The
ELECTRICITY · ACETYLENE
ILLUMINATING ENGINEER
OIL · GAS
Edited by
LEON · GASTER

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

EDITORIAL.

The Standard of Light at the National Physical Laboratory.

The communication of Dr. Glazebrook, the Director of the National Physical Laboratory, to the British Association on the subject of the standard of light adopted at the Laboratory is an exceedingly important one in several respects.

Briefly, it is proposed to alter the method of specifying the amount of water vapour present per cubic metre of air in the photometer-room, the value of which previously was measured by the unventilated wet and dry bulb hygrometer. This is now to be measured by the aid of the Assmann ventilated instrument, which has been employed in Germany for this purpose. It now appears that the percentage of water vapour that would have been registered on the unventilated instrument as 10 litres per cubic metre of air would be indicated by the ventilated instrument as 8 litres. As the Assmann instrument is believed to be the more trustworthy instrument of the two, and as it is employed on the Continent, it is now proposed also to adopt this instrument for use with the British standard and to call the standard amount of water-vapour 8 litres per cubic metre of air in future.

One important result of the discovery of the difference in reading between the two instruments will be that the relations between the standards of light employed in England and on the Continent will need revision. This seems to lead to a fortunate simplification, namely, that the Hefner unit will in future be deemed to be practically 0·9 times the British pentane unit, while the Bougie decimale and the British unit come into practical equality. This may naturally affect any future decisions as to the possibility of adopting a convenient international unit.

A second interesting result arising from this discovery of the difference in the results obtained by the two forms of hygrometers is that the old discrepancy between the relations of the standards in different countries, as determined by direct comparison, and as obtained by the interchange of standardized incandescent lamps, is now partially accounted for; there still remains a small error of something over 1 per cent, however, and this is now being investigated jointly by the National Physical Laboratory and the Reichsanstalt. To some it may appear hardly necessary to attempt to obtain such consistency in photometrical measurements as the above percentage indicates, but we are more disposed to feel that in standard work of this kind the existing progress in this direction, though marvellous under the circumstances, still leaves something to be desired.

Apart from this aspect of the matter, however, we think that the moral effect of this steady removal of all the old sources of uncertainty can scarcely be overestimated. We are unable to agree with those who seem to see in the discovery of these unsuspected errors some ground for objection to the work on which it is based. At one time, when such investigations had not yet been undertaken, the cumulative effect of unrecognized errors of this kind was not infrequently ascribed to personal error; thus it came about that photometry came to be regarded as a hopelessly unreliable process, to the arbitration of which commercial matters could never be subjected. Now, however, the old sources of uncertainty are being one by one recognized and removed, and it must now be recognized that photometry, well within the limits of accuracy imposed by commercial consideration, is possible. There is still much to be done before one could say that photometry has become an exact science in the true sense of the word. We are however approaching those conditions.

An International Unit of Light.

The International Conference upon Electrical Units is to take place in London on October 12th, and will be followed by the meeting of the International Electrotechnical Commission on the 19th. It is probable that the latter conference will come to some conclusions of considerable interest to illuminating engineers with regard to the possibility of establishing a common unit of light. We understand that the French National Committee have made the suggestion that in future the British candle should be raised 2 per cent and the United States candle lowered 2 per cent, the French intermediate unit remaining unaltered, so that the three units would be brought into practical agreement. This suggestion, however, will now have to be considered anew on account of Dr. Glazebrook's communication to the British Association on the subject of the National Physical Laboratory standard. According to the text of this communication, which is dealt with elsewhere, the relations hitherto accepted as correct between the standards of light in the different countries will have to be subjected to revision.

The Testing of Flame Arc-Lamps and Incandescent Gaslights.

We notice, in a recent number of the *Gas World*, some comments by Mr. W. H. Y. Webber upon the two articles by Prof. J. T. Morris, which were published in our last two numbers. We appreciate Mr. Webber's recognition of the value of these articles and welcome his discussion of the matter, if only as an illustration of the necessity that both gas and electrical engineers should come forward and express their views on disputed points.

One point to which Mr. Webber refers is the conventional method of expressing the performance of an incandescent gas lamp in terms of the intensity of the horizontal beam. This custom, Mr. Webber explains, is merely a derivation of the old system of testing the performance of a variety of gas, and is not devised with the object of selecting the direction of maximum intensity. It answers for the comparison of different qualities of gas or for the comparison of different lamps giving exactly the same variety of distribution-curve. But it is clearly misleading when applied to the comparison of lamps that differ considerably in this respect, and if so used is, as Mr. Webber does not fail to point out, quite likely to be the cause of much misunderstanding. Whether we elect to base our comparison of gas and electric lamps on mean spherical or mean hemispherical C.P. or neither, it is at least desirable that there should be a common understanding between those in both professions on the matter, and we cannot see why some form of concerted action to this end, such as that recently undertaken by the Institutions of Gas and Electrical Engineers in Germany, should not also be possible in this country.

Another question touched on by Mr. Webber—the value of street-lights from a decorative point of view—constitutes very debatable ground, and is really a problem entirely distinct from the use of light for purely illuminating purposes.

Some people apparently consider a long row of lamps decorative. Others, while admitting the æsthetic possibilities of light so used, only recognize in most modern sources, disagreeably bright and glaring points of light that interfere with the clear view of the background, and call for some method of shading. Moreover, many people do not really base their judgment on the illumination at all, but only on the degree of apparent brightness of the lamps themselves. We do not ignore the æsthetic possibilities of street-lighting, but we do think that the time has come when these two aspects should be distinguished from one another, and the question of what constitutes artistic lighting more carefully studied.

Electrical and Gas Supply Companies and Illuminating Engineering.

We have repeatedly called attention to the growing recognition of the importance to supply companies of studying the conditions at the consumer's end of the wire or pipe, and in this number some reference is made to the recent articles of Mr. A. J. Marshall, of the Illuminating Engineering Bureau of New York, bearing on this point. It was pointed out that the company is bound to bear at least a share of the odium resulting from high bills and poor lighting, and it is obviously to their interest to do all that is possible to obtain the consumers' confidence.

Not a few of the manufacturing companies in the United States have for some time maintained departments of illuminating engineering to deal with such problems. The General Electric Co. have a special Bureau in Schenectady, but we believe that the Edison Electric Illuminating Company of Boston are the first electrical supply company actually to organize an expert staff of illuminating engineers from whose advice consumers and supply company will both benefit. In this Bureau they have acquired the services of Dr. Louis Bell, who is, the President of the Illuminating Engineering Society this year, and who is to supervise the work of the department.

We understand that the efforts of the company in this direction have already met with an immediate response, and we do not doubt that they will reap the benefit of their foresight and enterprise, and that their example will shortly be followed by others.

The Educationalist, the Physiologist, and the Illuminating Engineer.

The meeting of the British Association this year served to show in a very marked manner how many points of interest the physiologists and those interested in education have in common.

Prof. Sherrington, Prof. F. Gotch, and others all pointed out the importance of those who are concerned with the education of children knowing something about the minds and bodies of those they teach, in order that they may be able to guard against the possibility of introducing methods of teaching or injurious local conditions which may prejudice the health of the children.

Some of those present spoke of the difficulty in securing the support that the vital importance of this subject demands. We ourselves, therefore, can understand how the particular physiological conditions with which we are mainly concerned—the provision of adequate lighting arrangements—has not always received the public recognition that it deserves.

Nevertheless it is only necessary to reflect how great a proportion of the impressions of the growing child are derived through the eyes to understand how important it is that these organs should be well served in the matter of illumination. All this we have said in greater detail in our first number ('ILLUMINATING ENGINEER,' Vol. I., Jan. p. 58). On this occasion we supported our suggestions by quoting the opinions of many of the medical profession, and pointed out that a system of medical inspection of schools, intended to include tests of eyesight, ought logically also to include tests of the defective conditions of illumination responsible for the eye troubles investigated.

In the report of the Committee on the 'Conditions of Health essential to the Carrying on of the Work of Instruction in Schools,' no reference whatever is made to the conditions of the illumination in schoolrooms, and we hope that this omission in its scope may be made good. This is the more to be desired because the report concludes with the suggestion that a Royal Commission should be appointed to deal with the matter, and the vital necessity for good illumination should not be overlooked.

The Editor, who visited the meeting of the British Association with the express object of learning the views of physiologists on these questions, received ample assurance that the medical profession thoroughly recognize the necessity for studying the physiological principles underlying good illumination.

Illuminating Engineering Literature.

On the 5th and 6th of this month is to be held the second Annual Convention of the Illuminating Engineering Society in the United States. We have already published the list of papers to be read (see 'ILLUMINATING ENGINEER,' August, p. 697), and pointed out the wideness of the ground to be covered by them; with these papers we mean to deal in detail in a subsequent number.

Meantime, it is to be noted that the number of sources of information relating to illuminating engineering is already legion, and, in contrast to the premature predictions in some inadequately informed quarters, the ever-growing developments of the subject promise yet more numerous and valuable additions to the existing literature.

In the United States, for example, the subject now forms an integral portion of the discussions of many local societies and of many of the foremost technical journals. We note, for instance, that both the *Electrical World* and the *Electrical Review* of New York have, in their recently issued special numbers devoted to the progress of electric lighting, included general articles on illuminating engineering; this is surely an interesting indication of the general demand for information of this nature. The experience of these two periodicals, however, is evidently shared by many other technical journals here and on the Continent, who, though but a few years ago would not have dreamed of including illumination in their scope, now regularly publish articles more or less directly bearing on the subject.

LEON GASTER.

Review of Contents of this Issue.

Mr. A. P. Trotter (p. 799) now enters upon a description of the Chief Forms of Photometers, and contributes a few general remarks on the classification of such instruments, explaining that the vast majority of existing types, though differing considerably in matters of detail, are yet subject to the same general principles. He also refers to some of the early work of Bouguer, and describes the form of photometer with which his name is connected.

Dr. M. Corsepius (p. 801) describes a series of original investigations on a new method of Measuring Mean Hemispherical Candle-Power with the Ulbricht Globe.

This is accomplished by inserting a specially designed vessel within the globe in such a way as to completely absorb all the light emitted by the source examined in one hemisphere. The advantages of the method are fully explained; the author also discusses in detail some of the possible sources of errors, including those due to the presence of "foreign bodies" within the globe.

Dr. F. W. Edridge-Green (p. 807) gives some account of the Physiological Basis of Colour and Light Perception. He gives some account of the functions attributed to the action of the "rods" and "cones" on the retina and of the visual purple, and proceeds to explain his theory of colour-blindness. Finally he remarks upon the importance of lighting a room satisfactorily from the physiological standpoint, and states that the question as to best quality of light for ordinary purposes requires further investigation, before any definite opinion can be expressed.

Mr. Percy J. Waldram (p. 811) contributes a second article dealing with the Measurement of Daylight Illumination from the Architect's Standpoint. He describes a modification of the Trotter Photometer, specially devised for the purpose of measuring a wide range of daylight illumination, and enters into the theoretical principles underlying the use of the instrument. As a result of his investigations Mr. Waldram confirms the result of Dr. Ruzicka (*Illuminating Engineer*, Vol. I. July), to the effect that, for a uniformly illuminated sky, a constant relation between its intrinsic brilliancy and the resulting illumination at any given point in a room exists, and suggests the possibility of predetermining the illumination in a building by the aid of a small specially constructed model.

Mr. B. Duschnitz (p. 817) describes a new form of Metallic Filament Lamp for High Pressure and Small Candle-Power. In this case the plan of utilizing a small carbon filament glow-lamp mounted permanently in series with a metallic filament is adopted. By this means the inconvenience of being obliged to make such a very long thin filament is avoided, and, it is claimed, only at the cost of a small loss of efficiency. The lamp, as a whole, is stated to give about 1·54 watts per H.K., and has also the incidental advantage that the initial rush of current taking place in the case of the cold metallic filament is very greatly reduced by the high cold resistance of the small series carbon filament.

Dr. C. V. Drysdale (p. 821) continues the section of his series of articles dealing with the Laws and Measurement of Radiation. The present instalment contains a description of several of the best-known sensitive instruments utilizing the principle of the thermopile for the measurement of radiation; among the instruments described in Dr. Drysdale's article may be mentioned the Boys radiomicrometer and the Angstrom Pyrheliometer.

Mr. Lancelot Wild (p. 825) describes an Improved Form of Grease-Spot Flicker-Photometer, enabling the operator to observe both sides of the screen, and thus to balance the "flicker" in each case by a process analogous to the "contrast" method; this modification is said to lead to increased sensitiveness.

The **Special Section** in this number is devoted to the second of the series of descriptions of well-known laboratories in different countries. On this occasion **Mr. C. C. Paterson** and **Mr. E. H. Rayner** (p. 845) describe the PHOTOMETRIC ARRANGEMENTS AT THE NATIONAL PHYSICAL LABORATORY. The article is fully illustrated, and includes a discussion of the various errors experienced in standard work and the methods by the aid of which they are avoided. These methods are illustrated by views of the test benches, the extent of the scale of the standard voltmeter, &c., and the "substitution-method," as employed at the Laboratory, is described. Some details of the general work of the laboratory are also given, including the method of carrying out life-tests, and the nature of the equipment available for this purpose.

Among other articles in this number attention may be drawn to that on p. 819 describing some of the methods that are being evolved in the United States in order to facilitate the MUTUAL CO-OPERATION BETWEEN THE SUPPLY COMPANY AND THE CONSUMER, and to win the latter's confidence. An example is furnished by the action of the **Boston Edison Electric Supply Co., Ltd.,** who have organized a SPECIAL DEPARTMENT OF ILLUMINATING ENGINEERING under the supervision of **Dr. Louis Bell,** for the purpose of advising customers in the arrangement of their installations. On p. 827 will be found an article describing a NEW METHOD OF INCANDESCENT GAS LIGHTING, utilizing bundles of small rod - filaments, instead of the usual mantle; it is claimed that such bundles are much less fragile than mantles of the ordinary variety. Particulars are given by **Mr. H. Koffler** (p. 829) of a new method of making CARBIDE "BRIQUETTES" for the generation of acetylene. The generation of acetylene from this material is said to take place very uniformly, and the old trouble of "after-gassing" is avoided.

The continuation of the article on the effects of light upon the human body discusses some physiological EFFECTS OF THE LIGHT WITHIN THE VISIBLE SPECTRUM (p. 836), including the so-called "depressing" and "exhilarating" influences ascribed to the rays from the violet and red ends of the spectrum.

Another article contains some further examples of shop-window lighting by gas; there will also be found a brief résumé of the chief points of interest, from the standpoint of illumination, at the RECENT MEETING OF THE BRITISH ASSOCIATION (p. 831). Special interest attaches to the communication of **Dr. Glazebrook** relating to the proposed alteration in the conditions by which the candle-power of the STANDARD OF LIGHT AT THE NATIONAL PHYSICAL LABORATORY is in future to be specified, and their influence upon the standards of light in different countries.

The present number also contains an abstract of the recent discussion upon the paper by **Drs. Schanz** and **Stockhausen** (abstracted in our last number p. 772) relating to the EFFECTS OF ULTRA-VIOLET LIGHT UPON THE EYE (p. 853). While the suggestions of the authors did not escape criticism, it was agreed that the point raised was an important one to the lamp industry, if only on account of the apprehensions to which such possibilities give rise.

Some account of the recent papers by **Prof. W. Wedding** (p. 858) and **Herr H. Remané** (p. 861), before the Verband Deutscher Elektrotechniker are also included in this number; they contain some exhaustive particulars of TESTS AND CALCULATIONS COMPARING THE MERITS OF THE NEWER ELECTRIC ILLUMINANTS, including the results of a series of tests on modern metallic filament lamps. A recent article on the "OVERSHOOTING OF TUNGSTEN LAMPS" will be found on p. 868.

Dr. E. W. Marchant and **Prof. J. T. Morris** write to our columns discussing the absorption of the globes of flame arc-lamps (pp. 870 and 871) and **Mr. K. Sartori** replies to a comment on the TEMPERATURE OF THE SUN (p. 868).

For the usual **Review of Current Literature dealing with Illumination** and the **Patent List,** see pp. 873-80.

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.* 716.)

Photometers. — At first it would seem that photometers ought to be divided into two classes, one for measuring the candle-power of a source of light, and another for measuring the illumination at a given point on a plane set at a given angle and aspect. But on closer examination it is found that any instrument of the second class may be used with more or less convenience for measuring candle-power, and that every candle-power photometer depends on the observation of the illumination of a screen or screens. Those types which are peculiarly adapted for the measurement of illumination, and are less well suited for measuring candle-power, may be called illumination-photometers. It would be beyond the scope of these articles to go minutely into the details of ordinary visual photometers. A brief description of a few leading types will be given, sufficient for the purpose of the engineer who desires a general knowledge of the subject. It will be shown how these types, though at first sight appearing very different, and having no structural resemblance whatever are in fact so closely related, that intermediate kinds may be found, filling up all the gaps. Visual photometers are in general a class of apparatus in which there is a gradual transition from each pattern to some other, and there is very little to choose between them.

