. G.*).
Wedding, W. Tests on the Keith High-Pressure inverted Lamp (*J. G. L.*, July 14).
The Annual Meeting of the Société Technique de l'Industrie du Gaz (*G. W.*, June 27).
A simple discovery increases lighting efficiency (*J. G. L.*, July 14).
Zur Frage des nächtlichen Schliessens einer Hausgasleitung (*J. f. G.*, June 27, July 11).
Verfahren zur Herstellung von Glühstrumpfen (*Z. f. B.*, July 10).
The International Congress on Acetylene, papers read before (*Acetylene*, July).
L'Eclairage des chemins de fer (*Rev. des Eclairages*, July 15).

CONTRACTIONS USED.

E. T. Z.—*Elektrotechnische Zeitschrift.*
Elek. Anz.—*Elektrotechnischer Anzeiger.*
Elektrot. u. Masch.—*Elektrotechnik und Maschinenbau.*
G. W.—*Gas World.*
J. G. L.—*Journal of Gaslighting.*
J. f. G.—*Journal für Gasbeleuchtung und Wasserversorgung*
Z. f. B.—*Zeitschrift für Beleuchtungswesen.*
T. I. E. S.—*Transactions of the Illuminating Engineering Society.*

PATENT LIST.

PATENTS APPLIED FOR, 1908.

I.—ELECTRIC LIGHTING.

12,736. Adjustably suspending incandescent lamps. June 13. C. E. Heldbek, 72, Cannon St., London.
12,968. Filaments for glow lamps (C.S.). June 17. H. Kuzel, 322, High Holborn, London. (Addition to 28,154/04.)
13,015. Incandescent lamps. June 18. J. Gray, 83, Cannon Street, London.
13,029. Metal filaments for incandescent lamps. June 18. T. W. Lowden and The Westinghouse Metal Filament Lamp Co., Ltd., Westinghouse Building, Norfolk Street, Strand.
13,100. Arc lamps (C.S.). June 19. Miertschke, 65. Chancery Lane, London.
13,230. Lamp-holders. June 22. W. Fennell and W. P. Perry, 68, Dudley Road, Tipton, Staffs.
13,275. Arc lamps. June 22. The British Thomson-Houston Co., Ltd., and W. H. Dalton, 83, Cannon Street, London.
13,449. Incandescent lamps (C.S.). June 24. P. G. Triquet, 70, Chancery Lane, London.
13,580. Arc lamps (C.S.). June 27. Siemens Bros. Dynamo Works, Ltd., and C. R. Riber, York Mansion, York Street, Westminster.
13,661. Fittings for incandescence lamps (C.S.). June 27. A. G. Bloxam, Birkbeck Bank Chambers, London. (From Siemens Schuckertwerke G. m. b. H., Germany.)
13,733. High voltage adaptor for metallic filament lamps. June 29. F. Wisotzky, "Rose Lea," Station Road, Hendon, London.
14,183. Metallic filament lamps for high intensity of light (C.S.). July 3. (I.C., June 22, 1908, Germany.) W. Majert, 18, Southampton Buildings, London.
14,184. Metallic filaments for incandescent lamps. July 3. W. Majert, 18, Southampton Buildings, London.
14,237. Arc lamps. July 4. E. R. Grote, 40, Chancery Lane, London.
14,411. Electric lighting attachments (C.S.). July 7. A. J. Boult, 111, Hatton Garden, London. (From Benjamin Electric Manufacturing Co., U.S.A.)
14,436. Filament for incandescent lamps. July 7. The British Thomson-Houston Co., Ltd., I. W. Howell and H. H. Needham, 83, Cannon Street, London.
14,502. Metallic filament lamps (C.S.). July 8. (I.C., June 13, Germany.) W. Majert, 18, Southampton Buildings, London.

II.—GAS LIGHTING.

12,802. Turning lights on and off. June 15. G. Robson, 18, Southampton Buildings, London.
12,905. Globe-holders for inverted incandescent burners (C.S.). June 16. G. A. Akers, C. W. Akers, and A. E. Akers, 88, Chancery Lane, London.
13,204. Burning off gas mantles (C.S.). June 20. (I.C. Nov. 8, 1907, Germany.) H. Drehschmidt, 77, Chancery Lane, London.
13,324. Inverted gas arc lamp. June 23. F. G. Gumprecht, King's Oak Hotel, High Beech, Loughton, Essex.
13,439. Flash-light apparatus (C.S.). June 24. M. L. Krimer and G. A. Tee, 165, Queen Victoria Street, London.
13,621. Incandescent lighting apparatus. June 27. J. Webber, 18, Southampton Buildings, London.
13,693. Incandescent burners and anti-vibrating devices therefor (C.S.). June 29. T. Eaves, 4, St. Ann's Square, Manchester.
13,754. Incandescent lamps. June 29. E. C. P. Eddrup, H. F. Boughton, and W. H. Everson, 276, High Holborn, London.
13,828. Metallic incandescent mantle for lighting and heating (C.S.). June 30. H. Reeser and H. E. Bray, 20, Copthall Avenue, London.
13,912. Gas and air regulator for incandescent burners. July 1. C. J. Sutton and J. Rudd, Nelson Square, Bolton, Lancashire.
14,006. Incandescent mantles. July 1. L. St.-C. Fewings and Curtis's and Harvey, Ltd., 31, Basinghall Street, London.
14,061. Incandescent burners. July 2. A. C. Wigley and J. J. Rowe, 6, King Edward Parade, Ilford, London.
14,205. Means for carrying a shade or smoke consumer over an inverted incandescent burner. July 4. W. Beal, 128, Colmore Row, Birmingham.
14,253. Incandescent burners. July 4. C. Skaife and J. A. Gibson, 6, Lord Street, Liverpool.
14,470. Inverted incandescent lamp. July 8. W. Hotton, sen., 21, Charterhouse Buildings, Aldersgate, London.
14,631. Incandescent burners. July 10. W. Fitton, 4, St. Ann's Square, Manchester.

III.—MISCELLANEOUS

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

12,991. Electric or gas pendants. June 18. E. C. Peck, 151, Victoria Road, Old Charlton, Kent.
12,995. Oil lamps. June 18. J. McNair, 154, St. Vincent Street, Glasgow.

13,321. Artificial light globe or chimney. June 23. J. Wale, 161, New Kent Road, London.
13,752. Incandescence vapour lamps. June 29. A. Kitson, Birkbeck Bank Chambers, London.
14,472. Lamps. July 8. J. T. Smith, 111, Hatton Garden, London.
14,497. Controlling from outside whether light is used in a room. July 8. W. Becker II., 345, St. John Street, London.
14,608. Incandescent lamps. July 9. W. Majert, 18, Southampton Buildings, London.
14,657. Search lights. July 10. Siemens Bros. Dynamo Works, Ltd., and G. S. Grimston, 139, Queen Victoria Street, London.
14,688. Acetylene lamps (C.S.). July 10. I. Fizel *née* Bona, 6, Lord Street, Liverpool.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