Since this somewhat peculiar relation exists, it does not matter where we enter the line, and we may as well begin with the first three patterns in historical order, quoting the original description, and reproducing the illustrations.

The Bouguer Photometer.—No writers on optics up to the beginning of the eighteenth century seem to have paid attention to comparisons of intensities of lights. Although several proposals had been made by astronomers for measuring what may vaguely be called "light," Pierre Bouguer,* Professeur Royal en Hydrographie, seems to have been the first to recognize the conditions and to describe scientifically correct methods of photometry. In 1729 he published his 'Essai d'Optique sur la Graduation de la Lumière,' and in 1757 contributed a paper on 'Means for Measuring Light, and some Applications of these Means,' to the Academie des Sciences. It is to be found in the 'Mémoires de Mathématiques et de Physique' of that year. Many photometrical experiments are described in these writings, but without going into instrumental details.

Bouguer died in 1758, and two years afterwards the Abbé de la Caille edited his papers, and the 'Traité d'Optique sur la Graduation de la Lumière' was

* Bouguer took part in the expedition which Louis XV. sent in 1735 to Peru to measure an arc of meridian; he invented the heliometer.

published as a volume of the Académie des Sciences.

He alluded to a little book by a Capuchin Père François Marie, 'Nouvelles Découvertes sur la Lumière' published in 1700. "When he wished to measure the strength (*la force*) of a light he tried how many pieces of glass or of separate mirrors he had to use to make it completely disappear ....in the same way as several other people who fell into the same error; but what rendered his expedients more defective, was the bad use he made of them." He pointed out several objections to this method, which has often been revived in different forms. "The different state of the observer's eyes, being more or less sensitive at one time than another or being fatigued. Each observer would then attribute a different value to the light which he measured. It is not possible to agree when observing at different times....and the measurements never gave the exact ratios."*

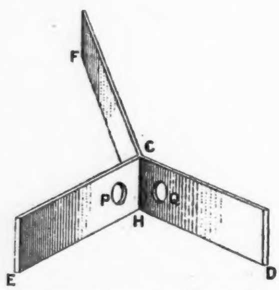

FIG. 47.—Bouguer's Photometer.

On p. 9 of the 'Traité d'Optique' he describes an arrangement which, though primitive, must be recognized as the first photometer. "To receive the two lights to be compared a simple piece of cardboard E C D as seen in Fig. 47), may be used, which has a fold C H, so that each half of the surface may be exposed more perpendicularly to each light, the whole of this piece of cardboard is black, but it has two holes of exactly the same size, say of three or four lines in diameter to which paper soaked in oil, or two perfectly equal pieces of glass, are applied, and these are made equally mat or white with emery or gritstone. The oiled paper or the mat glass are sometimes more transparent than necessary, and I have more often used two pieces of ordinary very fine and very white paper, which I took side by side from the same sheet. I let the two lights fall on these two pieces of paper, and I judged the equality of their force by looking at them from behind, or sometimes from in front. A second piece of cardboard F C served as a diaphragm, and prevented the two lights from mixing before illuminating the two little surfaces P and Q. This diaphragm was black on both sides, and joined to the first piece of cardboard exactly at the ridge which formed the fold."

* Bouguer, 'Traité d'Optique,' p. 46.

After describing how lenses may be used to adjust the illumination of the two spots, when it is not convenient to move the lights, and how the "force" may be calculated from the relative positions of the lenses, he goes on to say: "At length I noticed that another point of which I have already spoken is not less important; it is to give exactly the same shape and same size to both parts P and Q which serve as images or pictures to make all the circumstances exactly the same for the observer who examines them. The two illuminated images cannot be too close one to the other; it is absolutely necessary for them to be seen at one glance, and it would be a good thing, if possible, to make their edges such as to touch each other. I have almost always looked at these same images through a hole made in another diaphragm, which I applied at some distance from the eye, and which hid everything else from me."

While the arrangement shown in Bouguer's illustration (Fig. 47) has not much to recommend it, the developments suggested in the last two sentences of the description convert it into nothing less than the photometer officially used by the Metropolitan Gas Referees at the present day.

(To be continued.)

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

By Dr. M. Corsepius.

When Ulbricht, eight years ago, brought out his globe photometer,* he had in view certain limited applications of the instrument, especially its use for the purpose of comparing different varieties of carbons intended to be subsequently employed in arc-lamps of a certain kind. At that time a globe photometer 50 cm. in diameter was considered adequate for the purpose of ordinary arc-lamp photometry, this diameter being selected to correspond with the usual dimensions of the globes of arc-lamps. Subsequently it came to be recognized that the greater the diameter of the globe photometer the more easily could the incidental errors of measurement be avoided. It was on the advice of Prof. Ulbricht that the author, when designing such a photometer in 1904, selected a diameter of 2 metres; this value, however, has frequently been equalled and, indeed, exceeded since that date.

But not only a gain in accuracy, but also an extension of the uses of the instrument was achieved in this way. One of the most important links in the chain of improvement has been the application of the globe photometer to the measurement of mean hemispherical candle-power. This application, although in a sense foreign to the actual theory of the instrument, has been very thoroughly worked out by Prof. Ulbricht,† in order to comply with the increasing importance attached to the measurement of mean hemispherical candle-power as a basis of comparison of different sources of light.

At the same time certain objections have been urged against the adoption of this measurement. In particular it has been contended that a comparison between the arc-lamp and other illuminants is prejudiced by the adoption of this system of rating, that it only conveys a correct impression when applied to the comparison of arc-lamps surrounded by clear glass globes, and that reliable deductions as to the actual illuminating value of different sources cannot possibly be made from a knowledge of the mean hemispherical candle-power alone. Arc-lamps are almost invariably provided with opal glass globes or other distributing shades or reflectors. Hence it follows that a separate measurement for each globe is necessary, and the difficulty also arises that photometrical observations must be made at a finite distance from the source, and that the exact position of the "radiant centre" and the plane passing through it from which the portion of the light thrown into the hemisphere is reckoned, is often uncertain.

It was largely this circumstance that induced Ulbricht to contrive a further means of overcoming this difficulty, and his efforts led to the introduction of an instrument for the purpose of determining the position of the radiant centre; this piece of apparatus is of the greatest value, not only in measurements executed with the globe photometer, but also in the cases of all other problems involving the distribution of light in space.

Recent experiments seem to suggest that even in the case of glow-lamps, the filaments of which certainly approach linear dimensions, the mean spherical candle-power is coming to be regarded as the only trustworthy basis of comparison. For instance, Wedding in a paper read at the annual meeting of the Verband Deutscher Elektrotechniker, presented a large number of values of the mean spherical candle-power of glow-lamps of different varieties, and insisted upon the necessity of expressing results in this way.*

The method proposed by Ulbricht

* *E.T.Z.*, 1900, p. 595 *et seq.*
† *E.T.Z.*, 1906, 3, and 1907, 32.

* *E.T.Z.*, 1908, 31, p. 730.

to adapt his instrument to the measurement of mean hemispherical candle-power has been described in his publications. According to this method a portion of the inner surface of the globe is either actually removed or rendered ineffective by covering it with some non-reflecting material.

Meantime certain rules and recommendations have been issued by the Verband Deutscher Elektrotechniker, relating to the photometry of arc-lamps. In opposition to the general suggestion that only the mean hemispherical candle-power should be measured, put forward but not accepted in 1906, it has now been laid down that *both* the mean spherical candle-power and the mean hemispherical candle-power should be determined, and that this should be indicated by the nature of the symbols representing the actual results.

The method of determining the mean hemispherical candle-power proposed by Ulbricht has the practical consequence that the arc-lamp must be tested under two distinct sets of conditions. This involves the removal of the photometer for both experiments, and necessitates another and more elaborate calibration. For, since the direct rays from the standard lamp must not be allowed to strike the blackened region of the inner surface of the sphere, the lamp has to be provided with a partial screen, and the effect of this screen allowed for by a special measurement.

In what follows I propose to describe a piece of apparatus designed and tested by me, which simplifies the double measurement, and enables it to be carried out in a more convenient manner. This device makes it possible both for the globe photometer to remain in the same condition throughout, and for the lamp to remain in the same position; it is also unnecessary to extinguish the lamp during the tests.

According to my method I do not alter the inner surface of the sphere

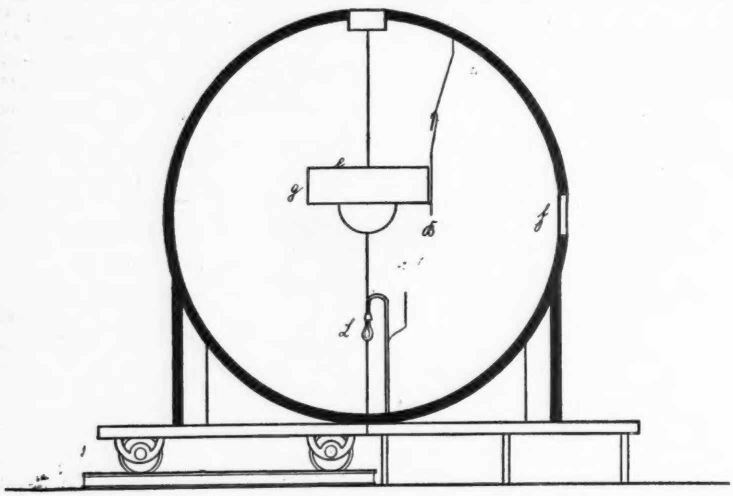

FIG. 1. Showing Vessel within the Ulbricht Globe.

with the object of rendering the light in the upper hemisphere inactive and, consequently, measuring the light-flux in the lower hemisphere. I measure the light from either the lower or upper hemisphere, the light from one of the hemispheres being obstructed by a specially contrived and shaped vessel introduced into the globe photometer and represented by "g" in Fig. 1.

In order to render the conditions of measurement as perfect as possible, it is essential for the inner surface of the vessel "g" to be dead-black, and the outer surface dead-white. The actual shape of the vessel is immaterial: for instance, it may take the form of a cylinder, a hemisphere, a cone, or as shown in Fig. 1, a vessel built up by utilizing two or more of the shapes specified. The face *e* occupies the horizontal plane passing through the radiant centre of the source, and must consist of a circle of sufficient diameter to comply with the conditions laid down by Prof. Ulbricht.

In Fig. 2 is shown a photograph of a hemispherical vessel in position within the globe.

By this arrangement it is possible to bring the radiant centre of the lamp into a position intermediate between the centre of the globe, and a point distant 0·58 times the radius ($a=30°$), this being the situation that favours the reduction of errors to a minimum. The circle of section (*i.e.*, the face of the vessel introduced into the photometer) may also be at a distance from the vertical axis of symmetry equal to the length of the diameter of the smallest sphere, capable of including the radiating surfaces of the source tested, and this without the diffusing action of the white inner wall of the globe being appreciably affected.

The combination in the vessel of two distinct portions renders it possible to employ a smaller circle of section in the case of lamps having relatively small globes, than when the globe is comparatively large; of course it is also open to the experimenter to employ two entirely separate vessels in the two cases.

The process of calibration is simpler than was the case when the previous method of using the photometer was employed. All that is necessary is to take measurements with the standard lamp in position first with and then without the vessel; moreover, if sufficient data as to the effect of the vessel on different varieties of lamps are available, we may content ourselves with a single calibration, carried out without the vessel, and then apply a known correction for the constant employed when the vessel is introduced into the photometer.

In order to render the calibration especially simple, I have preferred to utilize a calibration-lamp hanging in a vertical position, as shown by the lamp L in Fig. 1. Under these circumstances it is unnecessary to screen the light in an upward direction, and there is also the additional advantage of being able to employ metallic filament lamps, which only burn in a vertical position. This enables us to make use of lamps yielding 100 H.K. or more, and thus to obtain sufficient light to utilize the photometer with a bench of the ordinary kind. Osram 100 H.K. lamps have proved very satisfactory for the purpose; the special lamps selected are caused to burn for a considerable time before use.

It is, of course, essential to take precautions to secure that neither the circle of section *c*, nor the position of the radiant centre of the lamps employed, can alter with respect to one another.

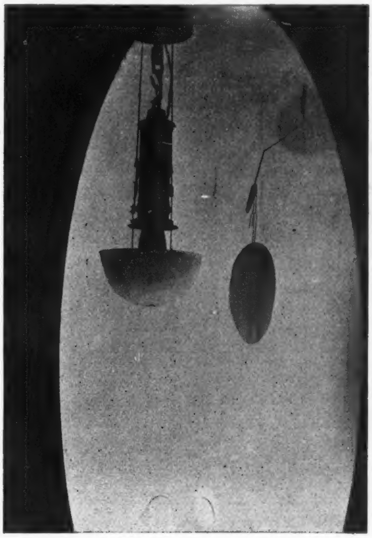

Fig. 2. Showing a small type of vessel in position.

The measurement, on the suggested lines, is carried out as follows :—

After removing the left half of the globe the lamp is introduced into the interior in such a way that its radiant centre falls about the position subsequently occupied by the face of the vessel, and the observer, by sighting towards the window from within the globe, makes sure that the direct rays

TABLE I.

Type of Arc Lamp.		Voltage.	System of Supply.	Current Amperes.	Consumption. Watts.	I_s	$I_{\frown}$	$I_{\smile}$	$\frac{Watts}{H.K._{\smile}}$	$K_{\circ}$	$\frac{I_{\frown}}{I_s}$	Kg Hem.	Kg. Spher.
1. "Carbone"	Clear Globe	110	D.C.	7·63	840	676	50	1,252	0·67	0·54	0·08	0·62	0·79
	,, ,,			8·06	887	687	59	1,256	0·71	0·55	0·08		
	Opal ,, ...			7·55	881	540	149	782	1·06	0·69	0·28		
2. "Radiante"	Clear Globe	110	D.C.	8·45	930	683	110	1,146	0·81	0·60	0·16	0·74	0·817
	,, ,, ...			8·46	931	678							
	Opal ,, ...			8·46	931	588	166	844	1·1	0·70	0·28		
	Without Globe ...			8·82	970	754							
3. "Polar"	Clear Globe	55	A.C.	9·25	383*	933	26	1,814	0·21*	0·51	0·028		0·55, without resistance
	Without Globe ...	55		8 95	387*	1,062	28	2,068	0·19*	0·51	0·026		
	,, ,,	110		8·6	895	1,006							
4. "Rebofa" giving white light Regina-Bogl. Fabr.	Without Globe ...	37	D.C.	8·9	329	746	120	1,252	0·26	0·595	0·16	0·59	0·69
	With Oval Globe ...			8·95	331	517	148	738	0·45	0·70	0·29		
5. "Rebofa" giving white light Regina-Bogl. Fabr.	Without Globe ...	37	A.C.	13·3		814	161	1,306	0·36	0·62	0 20	0·53	0·61
	With Opal Globe ...			13·8		494	150	688	0·70	0·72	0·30		
6. "Radiante" 4 amp.	Clear Globe	110	D.C.	3·95	434	252	abt. 5	494	0·88	0·51	0·02		
	Without Globe ...			3·97	437	289	,, 6	566	0·77	0·51	0·02		
7. Siemens & Halske	Without Globe ...	55	D.C.	10·52	578	502	9·3	986	0·59	0·51	0·019	0·56	0·75
	With ,, ...			10·20	561	367	97	540	1·04	0·68	0·37		

Note.—We have received from Dr. Corsepius some additional data too late for inclusion in the above table. This will be found at the foot of the opposite page.

from the reflector or the diffusing globe surrounding the source, are unable to pass the screen "b" and strike the observation window, "f."

After closing the globe the mean spherical candle-power of the source is measured in the usual way. If it is now desired to obtain the mean hemispherical intensity, the special vessel G is introduced into the interior, the source of light being left in exactly the same position as before, and a second measurement is made. The method indicated in Fig. 1 thus enables us to obtain the mean upper hemispherical candle-power. In order to obtain the mean lower hemispherical candle-power we subtract the value above from the previously determined mean spherical candle-power, and multiply the result by 2. It is desirable, for the sake of increased accuracy, to check the value of either the mean spherical or mean hemispherical candle-power by carrying out a second measurement under slightly varied conditions, and taking the mean of the two observations.

It may next be inquired what order of accuracy may be expected from such determinations. A number of results obtained in the manner described are collected together in Table 1 simply for the purpose of furnishing information on this point. In the sections 1 and 2 some details are given of tests on modern arc-lamps with inclined carbons, both of the ordinary and the "flame" variety, which furnish an almost shadeless illumination below the lamps, and are receiving a considerable amount of attention at the present time.

An observation of the results tabulated under the heading $\frac{I_{\frown}}{I_{\circ}}$ makes it clear that in cases 1 and 3, with clear globes, the light thrown up into the upper hemisphere only amounts to 8 and 2·8 per cent respectively of the total light emitted. The intensity in the upper hemisphere is obtained by the aid of the vessel described, and from the above figures it is clear that a considerable error might be permitted in this determination without affecting the value obtained for the *lower* hemisphere very appreciably. For instance, a 10 per cent error in the determination of $I_{\frown}$ would, in the two cases cited above, only produce an error of 0·8 per cent and 0·28 per cent respectively, while similarly an error of 3 per cent would only affect the result to the extent of 0·24 per cent and 0·08 per cent respectively, and would, therefore, be entirely negligible.

In the case of lamps with vertical carbons, such as those referred to in sections 2, 4, 5, 6, and 7, the light in the upper hemisphere forms 16, 16, 20, 2, and 1·9 per cent of the total light when clear glass globes are used. The errors corresponding to an error in determination of 10 per cent would, therefore, be 1·6, 1·6, 2·0, 0·2, and 0·19 per cent respectively; while a 3 per cent error in the determination of $I_{\frown}$ would in the same way cause errors in the result of 0·48, 0·48, 0·6, 0·06, and 0·06 per cent.

In the case of the tests of mean hemispherical candle-power of lamps with opal or other diffusing glass globes (which, be it remembered, are not insisted upon in regulations of the

Additional data received too late for inclusion in Table I.

Type of Arc Lamp.	Voltage.	System of Supply.	Current Amperes.	Consumption. Watts.	I_s	$I_{\smile}$	$\frac{\text{Watts}}{\text{H.K.}_{\smile}}$	Ko
8. "Rebofa" (New Type)								
Without Globe ...	37	D.C.	10·1	372	966	1,806	0·207	0·54
With Opal Globe	37		10·2	377	768	1,152	0·328	0·67
9. "Primer" (New Type)								
Without Globe ...	55	D.C.	10·3	567	1,952	3,675	0·154	0·53
With Opal Globe	55		8·7	479	1,470	2,125	0·226	0·69

Verband Deutscher Elektrotechniker previously mentioned), the corresponding contributions to the upper hemisphere amount in sections 1, 5, and 7 to 28, 28, 29, 29, 30, and 37 per cent, so that the error introduced on the previous assumptions in the final results becomes 2·8, 2·8, 2·9, 3·0, and 3·7, and 0·84, 0·84, 0·87, 0·9, and 1·1 respectively. When we recall how greatly different specimens of diffusing glass, even of the same variety, vary among themselves as regards the distribution of light, we may recognize that, even when errors in the determination of the mean upper hemispherical intensity of the magnitude mentioned above are made, the desired results can be relied upon with sufficient exactitude for all ordinary purposes.

The following considerations may furnish a guide as to the prediction of the magnitude of the errors of observation that are likely actually to occur. The vessel G is coated in the interior with a dead-black varnish, that has absolutely no regular reflection. For the purpose of providing this coating I have not availed myself of the ordinary varieties of so-called dead-black varnish nor the black lacquer usually employed for metal work. I preferred to use a special material composed of Frankfort-black added to turpentine with the addition of a small amount of a special adhesive lacquer ("Copallack"). The resulting solution adheres well, and though it is true that it loses colour somewhat when rubbed, that is not of much consequence for the purpose in view.

The introduction of the vessel into the interior of the globe gives rise to errors of the same kind as those due to "foreign bodies," screens, &c., and previously discussed by Ulbricht, though they are here encountered in a somewhat different form. Their magnitude will now form the subject of further investigation. Let

F represent the surface-area of the upper screen.

F_1 represent the surface-area of the lower screen.

α, the angle formed by the line joining the source of light and the window in the side of the globe with the horizontal; and α_1, the corresponding angle formed by the line joining the comparison-lamp and the window, and x and x_0, the distances of the screens from the vertical central line.

a, the coefficient of absorption of the screens.

Then a correction must be introduced into the observed value of the spherical intensity of

$$f-f_1=\frac{F.a}{\pi}\left\{\frac{\cos^7\alpha}{(2\cos^2\alpha-1)^2}+\frac{\cos^3\alpha}{4x^2}\right\}-\frac{F_1 a}{\pi}\left\{\frac{\cos^7\alpha_1}{(2\cos^2\alpha_1-1)^2(r-x_0)^2}+\frac{\cos^{-3}\alpha_1}{4x_0^2}\right\}*$$

In the course of my experiments I eventually settled upon the following dimensions for these quantities :—

$F=755$ $x=33$ $\alpha=13{\cdot}5°$
$F_1=201$ $x_0=19{\cdot}5$ $\alpha_1=30$

Thus $f-f_1 = 0{\cdot}566$ per cent for the spherical intensity.

In the same way one can predict the error introduced by the screening action of the vessel G, in conjunction with the error which is called into play by the screening of the lower standard lamp, when the mean hemispherical intensity is being determined. This is expressed by the relation

$$f-f_1=\frac{F.a}{\pi}\ \frac{\cos^7\alpha}{(2\cos^2\alpha-1)^2r^2}-\frac{F_1 a}{\pi}\cdot\left\{\frac{\cos^7\alpha_1}{(2\cos^2\alpha_1-1)^2(r-x_0)^2}+\frac{\cos^{-3}\alpha_1}{4x_0^2}\right\}$$

Now the plane F is derived by the solid projection of the surfaces of the portions of the vessel inserted in the photometer, from the window of measurement as origin, upon a vertical plane passing through the source of light. In the case of a vessel shaped like that shown in Fig. 1, we have to consider two semi-elliptical surfaces arising from the projection of the edges of the cylindrical portion of the vessel, each 62 centimetres in diameter, and of 362 square centimetres in extent. We have also to take into consideration the projection of the cylindrical portion itself, 1115 square centimetres in area, and lastly, the effect of the hemisphere attached to the base of this cylinder, making F=1900 square centimetres in all. Hence we find that $f - f_1$ =0·27 per cent in the case of observations of mean hemispherical intensity.

(To be continued.)

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* See *E.T.Z.*, 1907, p. 777.

The Perception of Light and Colour.

By F. W. Edridge-Green, M.D., F.R.C.S.

The eye has often been compared to a camera, but it is really a complete photographic apparatus.

The retina, which is the membrane situated at the back of the eye, corresponds to the sensitive plate, upon which images of external objects are focussed. The sensitive layer of the retina contains two sets of elements, which are called from their shape rods and cones. The rods contain a purple substance which is very sensitive to light, and which is called the visual purple. The part of the eye, namely the centre, which possesses the best vision contains only cones, and external to this there is one cone with a ring of rods round it, and then one cone with two rings of rods, and so on, the number of rods increasing as we get to the outer part of the eye. The explanation which I have given of vision is as follows. I assume that the cones are insensitive to light, but sensitive to chemical changes in the visual purple. Light falling upon the retina liberates the visual purple from the rods, and it is diffused into the centre and other parts of the retina. The decomposition of the visual purple by light chemically stimulates the ends of the cones, and a visual impulse is set up which is conveyed through the optic nerve fibres to the brain. It will be seen that there are three distinct retinal processes—diffusion of the visual purple, decomposition of the visual purple by light, stimulation of the ends of the cones by the decomposition products of the visual purple. There is evidence of these three processes.

I assume that the visual impulses caused by the different rays of light differ in character, just as the rays of light differ in wave-length. Then in the impulse itself we have the physiological basis of light, and in the quality of the impulse the physiological basis of colour. I have assumed that the quality of the impulse is perceived by a special perceptive centre in the brain within the power of perceiving differences possessed by that centre or portions of that centre.

It will be noticed that the central portion of the eye, which possesses the most distinct vision, contains only cones, and is therefore blind until the visual purple has been diffused into it. The following simple experiments can be tried by the reader.

If we look at two small isolated stars of equal magnitude either may be made to disappear by looking fixedly at it, whilst the other remains conspicuously visible. I find that the phenomenon is most marked on a dark night, and when the star looked at is in a portion of the sky comparatively free from other stars, and when only one eye is used. On a very dark night a considerable number of small stars, occupying the centre of the field of vision, may be made to disappear whilst stars occupying other areas of the field of vision are plainly visible. Other lights or objects, when small and with dark surroundings, as, for instance, pieces of white cardboard on black velvet, may be made to disappear in a similar manner. No change can be observed if a very bright light, a group of stars, or a uniformly illuminated surface, be made the subject of the experiment. If we look at an illuminated object through a pin-hole in a piece of black velvet, we find that unless it be very bright it will not be visible at all. On moving the eye so that the image does not fall on the centre of the retina, the object appears brighter.

We must assume that the visual centre was developed first, and that at one time in past ages all objects appeared without colour as in a photograph. When the colour-perceiving centre was first developed, the rays of light differing most in wave-length were the first to be distinguished, and so the spectrum appeared nearly all grey or neutral, but with a tinge of red at one end and a tinge of violet at the other. As more and more cells were added to the centre it was not necessary that the rays should differ so much in refrangibility before a difference was seen, and so the red and violet gradually invaded the grey or neutral band, until at a certain point they met in the centre of the spectrum. Such cases are called "dichromics."

It will be seen that the term dichromic vision describes and includes all such cases because they only see two definite colours (red and violet). All these persons have a perception of light similar to the normal sighted, but there is a complicating factor which may be present, that is more or less shortening of one or both ends of the spectrum. This condition may be present with otherwise normal colour vision. The rays in the shortened portion are either not seen at all or are seen very imperfectly, and so a person of this kind might look at a bright red light and declare that there was no light there. The dichromic with an unshortened spectrum corresponds to the so-called green-blind and the dichromic with shortening of the spectrum to the so-called red-blind. There are innumerable varieties connecting the two, which are inexplicable on the older theories of colour vision. When there is shortening of the spectrum there is also light loss, but when it is of normal length and brightness this is not the case.

It is evident that we are dealing with two distinct conditions. All who have had practical acquaintance with the subject of colour-blindness are aware that all dichromics (so-called red-green-blinds) are not equally colour-blind. One dichromic will put a very full red and green together, but another will object to this, but will put together as a match a red and green occupying a relatively nearer position in the spectrum. The dichromic with the smallest neutral band in the centre of the spectrum, separating the two colours red and violet, has the best colour perception. This it will be seen is a prediction from the theory, and is inexplicable on any other. A dichromic with the smallest neutral band is very difficult to detect with any of the usual tests, and will generally pass them with ease. The reason of this is that a dichromic of this kind sees about six distinct differences in the spectrum, he sees green as a lighter and greyer colour than red, and distinguishes between them, just as a normal-sighted person distinguishes between bluish-greens and blues. This is how the colour-blind match wools. The dichromic are therefore those who see two true colours and grey. They regard red, orange, yellow, and half of the green as one colour: the other half of the green, blue, and violet as the other. The presence of a neutral band causes the colours corresponding to this portion of the spectrum to be seen as grey. Therefore, the larger the neutral band the more colours will be classed as grey. If the rays which fall within one colour of the dichromic be mixed with those which fall within the other, grey will be the result. Therefore violet and red, instead of making a purple to the dichromic, make a grey which is indistinguishable to them from the grey made by blue and green.

The next stage of evolution of the colour sense is when the colour-perceiving centre is sufficiently developed to distinguish three main colours in the spectrum. The third colour (green) appears in the centre of spectrum, that is at the third point of greatest difference of refrangibility of the rays. In accordance with the prediction of the theory I found a considerable number of persons who saw the spectrum in this way, about 1·5 per cent of men. The trichromic see three main colours in the spectrum: red, green, and violet. They usually describe the spectrum as consisting of red, red-green, green, green-violet, and violet. They do not see yellow and blue as distinct colours, and are therefore in continual difficulty over them. There are very few of the tests in general use which can detect them, especially if names be not used. They will usually pass a matching test with ease. An examination with the spectrum shows that their colour perception is less than the normal in every part, though the curve has the same general shape. The three trichromics described in my recent paper on 'Observations on Hue Perception'* each saw ten consecutive monochromatic patches in the spectrum instead of the eighteen or nineteen seen by those who see six colours in the spectrum. It is easy to show that the trichromic are dangerously colour-blind. They will mark out with the spectral apparatus a patch containing greenish-yellow, yellow, and orange-yellow, and declare that it is absolutely monochromatic. When tested with coloured lights, they find great difficulty with yellow and blue. Yellow is continually called red or green.

There are several other degrees of colour-perception, and it may be well to say a word or two about them, though I class all above the trichromic with the normal-sighted for practical purposes, as they are not dangerously colour-blind, and can always distinguish signal-lights correctly.

In the next stage of evolution four colours are seen in the spectrum, and the fourth colour appears at the fourth point of greatest difference of refrangibility, namely at the orange-yellow of the hexachromic or six-unit people; these persons I have designated tetrachromic, because they see four distinct colours in the spectrum, that is red, yellow, green, and violet. They do not see blue as a definite colour, and are continually classing blues with greens: they usually prefer to call blue purplish-green. In the next stage in evolution there appeared those who see five colours in the spectrum—red, yellow, green, blue, and violet, blue being now recognized as a definite colour; these are the pentachromic group. These people pass all the tests in general use with ease; they however have a definitely diminished colour perception compared with the normal or those who see six colours in the spectrum. They mark out in the spectrum only fifteen monochromaitc patches instead of eighteen. They cannot see orange as a definite colour; for instance they can never tell whether a strontium light, which is red, or a calcium light, which is orange, is being shown them. In the next stage of evolution orange is recognized as a definite colour, and thus we get the hexachromic or normal group, and, as we should theoretically expect, the yellow of the pentachromic is now split up into two colours, orange and yellow.

In the last stage of evolution which we appear to have reached are those who see seven colours in the spectrum and the additional one is called indigo. These constitute the heptachromic group, and this seventh colour appears at the exact point which it should appear according to my theory, namely between the blue and violet. Persons belonging to this class have a marvellous colour perception and memory for colours. They will indicate a certain shade of colour in the spectrum, and then next day will be able to put the pointer at precisely the same point, a feat which is quite impossible to the ordinary normal-sighted person. They see a greater number of monochromatic patches in the spectrum than the hexachromic, but the curve has the same form. The marking out of the heptachromic does not appear correct to those who see six colours; for instance, the blue appears to invade the green, and the indigo does not appear a definite colour at all. If, however, we bisect the blue of the seven-colour man and then bisect his indigo, on joining the centres we get the blue of the six-colour man, showing most definitely that the blue has been split up into two fresh colours.

It will be noticed that there is room for much further evolution, and we could go on splitting up the spectrum indefinitely if only we had the power to distinguish these finer differences; but as a matter of fact I have never met

* *Trans. Ophth. Soc.*, 1907

with a man who could see more than twenty-nine monochromatic patches in the spectrum, and there are really millions, though by monochromatic patches I do not mean twenty-nine separate colours.

The first requirement of a test for colour-blindness is that colour names shall be used, and that the person to be examined and the examiner should employ and understand the use of the colour-names: red, yellow, green, and blue. I can say in the most emphatic manner that no test which ignores names can be efficient. I predicted that if colour-names were ignored in the Board of Trade tests normal-sighted persons would be rejected, and this prediction was fulfilled: of those who appealed from the decision of the Board of Trade over 38 per cent in one year and more than 42 per cent in another were found to have been rejected wrongly.

Nothing shows the value of colour names better than an examination with my lantern of certain educated colour-blind persons who have just passed several of the well-known tests with the greatest ease. They call red "green" and green "red," and apply either term to yellow, thus not only proving their colour-blindness, but showing how absolutely unfit they are to act as engine-drivers or look-outs. An engine-driver has to name a coloured light when he sees it, not to match it. The sailor has rarely opportunities of comparing lights. Such men have to say to themselves "This is a red light, therefore there is danger," and this is practically the same as if they had made the observation out loud. Several artists have remarked to me that they pay far more attention to shade than colour, and that the confusion colours of the wool test were more like the test green than those which are supposed to be picked out by normal-sighted persons. A very simple illustration may serve to make my point quite clear. Let it be supposed that I wish a man or a child to separate a roomful of people into men and women. I take him to the room and say, "Now I want you to separate these persons. I want you to put all who look alike in one class, and the remainder in the other." When I return I find that he has put all the big people in one class, and the small people in the other. If I then say, "You have classified them wrongly. I wanted you to put the men in one class and the women in the other," he could reply, "Then why did you not tell me that you wanted me to separate them into men and women?"

The principal tests I use are three in number: (1) Lantern Test. (2) Classification Test. (3) Spectrum Test.

It will be noted from this short account of the physiology of vision that the nature of the illuminant which is used for lighting a room is of very great importance. The distribution and arrangement of the illuminant are of equal importance.

I think that it is probable that the artificial illuminant which most resembles sunlight in its composition will be found to be most beneficial for the eyes; but this is a point which still remains to be settled.

An Interesting Case of Colour Blindness.

An interesting case of colour blindness, in which loss of colour was apparently experienced without great loss of perception of light, is described by Dr. Edridge-Green in his book on this subject. A captain was accustomed to work at embroidery in his leisure time at sea, and was in the habit of taxing his eyes in the twilight by working on without a proper light. One day, while so engaged, his sense of colour almost completely disappeared, the only colour that he could afterwards still clearly recognize being blue. Yet his vision does not seem to have been seriously affected in other respects for he continued his vocation for some time afterwards.