12,257. Arc lamps. May 25, 1906. Accepted June 24, 1908. W. J. Davy, 40, Chancery Lane, London.
8,947. Incandescent bodies for lighting and heating (C.S.). I.C., April 19, 1906, Germany. Accepted June 24, 1908. Allgemeine Elektricitäts-Ges., 83, Cannon Street, London.
13,129. System for the electric lighting and heating of vehicles (C.S.). I.C. June 9, 1906, Germany. Accepted June 17, 1908. H. Grob, 37, Essex Street, Strand, London.
13,147. Enclosed arc lamps. June 6, 1907. Accepted June 17, 1908. J. Brockie, Birkbeck Bank Chambers, London.
13,190. Electrodes for arc lamps. June 6, 1907. Accepted June 17, 1908. H. T. Harrison and H. Hirst, 46, Lincoln's Inn Fields, London.
14,713. Arc lamp electrodes. June 26, 1907. Accepted July 8, 1908. H. S. Hatfield and F. M. Lewis, 18, Palmeira Square, Hove, Sussex.
15,367. Producing refractory conductors, particularly metal filaments. July 3, 1907. Accepted June 17, 1908. The British Thomson-Houston Co., Ltd., 83, Cannon Street, London. (From General Electric Co., U.S.A.)
15,510. Illuminating bodies for incandescence lamps (C.S.). I.C. July 11, 1906, Germany. Accepted July 8, 1908. Deutsche Gasglühlicht Akt.-Ges. (Auerges), 55, Chancery Lane, London.
15,798. Incandescent lamp with metal filaments (C.S.). I.C. May 31, 1907, Germany. Accepted July 15, 1908. H. Kuzel, 322, High Holborn, London.
16,034. Pocket electric lamp. July 12, 1907. Accepted July 15, 1908. W. Thomson, Royal Institution Laboratory, Manchester.
16,053. Arc lamps. July 12, 1907. Accepted June 24, 1908. H. S. Hatfield and F. M. Lewis, 18, Palmeira Square, Hove, Sussex.
16,431. Incandescence lamps. July 17, 1907. Accepted July 15, 1908. C. H. Stearn and C. F. Topham, 47, Lincoln's Inn Fields, London.
17,817. Making joints in metal filament lamps. Aug. 6, 1907. Accepted July 15, 1908. A. C. Hyde, 7, Crown Office Row, Temple.
23,116. Metal-cored flame carbons for arc lamps. Oct. 19, 1907. Accepted July 15, 1908. M. Railing, M. Solomon, and H. E. Crocker, Witton, Birmingham.
24,138. Arc lamps. Nov. 1, 1907. Accepted July 8, 1908. A. D. Jones, Hartham Works, Hartham Road, Holloway.
24,299. Obtaining cold electric light by high tension electricity (C.S.). I.C. Nov. 3, 1906, Germany. Accepted July 1, 1908. D. Timar and K. von Dreger, 7, Southampton Buildings, London.
24,707. Refractory conductors (C.S.). Nov. 7, 1907. Accepted July 8, 1908. The British Thomson-Houston Co., Ltd., 83, Cannon Street, London. (From General Electric Co., U.S.A.)
27,809. Incandescent lamps (C.S.). Dec. 17, 1907. Accepted July 8, 1908. E. C. R. Marks, 18, Southampton Buildings, London. (From Parker-Clark Electric Co., U.S.A.)
4,461. Filaments for illuminating and heating (C.S.). I.C. June 10, 1907, France. G. Michaud and E. Delasson, 7, Southampton Buildings, London.
5,783. Incandescent lamps (C.S.). I.C. March 16, 1907, U.S.A. Accepted June 17, 1908. J. W. Howell, 83, Cannon Street, London.
6,409. Incandescent filament lamps (C.S.). March 23, 1908. Accepted June 24, 1908. C. Pauli, 20, High Holborn, London. (Addition to 27,541/07).
9,636. Fittings for glow-lamps (C.S.). I.C. June 25, 1907, Germany. Siemens-Schuckertwerke G. m. b. H., Queen Anne's Chambers, Broadway, Westminster.
11,524. Metal incandescence filaments free from carbon (C.S.). I.C. June 8, 1907, Germany. Accepted July 15, 1908. Siemens and Halske Akt.-Ges., Birkbeck Bank Chambers, London.
11,603. Tungsten incandescence filaments (C.S.). I.C. June 8, 1907, Germany. Siemens and Halske Akt.-Ges., Birkbeck Bank Chambers, London. (Addition to 16,489/07).
12,656. Arc lamps (C.S.). I.C. July 8, 1907, Germany. D. Timar & C. von Dreger, 7, Southampton Buildings, London.
12,720. Incandescent lamp filaments (C.S.). I.C. July 13, 1907, France. Société Française d'Incandescence par le Gaz (Système Auer), 24, Southampton Buildings, London.
13,734. Electrodes for furnaces, radiators, lamps, &c. (C.S.). I.C. June 27, 1907, Italy. G. Cornaro, 72, Cannon Street, London.
14,483. Mounting metallic filaments and electrically soldering them in incandescent lamps (C.S.). I.C. July 8, 1907, Italy. S. Marietti, 72, Cannon Street, London.

II.—GAS LIGHTING.