The Measurement of the Relation between Daylight Illumination of Rooms and Sky Brightness.

By Percy J. Waldram, F.S.I.

The daylight illumination of any point in a room may be considered as being a proportion of the illumination which it could obtain from the whole luminous sky above the horizon if the walls, ceiling, and all obstructions were removed. This proportion of the total daylight is obtained through the windows, and generally consists partly of direct rays from the sky and partly of reflected rays from walls, buildings, road surfaces, &c., the whole being reflected and counter-reflected from the walls, ceiling, and floor of the room.

The amount of daylight illumination at any point in a room depends partly upon fixed conditions and partly upon the variable brightness of the sky at any moment. The fixed conditions are the size, shape, position, and glazing of the windows, the extent to which their view of clear sky is obscured, the reflection co-efficients of the obstructions and of the walls, ceiling, and floor of the room itself. The combined effect of all these fixed conditions is, however, for all practical purposes, the same whatever the sky brightness, so that the proportion of the total flux of light from the sky received by any point in a room is practically the same at any time between sunrise and sunset from June to December, with the obvious exceptions of such times when the room may be receiving direct rays of sunlight or directly reflected rays. This proportion may be termed the "window efficiency," and may be measured for any point in a room or may be averaged over the whole floor area at table height or any other height.

The average "window efficiency" of any room may thus be defined as the fixed relation between its average interior illumination (a), and the sky brightness (b) or the ratio $\frac{a}{b}$.

The proportion of daylight illumination enjoyed by interiors is very much smaller than is usually supposed. If the illumination of a piece of white paper be measured first when the paper is placed on a table in the middle of an average room, and then when placed on a table outdoors in an open space, one finds a difference of say 1,000 to 1 in favour of the latter position. To any one considering the matter for the first time such a difference seems impossible; most people looking at the piece of paper in the two positions would estimate the respective illuminations at say 2 or 3 to 1, and would consider even 100 to 1 ridiculous. The difference, however, does not seem so startling when it is remembered that under the same conditions a photograph of any outside view might require say one-fifth of a second, whilst the necessary exposure for an interior might well be, say, five minutes with the same stop, a difference of 1,500 to 1.

The eye does not indicate these very large variations of diffused daylight illumination because it is able to adapt itself to them without sensible effort or strain; but the lower limits at which reading, writing, drawing, and indoor industrial operations become trying or impossible, are more sharply defined. One can as easily read out of doors under a diffused daylight illumination of say 800 candle-feet, as indoors at say 2 candle-feet, whereas at 1·5 candle-feet reading is not quite so easy, at 0·5 candle-feet it is somewhat difficult, and at below 0·1 candle-feet it soon becomes impossible.

But even in this matter of defining the lower limits at which it is advisable to supplement daylight by artificial illumination the eye is not to be trusted. So long as the illumination is decreased evenly and slowly, as in the waning light of a winter afternoon, the eye will loyally attempt to adapt itself to the more onerous conditions, and will not infrequently induce one to continue reading or writing by daylight, long after the time when the assistance of artificial light should have been resorted to. By the time the eye finds the strain unbearable, the mischief has been done.

The danger of this to the delicate eyes of school-children is only too obvious. A teacher may quite unconsciously strain constantly and seriously during the winter months the eyes of young pupils by a very natural disinclination to interrupt work to turn on artificial light until its necessity is apparent to his own eyes, which would be naturally trained by years of reading, or until a child acutally complains. It would cost very little to provide every public elementary school with a simple illuminometer, which would enable the head master to note a point of minimum daylight illumination, fixed by the medical inspector, at which artificial light would be necessary in the worst-lighted class-room. If this were done, not only would one of the greatest and most subtle dangers to eye-strain in children be removed, but means would be placed in the hands of head masters which would enable them to co-operate intelligently in studying and remedying the many defective features of artificial lighting in schools.

To measure the illumination, daylight or artificial, in candle-feet at any point in a room is the simplest of operations, consisting with an ordinary Trotter photometer of pressing a button and turning a handle until the illumination on two screens becomes identical, a pointer in the instrument automatically recording the illumination in candle-feet.

To ascertain the "window efficiency" of a room by comparing an average of such daylight measurements with a simultaneous measurement of sky brightness is, however, not quite so simple.

The extent of outside illumination is affected largely by surroundings, and even if one had an instrument capable of covering the wide range between inside and outside illumination it would be impossible to compare the window efficiency of one room with another unless all the respective outside illuminations were measured with an absolutely clear horizon. This, of course, would be a practical impossibility, and our photometer must therefore be capable of measuring the brightness of a portion of the zenith sky, and must take identical readings of it from the bottom of a deep light well or from the top of a roof.

Acting upon a suggestion made by Mr. A. P. Trotter, the author has found no difficulty in doing this with an ordinary instrument in the following manner.

The total daylight illumination falling upon the screen of an illumination photometer, placed horizontally with an uninterrupted horizontal horizon in the centre of an open plane, may be considered as the total flux of light coming from the interior of a hemispherical luminous sky surface of radius R; and on the cloudy days when the daylight illumination of interiors becomes important, this luminous surface may be considered as being for all practical purposes uniformly bright.

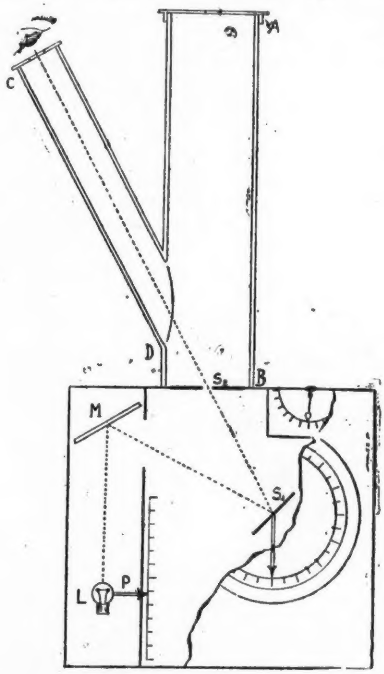
The illumination (I) on a horizontal surface, would, under those conditions be represented by the area of the hemispherical surface in feet multiplied by its brightness per square foot (B), and divided by R^2 or

$$(1) \quad . \quad . \quad . \quad I = B \times \frac{2\pi R^2}{R^2}$$

$$(2) \quad . \quad . \quad . \quad B = \frac{I}{2\pi}$$

Error Consider cosine leads to $B = \frac{I}{\pi}$

The radius of the sky thus disappears from the problem, because obviously the illumination of the horizontal photometer screen would be the same whether we measure the beams of light causing it at a radius of 10 miles or of 10 inches; their effect on the screen falling off in exactly the same proportion as their area increases. We can therefore assume any convenient value we like for R so long as we measure the illumination on a hemisphere of that radius. Also we need not trouble about the whole of the luminous hemisphere so long as we can measure any definite fraction of it. For practical measurements we can replace the actual sky by a small light-tight hemisphere of any convenient radius, pierced by a hole having an area which is a certain definite fraction of the surface of that hemisphere. The amount of illumination falling on the photometric screen from the portion of sky visible at the screen through that hole bears the same proportion to the total illumination which would fall upon an uncovered screen as the area of the hole bears to the total surface of the hemisphere. The measured brilliancy of the hole in candles per square foot as seen from the photometric screen $\times 2\pi \div r^2$ gives the same figure for the sky brightness



in candles per square foot whatever radius (r) it may be measured on. It is, of course, unnecessary to construct an entire hemisphere, a tube of a length equal to the proposed radius giving exactly the same result.

Using an ordinary Trotter photometer with a yellow or orange screen outside, and a white screen inside (*vide Illuminating Engineer*, vol. i. No. 6, p. 502) one can obtain excellent results by means of an apparatus made out of the cardboard capped tubes used for conveying drawings.

A 10-in. length of tube A B is cut very exactly with a sharp penknife, a short side inlet tube C D for viewing the top slide is neatly fitted to one side at such an angle that when fitted over the outer screen S^2 its axis is in line with the slot and the index pointers of the inner screen, S^1. The whole is made perfectly light-tight and blackened inside, and can be held tightly on to the instrument by means of elastic, looped round the larger tube, passing round the photometer and looped over the side tube, the joint at B being made light-tight, if necessary, with a narrow black velvet washer. On the top of A B is placed the ordinary cardboard cap of the tube, in the centre of which a hole 1·55-in. diameter is neatly cut, giving an aperture area of 1·884 square inches, or 3 to 1000 of the area (628 square inches) of a 10-in. hemisphere. Holes representing areas of 2-1000, 1-1000, 1-2000, &c., can be cut out of thin postcards, and fitted concentrically inside the cap as required, in order to get readings which will be within the range of the instrument with varying degrees of sky brightness, in the same way that a photographer uses a different stop in the lens of his camera to suit varying conditions. The minute difference in the diameter between these stops necessitates very careful setting out and cutting; but with care they can be cut to give readings correct to 0·01 candle-feet exactly in proportion to their areas. They can, of course, be replaced by a suitable iris diaphragm to facilitate the working, but there is less liability to error with fixed stops. Although the author would not advocate the general use of such a home-made appliance, it is nevertheless capable of a very large amount of good work. It gives absolutely identical readings when held (1) outside a window, (2) from the top of a roof, or (3) from the bottom of very deep narrow areas. After a little practice one can readily select for any sky say three or four stops within the range of the instrument, say 1-500, 1-1000, and 1-2000, and the proportion which should obviously exist between the resulting readings acts as a ready check on their accuracy. An ordinary sky reading might be say 0·52 candle-feet with a 1-1000 stop. If the 1-2000 stop be inserted 0·26 should be recorded and 1·04 with a 1-5000 stop.

The area of a 1-1000 stop being 0·63 sq. in., and the distance from the photometer screen to the aperture 10 in. the sky brightness in candle-power per square foot (B) as measured at the aperture would be :—

$$B = 0{\cdot}52 \times \frac{144}{\cdot 63} \times \frac{10^2}{12^2} = 82{\cdot}5 \text{ candles}$$

per square foot.

Or this could be obtained by simply dividing the reduced reading by 2π as equation (2)

$$B = \frac{520}{2\pi} = 82{\cdot}5 \text{ as before.}$$

For measuring the window efficiency of a room it is not necessary to reduce the readings of outside illumination to terms of sky brightness, although this is desirable for purposes of record. The inside illumination in candle-feet is simply compared direct with the corrected reading in candle-feet of the outside illumination. If the outside reading be, say 0·7 candle-feet, with a 1-1,000 stop, and the average inside reading be 0·5 candle-feet, then the room has an average efficiency of $\frac{0{\cdot}5}{700}$ or $\frac{1}{1400}$.

It should be noted that the accuracy of photometric measurements of window efficiency is *not* affected by the calibration of the instrument; nor does any drop in the efficiency of the photometer standard lamp, or in the voltage of its battery, make the slightest practical difference, as the indoor and outdoor readings are necessarily taken as nearly simultaneously as possible. The name of the makers of the Trotter photometer (Messrs. Everett, Edgcumbe & Co.), would of course be ample guarantee of correct calibration, but it is satisfactory to remember that efficiency readings are independent of any deterioration in the lamp or battery.

If all readings of sky brightness be carefully recorded, with dates, times, class of sky, &c., very valuable information is obtained as to average sky brightness, of which no complete records for English towns have yet been published. The author has in preparation a complete year's record for London, based on daily observations taken at 9.30 A.M., 12 noon, and 4 P.M., and also upon observations taken every hour from sunrise to sunset upon typical days in each month. But the daily duration of natural light is so important a consideration with all lighting problems that there is need for records more exact, continuous, and authoritative than any individual statistics, however carefully compiled, can possibly be.

In recording isolated measurements of sky brightness on given dates and times it is necessary to define, at least roughly, the state of the sky if the record is to be of any value, in estimating continuous records.

The following classification was adopted by Dr. Basquin for a very large number of sky brightness measurements taken in Chicago (*vide Illuminating Engineer* of New York, vol. i. No. 10):

Class 1. Clouds, no blue sky, no sun, storm present or near.

Class 2. Overcast, no blue.

Class 3. Clouds predominating, generally cumulus.

Class 4. Blue predominating, clouds generally cirrus.

Class 5. Cloudless, either clear blue or hazy.

This is the order in which nine people out of ten who were not expert photographers would arrange the different kinds of sky if asked to place them in order of brightness. As a matter of fact, with the exception of class 1 the correct order is exactly reversed, the relative mean brightness being in round figures :—

Class 1.—200 Candles per square foot
,, 5.—300 ,, ,, ,, ,,
,, 4.—430 ,, ,, ,, ,,
,, 3.—560 ,, ,, ,, ,,
,, 2.—620 ,, ,, ,, ,,

These values are, of course, only relative, and vary for each class of sky according to the season and the time of day. They are instructive, however, as showing the great and unexpected difference which can honestly exist between the observations of the daylight illumination of a room taken at similar times on consecutive days. Very few people would expect to find the illumination increased by clouds, scarcely any one would expect the illumination from a cloudy sky to be more than double that from a clear blue sky.

For the estimation of the daylight illumination of interiors, however, the eye is at best a measuring instrument of ridiculous inaccuracy, far more liable to record insignificant factors than the total result. The exact measurement of those essential factors which affect gas and electric light bills and their estimation by the untrained eye are frequently two very different things; and generally speaking there is more difference between the apparent and the real daylight illumination of a room than there is between a pencil landscape sketch and a trigonometrical survey.

Many people when estimating the brightness of a room unconsciously base their estimate simply upon the effect, pleasant or otherwise, which the wall-paper has on them. Wall-paper certainly affects interior illumination, but it is most difficult to estimate correctly even the relative advantages of different colours and shades—light red, for instance, gives apparently quite as light an effect as light buff or pale grey, whereas the two latter really reflect nearly four times as much light.

The view from the windows is another criterion frequently applied most erroneously. Hard-headed business men, selecting town offices with a view to a good light, will stand in the middle of empty rooms and really decide upon what they see at a distance outside the middle (not the top) of the windows, and not upon the light that is really coming in at desk height at all. Offices with single large low windows facing a high new wall will sometimes let whilst others with high windows facing a low old wall will remain empty; because there is, according to prospective tenants, "no comparison between them in point of lightness"; whereas the probability is that the bill for gas or electricity during ordinary office hours would be quite 20 per cent less in the latter offices.

The measurement of the only true criterion of daylight illumination, *i.e.*, window efficiency, is by the means described, effected for any room at any time except when the sun is directly shining or reflected into it.

But before the window efficiency of different rooms can be exactly compared it is necessary that the factors affecting efficiency are either identical or are reduced to a common standard. All rooms have not the same wall and ceiling papers, proportions vary; window glass and its relative cleanliness, or rather relative dirtiness, the angles of obstructed horizon, and all other essential factors must, for real comparison, be standardized by comparison with white walls and ceilings, clean clear glass, unobstructed horizon, &c. Fortunately it is possible to reproduce the conditions of actual rooms in small models and obtain the same results by identical measurements, and in such models the various effects produced by variations in essential conditions can be studied at no great cost. For instance, a model can be temporarily papered with samples of twenty different wall-papers, and their different effects noted in less time than an actual room can be temporarily hung with two—every possible condition of obscured horizon can be built up of sheets of paper or cardboard, having reflection co-efficients identical with those of all known building materials; the relative lighting capacity of every square foot of wall surface can be separately found for every degree of obstruction and for any given distance back from the window wall; and, in fact, every possible condition can be reproduced, measured, and standardized, so that the essential conditions for any given window efficiency can be accurately predetermined by simple calculation. The average number of hours during which natural light must be supplemented by artificial light over any given period, say from 9 A.M. to 6 P.M., can, of course, be directly obtained for any given window efficiency from yearly tables of average sky brightness.

Illumination in Emergencies.

THE recent strike of the employees of electrical supply companies in Paris furnished an example, on an exceptionally great scale, of the inconvenience attending the sudden deprivation of the regular method of lighting. With dramatic suddenness the lights in the theatres went out, and the audiences dispersed; while in some of the restaurants a number of customers are said to have availed themselves of the darkness to escape without paying their bills.

Under the circumstances a sudden call upon the available supplies of candles in neighbouring shops was inevitable. The candle has come to be looked upon as a mainstay in such cases, simply because, although hardly yielding sufficient light for most ordinary purposes, it is self-contained, and can be put in use at short notice. It has, indeed, been shrewdly remarked that, had the candle been invented for the first time in the present age of illumination by the aid of transmitted energy, it would have been hailed with enthusiasm as a magnificent discovery. At the same time the candle has many obvious drawbacks even for emergency-lighting, and it seems to be now desirable to provide for such accidents more perfectly than has been hitherto attempted. Already it has become customary in the case of important buildings to specify that two alternative systems of lighting, such as gas and electricity, must be provided, so as to avoid the inconvenience of a breakdown of either.

After the example of Paris, however, a strike affecting *both* systems of lighting does not seem inconceivable. Moreover supply companies, particularly electrical ones, are naturally not over-anxious to assist consumers who merely propose to utilize them as a stand-by in an emergency. Some system entirely independent of outside supply seems needed to ensure the most perfect safety from all disturbances.

In the case of electricity there is, unfortunately, no practical method of storing, analogous to liquid acetylene for instance, unless indeed accumulators be so considered. There is on record a case of a theatre-manager who had taken a new theatre, and billed a play to appear on a certain night. When the date arrived it transpired that the electric supply company was not ready, but the enterprising manager ran the lighting for the time being from an imported battery of charged accumulators.

Permanent independence, however, can only be achieved by a private installation, and this plan naturally commends itself to many large restaurants and theatres. Petrol-air gas and acetylene offer an alternative method of private supply. Oil-lighting, of course, has long been recognised as a stand-by, and has many advantages if only the possibility of an emergency is kept in mind, and the lamps are properly attended to.

Liquid acetylene, on account of its ease of transport, now merits consideration in an emergency, while it is claimed for some of the various qualities of liquid gas now coming into use, that they can be connected and used with an ordinary system of gas-piping should an emergency occur.

A Metallic Filament Glow-Lamp for High Voltage and Low Candle-power.

BY B. DUSCHNITZ.

As is well known, it is only quite recently that it has been found possible to manufacture metallic filament glow-lamps for high voltages. This feat has also only been accomplished as yet by a few firms. At the present time the majority of manufacturers are content to make lamps for a maximum pressure of 130 volts.

Even in cases in which their efforts have been successful, the makers have been obliged to grapple with tremendous difficulties in manufacturing such lamps, and have only done so in order to meet the demands of consumers supplied with a pressure of 220 volts, who disliked burning the lamps in series.

However, as we know, the Auer Gesellschaft have met this pressing demand, to the extent of already manufacturing 220 volt 50 H.K. lamps. But the filament utilized in these lamps is about 1,030 mm. long, and about 0·03 mm. in diameter.

A second example is afforded by the "Just" Wolfram 220 volts 50 H.K. lamp. In this case six U-shaped filaments are mounted in series, each of these being 80 mm. long, thus yielding a total length of filament of 960 mm.

When we recall what immense difficulties were at first experienced in making even a 110 volt 25 H.K. tantalum lamp (having a filament 650 mm. long and 0·05 mm. in diameter), with the ordinary standard Edison cap, we can readily concede the difficulty of mounting filaments 960 or 1,030 mm. long in a bulb, the cap of which must be no bigger than that of the tantalum lamp.

That the fragility of filaments only 0·03 mm. in diameter leads to an immense number of breakages in manufacture is easy to understand. And how easily such filaments are ruptured in use and transport! The writer himself, a short time ago, was present when a 50 H.K. 220 volts osram lamp was merely carried—quite carefully—from one table to another; yet the filament broke. Such cases must occasionally have come within the observation of any one who has had much experience of high voltage metallic filament lamps, especially those of inferior make.

Another very noticeable quality of metallic filament lamps is their difference in resistance when switched on and when in the cold state. That this difference is anything but trifling will be understood from the following details.

A portion of a tantalum filament, 1 mm. long and 1 sq. mm. in cross section, has a resistance of 0·17 ohms in the cold state, but this increases to 0·83 ohms when the lamp is burning.

Again, a piece of osmium filament, 1 mm. long and 1 sq. mm. in cross section, has a resistance of about 0·095 ohms at 20 degrees Centigrade, but at the ordinary temperature of incandescence of the lamp this rises to 0·798 ohms. In the case of other metals we obtain very similar results. On the average the resistance of a metallic filament in the cold state becomes multiplied eight times when the lamp is actually burning, and therefore the initial value of the current taken by the lamp may be eight times its normal value.

One not infrequently finds that a metallic filament burns out the instant it is switched on, simply on account of this high initial current; naturally, too, the tendency to failure in this way is more marked the thinner the filament. In order to provide against this difficulty the makers of high voltage lamps are abandoning the attempt to make these lamps with an efficiency of 1 watt per H.K., and revert to about 1·5 watts per H.K., in order that the filament may be stout enough to stand the initial rush of current without fusing.

Now the great majority of electric installations date from the time when carbon filament glow-lamps held undisputed sway, and are adapted for the use of 16 candle-power lamps. The consumers would in most cases gladly avail themselves of the metallic filament lamps in order to reduce the current consumed for the same or a somewhat greater amount of light than they had previously at their disposal.

When, however, we reflect that a metallic filament 220 volt 50 H.K. lamp burning at, say, 1·25 watts per H.K., consumes 62·5 watts, it becomes clear that the consumer who substitutes such a lamp for an ordinary carbon filament 16 candle-power lamp, consuming 56 watts at 3·5 watts per H.K., gains nothing whatever as regards reduction of current. On the contrary, he would actually have to consume 62·5–56, *i.e.*, 6·5 watts per lamp more than before.

FIG. 1.

Granted, even, that 220 volt 40 H.K. were available, the initial costs of such lamps and the fragility of the long filament would militate against their general acceptability.

All this, however, is only intended to apply to the purely metallic filament lamps, *i.e.*, such lamps as are not provided with any additional accessory apparatus in series with the metallic filament. The author has recently had the opportunity of studying a new type of combination-lamp invented by Schäffer of Berlin, and manufactured by Messrs. Köhler, Spiller & Co. of Hamburg.

The general nature of this so-called "Econo-Metallic Filament Lamp" will be understood from Fig. 1.

In this case the bulb of the lamp does not terminate in the usual Edison cap, but is attached to a projecting ring and metal gallery, in the interior of which is mounted a smaller evacuated glass bulb containing a spiral, triply wound carbon filament. The small vessel is melted on to the main bulb, containing the usual metallic filament, to which the carbon filament in the small bulb is connected in series, serving the purpose of a ballast-resistance.

The resistance of the carbon filament is so chosen that it consumes 80 volts, leaving 140 volts to be consumed in the metallic filament. The latter is arranged to run at an efficiency of 1 watt per H.K., when it receives 130 volts; at 140 volts the consumption is about 0·95 watts per H.K. The carbon filament, however, is also rendered incandescent, contributing about 1·5 H.K., and the total light yielded by both filaments amounts to about 30 H.K. The current taken by the lamp as a whole is 0·21 ampere, the power consumed being therefore $220 \times 0{\cdot}21 = 46{\cdot}2$ watts. This corresponds to a specific consumption of $\frac{46{\cdot}2}{30} = 1.54$ watts per H.K.

The Schäffer lamp seems, therefore, well adapted to replace the 16 candle-power carbon lamp on 220 volt circuits. For by using such a lamp we save $56-46{\cdot}2=9{\cdot}8$ watts, and gain $30-16=14$ candle-power (H.K.).

Moreover, as the metallic filament need only be about 500 mm. long, the risk of breakage is very much less than in the case of the ordinary high voltage lamps requiring a 1,000 mm. filament.

But special attention may be drawn to a particularly interesting characteristic of the lamp arising from the use of a carbon and metallic filament in series with one another. As a result the initial current taken by the lamp is but twice its final value, as opposed to eight times in the case of metallic filaments pure and simple. The explanation of the above property lies, of course, in the fact that the temperature coefficient of the metallic filament is negative, while that of the carbon filament is positive, so that a certain compensating effect occurs. This may be expected to have a favourable influence on the life of the lamps.

Some Examples of Practical Work in Illuminating Engineering.

It is becoming more and more generally recognized that supply companies will be obliged, in the future, to take a much more immediate and organized interest in the conditions of illumination enjoyed by their customers than in the past. We notice in some recent numbers of *The Electrical World* and *The Electrical Review* of New York some remarks by Mr. A. J. Marshall dealing with this subject. Mr. Marshall remarks at the outset that it is obviously in the interest of the company to see that their customers use their lights properly, to win their confidence as regards the methods of lighting they suggest, and to assure them that their interests are properly protected. If this is not done it may safely be assumed that in a great many cases the company is more or less directly blamed for the large bills and inadequate lighting that naturally follow.

Mr. Marshall suggests that this difficulty is to be met by employing canvassers who have a really adequate knowledge of illumination, and can assist the company's interests by attending to those of the consumer. The salaries usually paid are hardly such as to secure men with these qualifications, but Mr. Marshall considers that it would amply repay companies to afford the extra expense entailed.

Proceeding further, he suggests that illumination ought to be the subject of systematic inspection. Inspection is obligatory in the case of electric wiring, for instance, and a central station does not, as a rule, connect up to the consumers' premises without receiving an assurance that all is satisfactory. Why, therefore, should not the conditions of illumination be subject to some such similar scrutiny? Naturally such a course would require no little diplomacy, and Mr. Marshall hardly suggests that an electric company would go the length of refusing to supply in the event of the scheme of illumination not being considered satisfactory. But a regular and systematic inspection of premises previous to connecting up would enable the engineer to suggest means by which the lighting might be easily improved, and might save much subsequent dissatisfaction. It need not be said that in such matters the company should be prepared to act in co-operation with the contractor, but it is only reasonable that they should take an interest in matters in which both parties are so vitally interested; and, wisely carried out, such an arrangement would be to their mutual benefit.

A step further on the part of the company would be the establishment of a definite department of illuminating engineering organized for the purpose of assisting customers, and presided and assisted by competent illuminating engineers. In this connexion it is something of a coincidence that we have received a letter from the Edison Electric Illuminating Company of Boston explaining the steps they are taking in this very direction. The Company is opening a department that will be known as the Division of Commercial Illuminating Engineering, which will place the experience of Dr. Louis Bell at the service of consumers who require advice on the arrangement of their lighting units, and the department will maintain a staff of assistants for the purpose.

Accompanying the letter referred to the Company send us a series of pamphlets recently issued by them announcing this step. Although the Boston and other companies have previously sought to advise consumers in this way, this is probably the first occasion on which an electric supply company have organized a definite department to deal specifically with problems of this nature for the consumer's benefit, and the results already recorded are said to have amply proved the value of its existence.

It may also be recalled that the ILLUMINATING ENGINEERING BUREAU of New York deals exclusively with problems of this class, and that the GENERAL ELECTRIC Co. in Schenectady have also for some time maintained an organized department of illuminating engineering.

Another aspect of this question is the progressive education of the public in these matters which is now taking place, and which in itself seems likely to render arrangements of the nature described on the part of supply companies almost obligatory. The August leaflet of the HOLOPHANE Co. affords interesting reading in this respect, and gives some idea of the educational work among the general public that is constantly taking place in the United States. We notice, for instance, a description of the popular demonstrations being undertaken by Mr. C. A. Howe. At the meeting for business men, organized in co-operation with the Kankakee Electric Light Co., those present were invited to bring up any lighting problems they had experienced, and almost all joined in the discussion. Subsequently the entire audience visited several shops in the neighbourhood, in order to inspect illustrations of the principles just discussed. It is stated, indeed, that Mr. Howe has been invited to give a second lecture at the Women's Club in Kankakee, the subject being 'Economical House Lighting.' This, however, is said to be only one among a number of women's clubs, distributed in different parts of the country, that Mr. Howe has visited.

The Prevalence of Cataract Among Glass-Workers.

THERE is one section of the recently issued annual report of Dr. T. M. Legge, H.M. Medical Inspector of Factories, which is particularly interesting in view of the recent discussion by Dr. Schanz and Dr. Stockhausen, Dr. Voege, and others, upon the effect of ultra-violet rays upon the eye. According to some authorities the production of cataract may be at least partially due to the action of such rays, which have been proved to give rise to a certain turbidity of the eye lens, when present in large quantities; in particular it has been suggested that the exceptional prevalence of cataract among glassworkers might be explained in this way.

According to the report quoted, inquiry into the condition of the eyes of workers of glass in different parts of the country showed that persons continually exposed to incandescent molten glass and furnace-glare suffer from cataract more than ten times as frequently as other people, and the inspector, while abstaining from offering a definite opinion as to the explanation himself, mentions the suggestion as to the influence of ultra-violet light, and the possibility of using blue glasses as a preventive. He also points out significantly that "the combined knowledge of the physicist and physiologist is required to arrive at a conclusion on these points."

The problem in question is an excellent illustration of the value of co-operation of this nature, which *The Illuminating Engineer* has constantly advocated.

Dr. Schanz and Dr. Stockhausen, it will be remembered, have recently declared that ordinary glasses, and even those constructed of blue glass, fail to stop the ultra-violet rays of the most dangerous nature, and they therefore suggest the desirability of using a special "euphos" glass, which is completely opaque to the objectionable radiation.

If the prevalence of cataract among glassworkers is indeed actually due to the effect of these rays, such a glass might prove very useful; in any case it might enable experiments to be carried out with the object of definitely proving whether the objectionable physiological effects are due to the actinic rays or no.

The Production and Utilization of Light.

THE LAWS AND MEASUREMENT OF RADIATION.

By DR. C. V. DRYSDALE.

(*Continued from p.* 718.)

THE majority of the accurate measurements on radiation, however, have been made with one of two electrical devices, the thermopile and the bolometer. Seebeck's discovery of the thermo-junction in 1821 and Nobili's pile made up of several bars of bismuth and antimony enclosed in a metal case which could be provided with a collecting cone (Fig. 6) led to Melloni's classic experiments in radiation, and the important investigations of Tyndall, to be referred to later. To Prof. C. V. Boys, however, we owe the extension of this principle to the production of one of the most sensitive means of detecting radiation extant—the radio-micrometer, or micro-radiometer. The principal defects of the ordinary thermopile and galvanometer combination lie in the high resistance, when connexions are included, the great heat capacity of the pile, and the thermal conductivity from the hot to the cold junction. In the radio-micrometer which is shown in Fig. 7 the junction and galvanometer are combined in a single instrument, which consists essentially of a d'Arsonval galvanometer, in which the moving coil is formed by a long narrow single

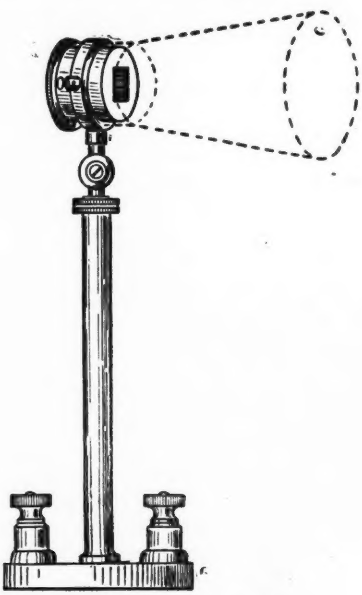


FIG. 6.—Nobili or Melloni Pile.

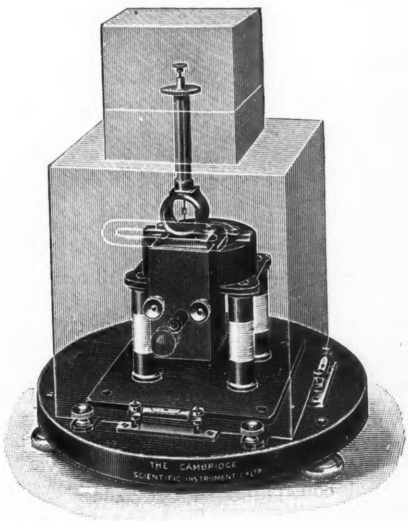


FIG. 7.—General View of Radio-Micrometer.

loop of copper wire (Fig. 8) at the bottom of which are soldered two minute rods, one of bismuth and tin, the other of bismuth and antimony. A small blackened silver plate is soldered to the lower ends of these rods, thus completing the circuit and receiving the radiation, which sets

FIG. 8.—Moving System of Radio-Micrometer.

up a thermo-E.M.F. in the circuit. The loop is simply suspended in the field of the magnet by a quartz fibre, thus securing the advantages of a very low resistance galvanometer without leads or metallic suspensions; and, consequently, a very small controlling torque is exercised. The sensitiveness of the instrument as ordinarily constructed is such that one watt at a distance of about 7 metres gives 1 mm. deflection at a metre distance, and its readings are rapid and definite, almost perfect damping being obtained by the magnetic action on the short-circuited coil.

An instrument which is also extremely sensitive, and which has been more used than the radio-micrometer is the bolometer. Although the principle of this instrument was discovered and employed by Svanberg in 1850* it was left for Langley in 1881† to develope it into a sensitive instrument, with which he conducted his famous researches on radiation in the spectrum. The original instrument of Svanberg is shown in Fig. 9, and was called by him a "galvanic differential galvanometer." It consisted simply of a flat spiral of silk-covered wire supported inside a hollow wooden cylinder. The rise of temperature due to radiation falling on the spiral was measured by the increase of its resistance, and he was able to measure a temperature difference of one-six-hundredth of a

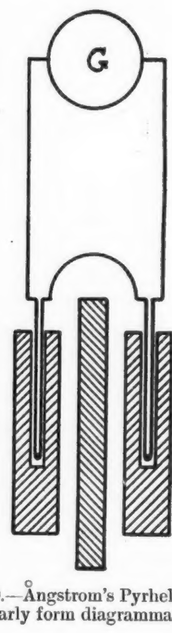


FIG. 10.—Ångstrom's Pyrheliometer. (Early form diagrammatic.)

degree. Langley employed gold, platinum, and palladium foil, thin iron strips, &c., about 10 mm. long, 1 mm. wide, and ·01 to ·002 mm. thick. Two of these were included in adjacent arms

* Pogg. Annalen LXXXIV., 1851, p. 411.