13,648. Gas lamps. June 13, 1907. Accepted June 24, 1908. G. Helps, Izon's Croft, Ansley, Atherstone.
14,879. Inverted incandescent burner. June 29, 1907. Accepted July 8, 1908. J. H. Woodroffe, Clifton Villa, Finch Road, Handsworth, Staffs.

1,852. Incandescent mantles (C.S.). January 27, 1908. Accepted July 8, 1908. W. E. Lake, 7, Southampton Buildings, London. (From Akt.-Ges. Für Selas-Beleuchtung, Germany.)

3,055. Incandescent mantles (C.S.). I.C. Nov. 16, 1907, U.S.A. Accepted July 8, 1908. A. P. White, 28, New Bridge Street, London.

4,549. Inverted incandescent lamps (C.S.). I.C. May 1, 1907, Germany. Accepted July 1, 1908. M. Graetz and A. Graetz, trading as Ehrich and Graetz, 18, Southampton Buildings, London.

6,026. Incandescent mantles (C.S.). March 18, 1908. Accepted July 15, 1908. E. Ross, 56, Myddelton Square, London.

6,365. Gas-light pendants (C.S.). March 21, 1908. Accepted June 24, 1908. S. Chandler and J. Chandler, Birkbeck Bank Chambers, London.

6,468. Gas-mantles (C.S.). I.C. Aug. 10, 1907, U.S.A. Accepted July 8, 1908. P. R. Finch, 31, Bedford Street, Strand, London.

8,473. Gas pendants (C.S.). April 16, 1908. Accepted July 1, 1908. C. W. Kemp, 11, Burlington Chambers, New Street, Birmingham.

8,566. Inverted incandescent lamps (C.S.) I.C. April 18, 1907, Germany. Accepted July 15, 1908. Neue Kramerlicht G. m. b. H., 7, Southampton Buildings, London.

9,286. Nozzles for inverted incandescent burners (C.S.). I.C. Nov. 19. 1907, Germany. Accepted July 8, 1908, Deutsche Gasglühlicht Akt.-Ges. (Auerges.), 1, Great James Street, Bedford Row, London.

9,760. Lighting devices for street lamps, &c. (C.S.), May 5, 1908. Accepted July 8, 1908. O. Schubert, 18, Southampton Buildings, London.

10,856. Igniting street lamps (inverted incandescent) electrically (C.S.). May 19, 1908. Accepted June 24, 1908. F. T. Cotton, 8, Quality Court, Chancery Lane, London.

12,318. Inverted incandescent lanterns (C.S.). I.C. June 8, 1907, Germany. A. Luber, 77, Chancery Lane, London.

III.—MISCELLANEOUS

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

12,260. Combined electric and gas lamp (C.S.). I.C. May 25, 1906, Germany. Accepted July 8, 1908. H. A. Rhode, 6, Long Lane, Aldersgate Street, London.

14,551. Lighting and extinguishing lamps. June 24, 1907. Accepted June 24, 1908. A. T. Cowper-Smith, 4, South Street, Finsbury, London.

19,333. Portable lighting apparatus for indoor photography (C.S.). Aug. 28, 1907. Accepted July 1, 1908. J. Leclerc, 8, Quality Court, Chancery Lane, London.

25,695. Illuminated advertising devices (C.S.). Nov. 20, 1907. Accepted June 17, 1908. Radium-Licht-Reklame Co., m. b. H., and F. Stern, 6, Bank Street, Manchester.

EXPLANATORY NOTES.

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

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

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

Accepted.—Date of advertisement of acceptance.

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

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

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

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

TRADE NOTES.

We have received from Mr. Würthrich, manager and chief engineer of the British Department of the Oerlikon Maschinenfabrik, an account of the 6,000 k.w. turbo-generators recently supplied by the company to the Stockholm Electricity Works. The generators supply power at a pressure of 6,000 to 6,500 volts, a frequency of 25, and a speed of 750 revolutions per minute, and are stated to have given every satisfaction.

Messrs. The Union Electric Co., Ltd., send us an advance copy of their list of Union Motors and Fortiter Motor Starters, including air- and oil-cooled starters equipped with no voltage and overload release.