† Proc. Am. Acad. of Arts and Sciences, Jan. 12, 1881, Vol. VIII.

of a Wheatstone bridge, and when a considerable current was passed through this bridge it was found that an increase of temperature of either of the strips, amounting to one hundred-thousandth of a degree could be detected, and one ten-thousandth of a degree could be measured. He gave this arrangement the name of the actinic balance or bolometer (*βολη μετρον*). Since then the bolometer has been employed by numerous workers in America and Germany. One of the earliest in the field was Angstrom, who devised an instrument which he terms the pyrheliometer. The first instrument of this kind* employed thermo-junctions, and consisted of two small massive discs of blackened copper (Fig. 10) about 30 mm. diameter and 5 to 7 mm. thick, placed close together, but with a non-conducting partition between. In each of these discs a thermo-junction was embedded, and these junctions were connected in series with, but in opposition to one another, to a galvanometer, which thus indicated the difference between the temperature of the two discs. On allowing radiation to fall on one of these discs and shielding the other, the temperature of the former rose steadily and the rate of this rise could be easily obtained from the galvanometer deflection. But as the heat capacity of the disc was known from its dimensions, this enabled the amount of heat absorbed to be determined. This instrument is of interest as being the first which enabled radiation to be determined in absolute measure, but its sensitiveness was somewhat low. Angstrom, therefore, adopted the bolometer principle, and introduced his electrical compensation pyrheliometer,* which consisted of two exactly similar blackened bolometer strips, one of which received the radiation to be measured, while the other

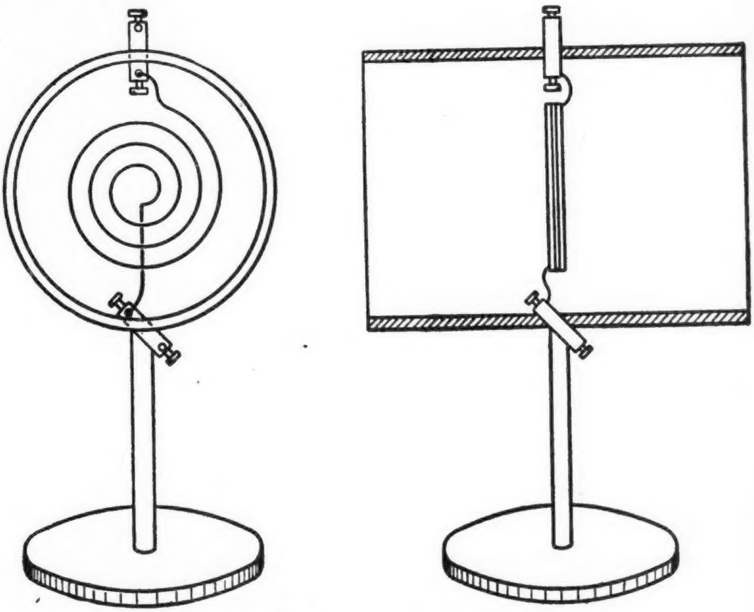


FIG. 9.—Svanberg's Galvanic Differential Photometer.

* Wied. Ann. XXXIX., p. 295, 1890.

* Wied. Ann. LXVII., 1899.

was traversed by a current which could be adjusted to raise its temperature to equality with the former. The power required to produce this equality of temperature, and hence of resistance, could be at once calculated from the current. Both strips being similar, no correction is necessary for convection or conduction.

The principle of the compensated bolometer has been employed by Kurlbaum, Callendar, and others, and found most valuable. For measurement of radiation over the visual range a photometer will, of course, serve, and many pyrometers have been devised on this principle, which will be described later.

(*To be continued.*)

On Reading in Bed.

Reading in bed is considered by many medical men, no doubt with reason, to be bad for the eyes, and one ought, at least, to take reasonable precautions to render it as harmless as possible. It seems reasonable to suppose that a considerable amount of the strain caused in this way is attributable to the fact that precautions are rarely taken to secure even fairly good conditions of illumination. A person reading in bed is often content with a makeshift device that he would regard as quite unsatisfactory in the study.

It is, in fact, a little difficult even deliberately to secure satisfactory conditions, as much will depend on the posture which the person assumes while reading, and, in any case, a recumbent position is really inconvenient for reading purposes. In an ordinary bedroom the general illumination provided is rarely sufficient to enable any one in bed to read with comfort, and a special local illumination is therefore necessary. A lamp may be placed quite close to the head, and it is, therefore, most essential that the direct rays from the source should be screened from the eyes.

The plan of attaching a fixture to the wall above the reader's head is not entirely satisfactory. If the lamp is too low it is very apt to come within the field of view, while there is also a tendency for the light to throw a shadow of the reader's head on the book, unless he assumes a particular position. Probably the best plan is to use a properly shaded lamp on a table at the bedside, and to support the book on a suitable rest.

One illustration of the want of care on the part of people reading in bed is afforded by their trying to do so in remote country districts where the only light available in the bedroom is shed by candles.

Candles may serve the purpose of those who merely wish to go to bed and get to sleep as quickly as possible ; but a single candle at the bedside yields far too weak a light to read by with comfort. Even supposing that the book is kept only one foot from the source and that the rays strike it vertically, we only secure an illumination of about 1 candle-foot, and this is now generally considered to be too low an illumination for continuous reading. As a matter of fact, however, the source of light will almost invariably be much more distant than this, and the attitude of the reader usually causes the rays of light to strike the book more or less obliquely, so that the effective illumination becomes but a fraction of the above value.

The constant flickering of the unshaded candle usually employed in such cases, and its dazzling effect, owing to its being necessarily so close to the head, are also undoubtedly very trying.

An Improved Form of Flicker Photometer.

BY LANCELOT W. WILD.

SOME of the desiderata in an ideal photometer are the following :—

1. It must be sensitive and certain on lights of varying colour.

2. The rays must fall upon the illuminated surfaces perpendicularly, so as to reduce angle error to a minimum.

3. The illuminated surfaces must be both directly over the pointer, and should not extend on either side of it, if an ordinary scale and bar is to be employed.

4. When balance is nearly obtained it should be easy to perceive which way the head must be moved to improve the balance, without the necessity of rocking it to and fro.

5. If complete reversibility is required, both illuminated surfaces should be absolutely identical, and must be the same distance from the eye.

6. In a flicker photometer, in order to secure sensitiveness, the transition from one surface to the other must be sudden, and there must be no dark line crossing the field of view, such as the unilluminated edge of a card.

It is claimed that the new Wild Flicker Head complies with all the above. It is extremely sensitive, and partly because of this and partly because it complies with requirement No. 4, the correct balance is so quickly judged that fatigue of the eye scarcely comes into play.

DESCRIPTION.

A species of Bunsen disc of the form shown in Fig. 1 is rotated on its centre by a small electric motor. The disc is made by a special process which ensures it being symmetrical, *i.e.*, if used as an ordinary Bunsen the same reading will be obtained again when the disc is reversed in its box, which is not the case with most Bunsens.

The disc is also much more sensitive and freer from angle error than the average Bunsen disc.

The disc as it rotates is maintained true by means of guides in close proximity to that part within the field of view.

A small portion of the disc is viewed through a diaphragm, and, as the dividing line separating the transparent from the opaque portion of it passes the field of view, a flicker is seen, which disappears when the head is brought to the position of balance, so that both portions of the disc are equally illuminated.

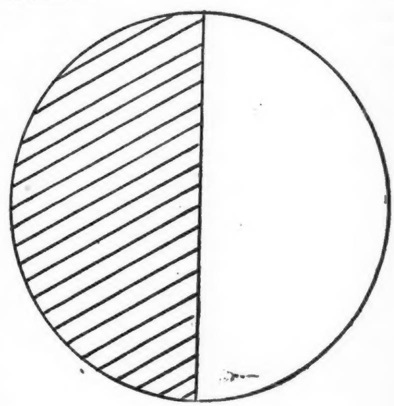


FIG. 1

The new improvement now made consists in the manner in which the disc is viewed. Both sides of the disc are viewed at once, and through the same eyepiece. The arrangement is shown in Fig. 2. P is a 60 degrees totally reflecting prism with a very sharp edge; L is a lens. At D is a diaphragm bent round the prism. MM are mirrors. On applying the eye to the lens one sees a circular field bounded by the diaphragm and with a thin black line, due to the edge of the prism down the centre. On the left of this line one sees the right-hand side of the disc and vice versâ.

The disc is purposely made so that the efficiency of the transparent part is slightly less than that of the reflecting part, consequently the two sides do not balance at the same point on the scale. Instead of attempting to reduce the flicker to zero, the operator moves the head till the two flickers on either side of the vertical line in the field of view are equal. If now the head is moved the least bit, an increase of flicker on one side and a decrease on the other is at once manifest, and the operator knows at once which way the head should be moved to improve the balance.

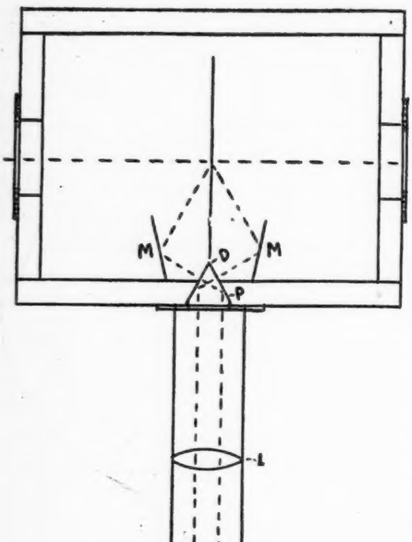


FIG. 2.

This double effect just doubles the sensitiveness, and partly because of this and partly because one does not have to hesitate before deciding which way one is out of balance, the whole operation is completed so quickly that fatigue of the eye has not time to set in.

It is found that it is not necessary to entirely eliminate colour flicker, and consequently the sensitiveness does not fall off as the colour difference increases to nearly the same extent as in other flicker photometers, the speed of which have to be increased when the colour contrast is great in order to eliminate colour-flicker.

Partly due to the rays falling upon the disc perpendicularly and partly due to the selection of suitable materials for the making of the disc, angle errors are practically nil. Turning the head on its pillar through an angle of 1 degree alters the reading $^1/_{10}$ per cent, as against fifty times this amount for a corresponding angular displacement with another well-known make of flicker head.

The disc is enclosed in a box eight inches long, and the light enters through bevelled holes $1\frac{1}{4}$ in. in diameter in brass flanges at either end. The disc is, therefore, well screened from stray light, a matter of considerable importance.

With a properly drawn scale and the lights correctly aligned, the same reading should be obtained on reversing the lights. Should, however, any doubt be entertained as to this, the head as a whole can be reversed by turning it over, an extra fitting being provided at the top.

A test for sensitiveness was made on one of these photometers against several other flickers. The results obtained, though depending somewhat upon the natural prejudices of the inventor, are set out below for what they are worth.

The special Whitman flicker had the disc cut so that the edge never crossed the field of view, and had to be worked upon a special bar and scale.

Type of Flicker.	Lights same Colour.	Pentane and Gas.	Red and Green.
	per cent.	per cent.	per cent.
Simmance ...	1·8	2·1	4·4
Ordinary Whitman	1·6	2·0	4·2
Special Whitman	·6	1·0	3·5
Wild, old type	·9	1·1	2·5
Wild, new type	·5	·6	·9

A New Variety of Incandescent Gaslight.

SOME of our readers have doubtless had the opportunity of visiting the showrooms in Cheapside, or the pavilion of the Universal Gas Methane and Buisson-Hella Co. at the Franco-British Exhibition, where some examples of an interesting and novel form of incandescent gaslight are on view.

This system represents a new departure in gaslighting, on which great expectations have been founded, and the following description, based mainly on information kindly afforded to *The Illuminating Engineer* by Mr. C. F. Killar, one of the directors of the company, may therefore be of interest.

The general nature of the incandescent device—the " bushlight "—will be best understood from the accompanying illustration, for the use of which we are indebted to the courtesy of the *Journal of Gaslighting*.

The actual incandescing material takes the form of a series of rods about 0·8 mm. in thickness, and usually 25 to 30 mm. in diameter. The composition of these rods forms the subject of two English patents by M. Laigle (Nos. 3785 and 9622 of 1908), who states the percentage composition to be as follows :—

Alumina	3·0	per cent
Berylla	2·0	,, ,,
Silica (or silicate of alumina) ..	1·0	,, ,,
Thorium oxide ..	92·8	,, ,,
Cerium oxide ..	1·2	,, ,,
	100·0	

These patents also discuss the use of oxides of lower melting point than berylla to serve as a permanent binding material, or berylla itself may be so used. When squirting the filament the whole material has to be reduced to a pasty, adhesive condition, necessitating the use of materials to serve as an agglutinant. Special mention is made of the need of securing removal of obnoxious residues formed from the binding constituents during the subsequent calcination, just as occurs in the case of some of the processes used in the manufacture of metallic filament lamps: pure gum arabic and ammonium oleate are mentioned as serviceable in this connexion, as they are decomposed by heat into volatile products. However, oxidizing materials are also included in the filament in order to completely remove undesirable carbonaceous residues. One characteristic of the process on which stress is laid is the production of the rod-filaments in a porous condition, the illuminating efficiency being thereby greatly improved.

As a result rods are obtained which are claimed to be quite exceptionally durable as compared with the ordinary incandescent mantle. Although these rods are sufficiently fragile to be deliberately broken (with some difficulty however) by pressure between the thumb and finger, it requires a very severe shock from without to affect them. Their rigidity is also stated to render them practically immune from the injurious effects of a severe draught on an ordinary mantle, and the eventually disintegrating action of continual lighting up and extinguishing the burners. Moreover, there is also the probability that careless handling of the mantle may merely snap off one or two of the rods and leave the rest intact, thus only slightly affecting the value of the glower as a whole.

Several illustrations of the ability of these mantles to withstand shock are afforded in the window of the premises in Cheapside. One such mantle is shown burning and being at the same time subjected automatically to a series of sharp shocks at the rate of about 50 a minute. A second mantle is exhibited, being dipped into water at regular intervals, but yet, apparently, continuing to yield its light unharmed after immersion.

The power of resisting shock attributed to these rod-filaments is being turned to special account in the design of portable lamps, capable of being lifted from one position to the other without danger of breakage, and for the purpose of motor-car headlights. Another probable useful application is to train-lighting.

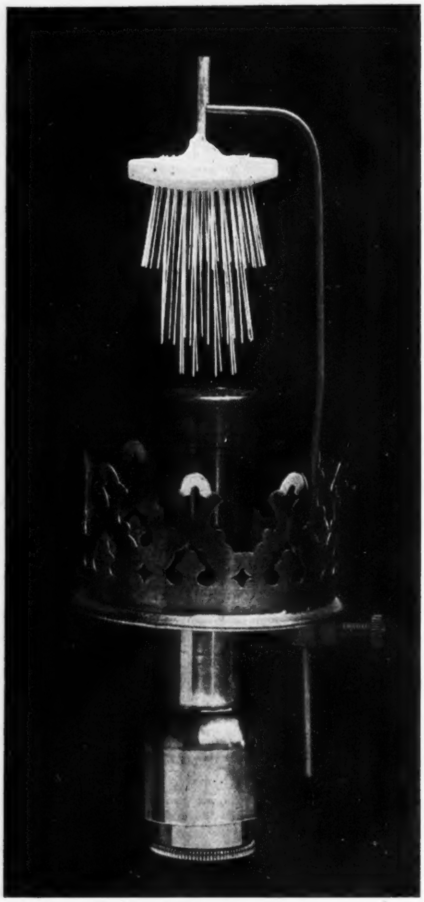


Fig. 1.

Apart from their toughness, however, it is also claimed that such filaments retain their initial candle-power almost indefinitely, and, indeed, gradually improve with use, for the subsequent heating seems in some way to complete the original chemical action and to cause them to incandesce with a given amount of gas more readily than before. Thus, we were informed of cases in which they continued to give as good results as was initially the case three or four years after installation.

The burner used with the "hella-bushlight" differs from those used with mantles of the ordinary variety, for instead of drawing up the flame outwards so as to envelope the mantle, it drives it up with some force centrally. It is understood, however, that burners can also be designed to burn petrol or acetylene if required. The efficiency of the arrangement at present on exhibition is said to approximate to that of ordinary mantles.

Although the only examples on show at present are of French manufacture and of the size most commonly used in France, there appears to be no difficulty in constructing the bushlight in different sizes; indeed, one would suppose that the method of mounting a number of separate rods was specially favourable to subdivision into sources of low candle-power.

It is also proposed to develope high candle-power sources for street-lighting, and for use on high-pressure systems. In this connexion the advantage claimed for these rod-filaments, of being practically immune from injury from wind or rain, would be a distinct advantage. The use of a higher flame-temperature may also be beneficial in enabling thicker rods to be used. For instance, it is hoped that such sources will be specially serviceable for the provision of intense lights for lanterns, lighthouses, and searchlights, and our representative was informed that a light of 5,000 candle-power was recently obtained by the incandescence of rods about one-eighth to one-quarter of an inch thick in the oxy-acetylene flame.

The bushlight is expected to prove useful for decorative purposes. Although usually worked up into rods, it appears that the filaments can also be constructed in any desired fantastic shape—stars, baskets of flowers, &c.—when in the plastic condition. It is also stated that the colour of the lights can be varied over a wide range by altering the chemical composition of the rods, and that this quality, too, will prove of great value for decorative and special trade purposes. For instance, the rod filaments installed for the illumination of some works in Nottingham, where the manufacture of lace is carried out, were specially designed to yield light of a somewhat greenish hue, in deference to a prevalent impression among workers in this industry that light of this colour is most suited for close work, liable to tax the eyes.

Such are a few of the interesting qualities attributed to this new form of incandescent gaslighting. Meantime we await with interest the publication of the results of actual tests of the rod-filaments, and hope to be able to supplement this description with some figures on the subject shortly.

The Generation of Acetylene Gas from Compressed Carbide Briquettes ("Brikettid Light").

By H. Koffler, of Vienna.

The manufacture of compressed and treated carbide, to which some inactive constituent is added, is carried out with the object of improving the conditions of gasification of the material, and rendering it less hydroscopic.

When carbide is treated with water, its hydroscopic qualities not only give rise to considerable loss and gradual deterioration of the material, but also constitute a source of danger, owing to the fact that the generation of gas continues after its period of actual use is passed. From the earliest beginnings of the acetylene industry attempts were made to avoid the inconveniences and dangers attending "after-gassing," by the design of automatically operated apparatus; the difficulties which were experienced, however, subsequently led to the abandoning of this method. The only apparent method of rendering the generation of acetylene gas less dangerous seemed to lie in the use of systems of hand-feeding; but even this method is naturally open to considerable objection from the commercial standpoint. For, in order to develope and store the whole of the gas available from a charge of carbide, a correspondingly large vessel must be employed, the high cost of which renders the application of the method impossible in the case of small installations of one to thirty lights.

More recently attempts have been made to render the material less hydroscopic, by adding some inactive substance, such as sugars and fatty materials, to the carbide. The variety of carbide produced in this way was better able to withstand dampness of the air, but it was still open to the objection that the danger of "after-gassing" was not avoided.

The briquettes invented by the author are specially designed to meet these conditions. They consist of finely granulated carbide intimately mixed with an inactive binding material, and forced into the desired shape under pressure. As the result we obtain a material possessing the following qualifications:—

1. *Great capacity for resisting damp*, in virtue of which the briquettes do not deteriorate with time, and can be stored as required, without the fear of gradual loss of gas owing to their slow decomposition.

2. *Absolutely uniform evolution of gas.*—The briquettes only evolve gas when brought into actual contact with water. They dissolve away in the apparatus at a perfectly uniform rate, because each individual particle of carbide only becomes active as its

protecting covering goes into solution in the water.

3. *Complete absence of "after-gassing."*—The quality of the briquettes described in the last paragraph also explains their freedom from "after-gassing." For, after the water has been forced out of the apparatus, the briquettes are left freely suspended in the gas generated, and do not come into actual contact with water; therefore, as explained above, they are practically unaffected by the surrounding water-vapour, and retain their good qualities until the time that the apparatus is again put into use.

4. *Complete gassification.*—One great advantage of briquettes constructed according to the process described over the use of ordinary carbide is that the undigested lumps, which remain in such a case after the acetylene has been evolved, are here completely avoided. The briquettes gradually dissolve away into the water, and are separated from the moist precipitated residue in the process; water can only again find access into the vessel when the very last volume of gas has been generated from the active material.

The behaviour of the briquettes, as contrasted with carbide of the ordinary variety, is illustrated by the results in Table I., which were obtained by an independent outside test. In the case of the ordinary acetylene generator, gas continued to be evolved for a long time after the cock was turned off, until eventually it overcame the pressure of the water and began to escape; while in the case of the briquettes no serious rise of pressure occurred.

The author believes that the method indicated has finally solved the problems referred to, and by the aid of a simple and cheap form of apparatus. The apparatus enables a dry and chemically pure acetylene gas to be produced, the temperature of decomposition being kept low, and the development of polymerides of acetylene, as an impurity, being thus avoided. The gas so generated has, therefore, the advantage of being well adapted for use with incandescent mantles. In Austria-Hungary and in some parts of Germany apparatus using compressed briquettes is exempted from the regulations affecting other apparatus for the generation of acetylene which forbid the installation of apparatus in dwelling-houses; it is expected that other Governments will shortly follow suit. This is the more to be desired, as the briquette method is especially favourable to the installation of acteylene light by small consumers, and will probably prove of great assistance in enabling acetylene lighting to compete with other illuminants in this field.

TABLE I.

Result of comparative Test of 1,000 *grammes Brikettid, and* 1,000 *grammes ordinary Carbide. Test made with Brikettid apparatus.*

I. *Brikettid.*—The apparatus was used continuously for one hour. Consumption of gas by burner = 100 litres per hour. Pressure 10·5 cms.

The cock was then turned off, and the subsequent manometer readings were:—

After 5 minutes	16·5 cms.
,, 30 ,,	19 ,,
,, 1 hour	20 ,,
,, 2 hours	20·5 ,,
,, 7 ,,	21·5 ,,
,, 20 ,,	19 ,,
,, 25 ,,	19 ,,

Efficiency 260 litres of gas per 1,000 grammes of Brikettid.

Temperature developed, 32·5° Centigrade.

II. *Ordinary Carbide.*—The apparatus was used continuously for one hour. Consumption of gas by burner = 100 litres per hour. Pressure 16·17 cms.

The cock was then turned off, and the subsequent manometer readings were:—

After 5 minutes	26 cms.
,, 30 ,,	30 ,,
,, 1 hour	33 ,,
,, 3 hours	37 ,,
,, 8 ,,	42 ,,

After 8 hours, escape of the gas occurred, owing to the pressure generated having exceeded that of the water.

Efficiency, 290 litres of gas per 1,000 grammes of Carbide.

Temperature developed, 54·5° Centigrade.

Some Notes on the Proceedings of the Annual Meeting of the British Association.

An account of the proceedings of the British Association at Dublin this year would be incomplete without some reference to the death of Lord Kelvin, whose presence helped to lend such distinction to the Leicester gathering last year, and to whose work Dr. Francis Darwin paid tribute in his inaugural address. Happily the attendance this year again reached a high figure, and while but one communication dealing specifically with photometry and illumination was given to the meeting, many of the addresses were of exceptional general interest.

Reference must first be made to the communication from the director of the **National Physical Laboratory** on the subject of the Standard of Light now to be adopted.

Mr. Paterson, it will be remembered, in 1904 presented the formula—candle-power$=10+0{\cdot}066(10-e)$—for the correction of intensity of the Harcourt standard for atmospheric moisture, the lamp having its correct value when $e=10$, *i.e.*, when there are present in the photometer-room 10 litres of moisture per cubic foot of air. Under these circumstances the humidity was measured with an ordinary wet and dry bulb thermometer. At the Reichsanstalt, however, an Assmann ventilator wet and dry bulb instrument has been used, and this hygrometer was recommended by the International Photometric Congress at Zürich in 1907.

More recently the value of the various hygrometers for the measurement of moisture has been studied more completely, and it has been ascertained that a difference of as much as 20 per cent between the readings of the ventilated and unventilated hygrometers exists. According to the Assmann instrument, which is regarded as giving a more consistent result than the ordinary hygrometer, the moisture actually present would be only 8 litres per cubic metre when a hygrometer of the ordinary variety would indicate 10.

If the Assmann hygrometer be adopted, Mr. Paterson's formula, therefore, becomes — candle - power $=10+0{\cdot}066(8-e)$—and the standard value of the lamp corresponds to 8 litres of moisture per cubic foot, instead of 10 as hitherto. The National Physical Laboratory adopted the latter as a mean value for the conditions in this country on the basis of investigations at their own observatory and at the Meteorological Office, carried out with the ordinary unventilated hygrometer, and some might regard it as objectionable to change the existing directions.

If, however, the Assmann hygrometer is adopted, and the 10 litres of moisture adhered to as the standard condition, it would involve a change of 1·3 per cent in the standard light. Now the existing unit has been adopted by the Engineering Standards Laboratory for glow-lamp testing, and utilized for the past three or four years for the purpose of creating many sub-standards in actual use to-day. For this and other reasons it is proposed to keep the *light-value* of the standard constant, but to use the Assmann hygrometer, and in future to adopt 8 litres per cubic foot of air as the standard condition of humidity. This proposition meets with the approval of the Gas Referees.

One important consequence of the change, pointed out in correspondence with the Bureau of Standards of America, is as follows.

The joint experiments carried out on the ratio of the Hefner to the Pentane lamp during 1906, in France, Germany, and England, led to practically identical results in Germany and England. Thus the German value was 0·909, while Mr. Paterson, at the National Physical Laboratory, obtained 0·907. Now the standard condition of moisture at the Reichsanstalt is 8·8 litres, while that at Teddington was 10 litres, measured by the unventilated hygrometer, and subsequently found to be 8 litres measured by the ventilated instrument.

But in either case a correction for the different standard conditions is needed in order to compare the Hefner and Pentane standards on an equal basis. From Mr. Paterson's formula and the results referred to above we find that, in using 8·8 litres in both cases :—

$$\frac{\text{Hefner candle at 8·8 litres}}{\text{Pentane candle at 8·8 litres}} = 0·908,$$

Taking 10 litres as the standard conditions of moisture in England, we have :—

$$\frac{\text{Hefner candle at 8·8 litres}}{\text{Pentane candle at 10 litres}} = 0·915\ ;$$

a result which was accepted at Zürich within ± 1 per cent.

But if we adopt the Assmann hygrometer and take 8 litres as the standard humidity for the pentane lamp, we obtain :—

$$\frac{\text{Hefner candle at 8·8 litres}}{\text{Pentane candle at 8 litres}} = 0·903.$$

And this figure approaches the convenient value 0·900 so closely as to enable us to say, within a margin of ± 1 per cent, that the Hefner is $\frac{9}{10}$ of the Pentane candle. An equally convenient result is attained as regards the comparison of the Bougie-decimale and the Pentane, for whereas—

$$\frac{\text{Bougie-decimale at 10 litres}}{\text{Pentane candle at 10 litres,}} = 1·02,$$

we find—

$$\frac{\text{Bougie-decimale at 10 litres}}{\text{Pentane candle at 8 litres}} = 1·006\ ;$$

and this ratio, within the limits of photometrical measurement, can be taken as unity. Thus we arrive at an interesting result that might, perhaps, hardly have been considered possible, namely, that the ratio between the pentane and the Hefner and Bougie-decimale, become altered to convenient round numbers, without the actual value of the light standards in either of the three countries being altered.

The convenience of using 8 litres as a standard, therefore, may be considered so great as to justify the International Photometrical Commission to modify the value of 0·915 for the value of the Hefner to the Pentane candle, which was based upon the information previously supplied by the laboratory.

This change does not remove another discrepancy of over 1 per cent, which has not yet been satisfactorily accounted for. This discrepancy is found to exist between the results obtained when the Hefner and the Pentane are compared direct, and those obtained when they are compared through the intermediary of electric glow-lamps.

Thus the ratio obtained by exchanging standardized glow-lamps between the various laboratories has been determined as follows :—

Paterson,	1905	..	0·891
Fleming,	1905	..	0·886
Sharp,	1905	..	0·890
Hyde,	1906	..	0·894
		mean	0·890

This want of agreement is considerably reduced by the change of the ratio of the Hefner to the Pentane from 0·915 to 0·903 ; but there is still something to be discovered, and this, with the co-operation of the Reichsanstalt, is now being examined.

Dr. Glazebrook's communication also mentions the possibility that the present method of defining the humidity by the number of litres of moisture present in a cubic metre of pure dry air may be modified. This method was followed by Liebenthal.

It appears, however, to be more usual to specify the number of litres of moisture in an actual volume of 1 cubic metre, including the CO_2, moisture and any other gases present. It is stated, however, that, even should this method be adopted in future by international agreement, it will lead, within the limits of possible accuracy of working, to virtually the same result.

In the Physiological Section much interesting ground was covered relating to general questions from which the study of illumination cannot be dissociated. Special reference may be made to the report of the Committee on the 'Condition of Health Essential to the Carrying on of the Work of Instruction in Schools, and the discussion on 'The Instruction of

School Teachers in Physiology and Hygiene.'

Prof. Sherrington, for example, likened the human body to a machine, and insisted that the school teacher, who might be considered in this sense a human engineer, ought to have some knowledge of physiology and some insight into the working of the healthy human body. In the present age the daily life of the school child was coming more and more under the supervision of the school-teacher. The medical inspection of school-children, again, was now an accomplished fact, and in order to make his work efficient, the medical officer would be obliged to rely upon co-operation of the teacher.

As a matter of fact, physical breakdown was not infrequently more or less due to defective educational methods, and the squinting child was very often a product of the schoolroom.

Prof. F. Gotch, again, remarked that he desired to see the teacher acquire a knowledge not only of hygiene, but also of physiology, and thought that a knowledge of those they proposed to instruct was quite as essential to the teacher as any other recognized system of educational training.

He could not understand how it was that another nation was prepared to maintain an expensive navy and also to give large sums of money to technical instruction of any variety, where we were unable even to spend money on the adequate training of our teachers.

When we observe the difficulties experienced by the medical profession in securing the carrying out of many of their general recommendations, it is hardly to be wondered at, perhaps, that the claims of illumination in schoolrooms, &c., which, of course, are only a part, though a very important part, of the general physiological conditions that require attention, have not as yet received the recognition they deserve. At the same time there seems some danger that the importance of this point both to the educational and medical authorities, may be lost sight of. It may be remarked, for instance, that the report of the committee on the conditions of health essential to school work, to which reference has already been made, contains no reference to illumination. The questions of ventilation, temperature, humidity, &c., and the number of cubic feet of air per individual, are discussed, but the equally essential question of the amount of illumination required by a child for certain classes of work is not specified.

As has been frequently pointed out in *The Illuminating Engineer* (vol. i. No. I. p. 58, Special Section, ' Illumination and Eyesight '), medical authorities are agreed as to the serious handicap to children of working under a bad illumination, and the strain to which it may expose them at a critical period in their development. The squinting child, referred to by Prof. Sherrington, might quite conceivably owe his defect to his having been obliged to work by badly placed and inadequate lights; while educationalists should be alive to the folly of expecting good work from children who are really unable properly to see the letters they are striving to decipher.

An important recommendation put forward by the Committee is that a Royal Commission should be appointed to deal with the subject, and it is to be hoped that in this case *all* the essential conditions of health will be studied, and that the subject of illumination will receive its due share of attention.

Among the other papers in this section may be mentioned several which, though purely physiological in character, might prove to contain suggestions of considerable value to those concerned with illumination, and for this reason: there seems to be a want of some convenient and ready method of determining the physiological effect of different systems of lighting; in schoolrooms, for example, it is highly probable that bad systems of lighting are responsible for mental fatigue, merely by increasing the natural difficulties of the tasks on which children are engaged.

In this connexion the paper by **Mr. H. Sackville Lawson** on ' Some Aspects of Mental Fatigue,' is suggestive. According to this suggestion mental conditions may be recognized by the state of sensitiveness of the skin.

Intellectual effort causes an accumulation of waste and poisonous material in the brain cells, and this reacts on the whole system, producing a change in skin-sensitiveness all over the body.

The sensitiveness of the skin is studied by means of a very simple form of instrument, the "Æsthesiometer," which is merely a modified pair of compasses. In conducting an experiment it is only necessary to determine the distance apart on the skin at which the impressions of the two points of the pair of compasses fail to be recognized as consisting of two distinct sensations. The author gave a series of graphs of skin-sensitiveness of students, professors, and a vicar in a surburban parish, &c., enabling the effect of mental effort on different days to be clearly demonstrated. Such a simple method of studying the subject may commend itself to educationalists engaged in investigating different methods of teaching, and might also, as indicated above, prove of value for the purpose of studying the effect of different systems of illumination.

In the same way the contribution of **Prof. Francis Gotch** on 'Certain Features of Retinal Photo-Electric Phenomena' is not without interest to the illuminating engineer. The considerable amount of attention now being devoted to photo-electric effects on the retina may lead to extremely valuable knowledge as to the means by which vision is accomplished, and it seems reasonable to hope that it may suggest a means of studying the effect of fatigue caused by different illuminants on the eye, and the exact influence both of the visible rays in the spectrum and also the invisible ones, about the action of which there has recently been so much discussion.

Dr. Edridge - Green delivered a paper on 'Colour-Blindness and Colour-Perception,' in which he discussed the classification of those having defective colour-vision. An important item in this division was the recognition that two classes of colour-blindness exist. In one case the loss of colour perception is accompanied by loss of perception of *light ;* in the other it is not. The speaker also explained his method of testing colour-blindness, by the "Lantern," "Classification," and "Spectrum" tests, in which the examinee is required, not merely to match, but to state the actual colours correctly, and to show the size of the portions of the spectrum which appear to him monochromatic.

Sir Wm. Abney and others took part in the discussion on this paper, and **Mr. L. Gaster,** who was present as Editor of *The Illuminating Engineer*, pointed out the practical importance of these physiological questions. Now that so many different varieties of illuminants were coming into use, and illuminants yielding such widely different spectra as the flame arcs and the mercury lamps, it seemed advisable to consider whether prolonged working under such sources of light might not lead to undesirable physiological effects, such as a distortion of normal colour-vision. He therefore inquired whether Dr. Edridge-Green had ever undertaken any tests with this object, and suggested that on such questions the co-operation of the engineer and physiologist was very much needed.

It was generally recognized by those present that this would be a profitable line of research, and that, generally, modern conditions of illumination offer a field of considerable interest to the medical profession and the physiologist.

Among various other papers dealing with physical subjects of interest, mention may be made of that by **Prof. H. H. Turner** on 'The Relation between Intensity of Light I, Time of Exposure, t, and Photographic Action.' It would be natural to suppose that the photographic action of light would be proportional to It. Sir Wm. Abney, however, has expressed the view that this relation does not invariably apply, and the author, in agreement with these and other published results, finds that a more complicated law represents the exact conditions more closely, and prefers the relation,

$$\text{Photographic action} = I \times t^{0 8}.$$

Mr. H. Stansfield described some experiences with the echelon spectroscope, and **Mr. G. A. Hemsalech** explained a new method of obtaining the spectra of flames devised by the author in conjunction with **M. de Watteville.** A glass bulb encloses a spark-gap between two electrodes of the metal whose spectrum it is desired to obtain. Air, on its way to a bunsen burner, is caused to pass through this glass bulb. When powerful electric sparks pass across the electrodes, metallic vapour issues from the latter and diffuses into the surrounding air, combining and forming very finely divided particles, which are carried forward into the bunsen-flame, and impart to the latter the characteristic spectrum of the element under examination.

There were other papers read before the Association which, while not dealing specifically with any aspect of illumination, contained food for thought for those in all sections of the engineering profession. Among these special mention may be made of **Prof. L. C. Miall's** 'ADDRESS TO THE EDUCATIONAL SECTION.' Many of his generalizations regarding education evoke immediate sympathy; unfortunately, as Prof. Miall admits, we do not always act upon our hardly-earned convictions in these matters, but are carried on by the inertia of former educational systems.

Prof. Miall expressly points out how book-learning as a means to an end may be a useful tool, but as an end in itself is often merely stupefying. "Happily for us a great deal that we once knew and might foolishly wish to retain in our knowledge quickly fades from the memory....It is not nearly so necessary to know more things as to know them better, to know what to do with them." And we must all recognize the necessity for deliberate choice as to what it is we mainly desire to know.

Yet, though most people agree, in the abstract, that scientific information is of relatively small value in comparison with the scientific method and scientific spirit, the teacher of science still loads the memory with facts, and the examiner bases his results on the quantity that the candidate has been able to accumulate.

In considering the subject of technical education Prof. Miall criticizes those methods that consist merely in supplying information directly applicable to the industry in question. "The information is not accurately lodged, either in the memory or the note-books of the students; it soon becomes obsolete in consequence of the advance of knowledge; and it does little to cultivate intelligence or the power of doing."

On Literature and Rhetoric, too, Prof. Miall has some interesting comments to make, especially when he points out that the growth of the scientific spirit must tend to weaken that variety of literary and rhetorical art which may fitly be described as insincere eloquence: "Rhetoric seeks above all to persuade, and in a completely scientific age men will only allow themselves to be persuaded by force of reason. Even in our imperfectly scientific age those men gain most by speech who have something important to say, who say no more than they know, and who use all possible plainness."

Space does not enable us to do more than briefly mention two others among the many communications of exceptional scientific and practical interest. 'THE REPORT OF THE COMMITTEE DESCRIBING SOME EXPERIMENTS FOR IMPROVING THE CONSTRUCTION OF PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS' contains some exceedingly important data, especially that referring to the work on some of the fundamental units, recently undertaken at the National Physical Laboratory, and recently published in *The Philosophical Transactions.*

Lastly, mention may be made of the paper by **Capt. H. Riall Sankey** on 'THE UTILIZATION OF PEAT FOR MAKING GAS OR CHARCOAL.' A scheme for the distribution of electricity generated by gas engines driven by gas obtained from peat has, it will be remembered, come before a Select Committee of Parliament this year; it may be of interest to some of our readers to mention that a complete account of these proceedings occurs in a special number of the *Irish Engineering and Industrial Review* for September in this year.

Some Effects of Light, Visible and Invisible.

(*Continued from p.* 756.)

HITHERTO we have mainly referred to the effects of *invisible* light of short wave-length upon the eye and the skin. There are, of course, vast stores of energy at the other end of the spectrum that take the form of dark heat rays, and may also be of influence. As a matter of fact, however, such investigations as have been published on this subject seem to convey the impression that no very definite and obvious effects arise when the sources of light are kept at a reasonable distance from the eye. Extreme heat, however, has been found to exert a drying and irritating effect upon both eyes and skin. Naturally a deliberate attempt to produce the heat rays in excess can cause more pronounced physiological effects, and has been utilized in certain courses of medical treatment.

A question of greater significance to the illuminating engineer is the effect of the visible rays in the spectrum. On this point comparatively little information that can be applied to practical conditions seems to be available. As explained above, common experience forbids the assumption that there is any very violent difference between the effects of ordinary illuminants, though there may exist small changes that act progressively, and eventually become worth taking into consideration. Here again it is sometimes suggested that certain rays have beneficial influence or otherwise on the skin, the pulse, &c. These, of course, are questions for the physiologist to study.

A great many conflicting and inadequately supported views are often put forward as to the beneficial physiological effects of certain illuminants. It is, for instance, known that the greatest sensitiveness of the eye to light occurs in the yellow in the spectrum, and Nichols has attributed this to the gradual development of the eye so as to utilize natural daylight to the best advantage (see abstract, *Illuminating Engineer*, August, 1908, p. 686). From this point of view it has been argued that yellow light must be that for which the eye is most perfectly developed, and amber-coloured glasses have occasionally been prescribed on this account.

On the other hand, it seems that the mere fact that the eye is most sensitive to yellow light is not necessarily a proof that the tendency to fatigue is least in that region of the spectrum. It might, indeed, be argued in the same way that because the pigmental change, or whatever it is that is responsible for the sensation of light, is most pronounced at this point, therefore such pigment would most readily be used up, and therefore the fatigue would be *most* evident in the case of yellow light. It also seems to be believed by many physiologists that chemical action on the retina becomes more and more pronounced with shorter wave-length, until in the ultra-violet the effect becomes extremely violent. But it need not be assumed that this effect is identical with that responsible for the sensation of light.

An entirely different view has been taken by those who exalt the mercury vapour lamp on the ground that it contains no red rays. This is founded on the supposition that red rays are most trying to the eyes. Steinmetz, indeed, has gone so far as to trace a connexion between the quality of the light and the opening of the pupil-orifice. The aperture appeared to contract most readily in the case of red light. It was, therefore, supposed that the red end of the spectrum was most irritating, the eye tending to protect itself by the closing of the pupil-orifice.

As regards the eye this result is certainly not in accordance with those of other workers. There really does, however, seem to be some ground for the belief that the colour red is, in some way, of a stimulating and exciting nature. There is a general impression that the red end of the spectrum is cheerful and stimulating, and that the blue end is correspondingly subduing and depressing. In the same way we speak of "warm" and "cold" tones. It is something more than a coincidence that we have selected red for the most exciting ideas; it is the symbol of danger, of war, and of revolution, and, as is well known, many animals—and proverbially the bull—are subject to its influence. So well does this appear to be realized by the medical profession, that a method of treating the insane has been founded upon the effects of red and blue light respectively.

A hypochondriac—a person, that is, who suffers from unreasonable depression of spirits—is placed in a room from which all but red light has been excluded. As a result his depression is stated to disappear and to be ultimately replaced by cheerfulness. After this point it is wisest to remove the patient, as his cheerfulness eventually turns to extreme excitability. Maniacs, on the other hand, who are abnormally excited, are said to be quieted by living in a room from which all but the *blue and violet* portions of the spectrum are excluded. This has a calming effect, but again must not be continued too long, as the ultimate result of exposure to energy of this kind is depression or even stupefaction.

Miss M. A. Cleaves (see 'Light Energy') has even recorded a supposed method of treatment of political offenders by shutting them up for a long period of time under blue light. As a result their faculties become numbed, and eventually, when released, they are no longer in a condition to cause the authorities any serious concern.

In all these circumstances, we must remember, we are only dealing with comparatively small quantities of monochromatic light, such as is commonly produced by putting blue glass in front of sunlight, and thus extracting the relatively minute store of energy that appears in the form of the blue and violet rays. When special efforts are made to concentrate light of this description we may expect to secure more immediate effects. Thus Dr. Radard of Geneva is reported to have successfully utilised the application of blue light in a concentrated form to produce local anæsthea for purposes of dentistry. The same effect has been known in the United States for several years, and concentrated blue light has actually been utilized as an anæsthetic, and allowed to play upon the part of the body on which it is desired to operate and so produce temporary insensibility. The advantages of such a form of anæsthetic, if its value be confirmed, would seem to be worth attention.

Seeing that such apparently violent effects can be produced by monochromatic light, and that these phenomena appear to be seriously considered by physiologists at the present day, it seems legitimate to inquire whether the so-called "warm" colour of certain varieties of illuminants has not a basis in actual physiological experience. It will be found that many people have a dislike for the whiter light of the carbon arc, which approaches daylight more closely in spectral composition than does the carbon filament incandescent lamp. They consider it depressing and cold.

On the other hand, there is a general feeling that the yellow tones of the oil-lamps, and to a less degree the ordinary carbon filament glow-lamp, are stimulating and "cheerful." It seems, therefore, conceivable that the predominance of red rays in the spectrum of these illuminants really does stimulate, and thus render them specially effective for festive occasions when people are gathered together and desire to be cheerful.

Another interesting and ingenious suggestion to account for this desire for the red and yellow is based on mental association. All the original illuminants were ruddier in hue than those now coming into use.

One of the very earliest and most primitive sources of light was the camp fire, and the pine-torches of the ancients and the middle ages, the crude oil-lamps, and the candle show a marked tendency to lighten in tone. More recently we have learned to make use of higher temperatures of incandescence, and this has resulted in a growing accentuation of the blue end of the spectrum and a whiter light.

One can therefore believe it possible that mankind has gradually become accustomed to associate the red and orange tones of the spectrum—the hue of the cheerful firelight within—with warmth and festivity, while the bluish shades are associated with the hues of twilight and the coldness without.

Yet it does not follow that the physiological effect of such illuminants, though pleasant, is to be preferred to that of daylight. Their mild stimulation is not necessarily the best for continuous use.

On the whole, when we consider how little is really generally known about the physiological influence of light, we may feel assured that our wisest course is to imitate the natural daylight, to the best use of which our eyes have been gradually developed, as closely as possible. Fortunately the light yielded by most artificial illuminants now in use resembles daylight fairly closely. Other more peculiar forms of radiation we may utilize for special purposes, but we ought to be slow to recommend their continuous use until we feel quite certain that there is no danger of their giving rise to any undesirable physiological effect.

J. S. D.

Cleaning Tungsten Lamps and Reflectors.

In a recent number of *The Electrical World* attention is drawn to the need for careful periodical cleaning of installations of tungsten lamps and prismatic reflectors. In a large city where much soft coal is used the lighting of a shop may deteriorate by from 10 to 35 per cent during a period of six weeks, simply owing to the deposit of dust and dirt.

Owing to the fragility of the tungsten filament, the necessary periodical cleaning must be carried out with care. The lamps should be cleaned while the filament is burning, and therefore in a more plastic condition. The lamp should be washed with a fairly moist cloth and subsequently wiped clean; but the cleansing of the reflectors should be carried out with the aid of a damp brush with stiff bristles, so as to get into the crevices of the prisms of the reflector satisfactorily.

In this connexion it is interesting to recall that a well-known firm in Germany deprecate the rubbing of the bulbs of tungsten lamps with dry cloths, on the ground that this may cause electrification of the outside of the bulb, with the result that the long tungsten filament is attracted and snaps off. For the same reason it is regarded as inadvisable to coat the lamp-bulbs with coloured varnishes, &c., containing shellac, which are easily electrified by friction. Presumably, however, this only refers to the older type of lamp in which the method of supporting the filament allowed it an undue amount of freedom.

Owing to the brilliancy of the tungsten lamps it is well for the operator to make use of a pair of dark glasses.

Cleansing ought to be carried out about once a month.

It is also a good plan to keep a stock of a few clean reflectors in hand, and to replace the dusty one whenever it is necessary to renew a broken tungsten lamp. The opportunity can then be taken to clean the old reflector thoroughly. Under ordinary circumstances to attempt to remove the reflector is to run some risk of breaking the fragile filament of the lamp used with it.

Some further Examples of Shop-Window Lighting by Gas.

IN a recent number of *The Illuminating Engineer* attention was drawn to a newly introduced system of shop-window lighting, according to which the sources of light are placed behind panels of diffusing glass installed above the contents of the window.

The illustration shown in Fig. 1 is another excellent example of this method of lighting, It represents a shop in diffusing action of the glass, provides a strong and uniform downward illumination. The piping is brought up at the rear of the window, the gas-cock being placed in a convenient position. The distance of the lamps above the glass is also sufficient to enable a fitter to attend to the mantles, and occasionally to clean the glassware and dust the glass "deck."

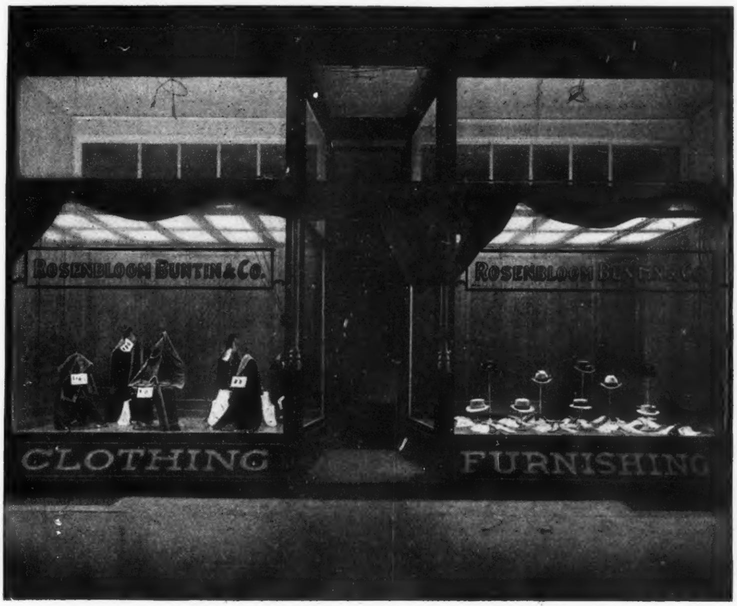


FIG. 1.—Show window, Richmond, Ind., U.S.A. Night View. Twelve minute exposure.

Richmond, Ind., U.S.A., lighted by gas by the Welsbach Co., to whom we are indebted for the block here utilized. The photograph was taken by the aid of the light in the window alone, necessitating a twelve-minute exposure.

An inverted mantle equipped with a concentrating conical silvered reflector is placed above each panel, and this, in conjunction with the

In this case electrical ignition is installed, batteries and induction coil being placed below the floor, and the switch beside the gas-cock, so that in order to light up it is only needful to turn on the gas and press the button.

Some other interesting examples of the "open" as opposed to the decked-in system of window-lighting are shown in Figs. 2 and 3. The shop exhibited in

Fig. 2, for instance, had a particularly high ceiling, and this permitted the use of individual gaslights equipped with suitable diffusing reflectors, placed on the ceiling well out of the normal range of vision ; the object in this case was again to produce a uniform, even illumination, free from "spotty" patches of light and shade. In this case also the piping was effectually concealed behind the panelling at the top of the window. The interior purpose of uniformly illuminating both the contents of the window and some of the counters immediately to the rear of it.

Other sources serve the combined purpose of illuminating the sign "Cigars," and the goods in the window, being, at the same time, very effectually screened from the direct range of sight. This shop is likewise provided with a "jump-spark" system of electrical ignition, the battery and switch being

FIG. 2.—Show window in Philadelphia, U.S.A. Night view. Fifteen minute exposure.

decoration of this store was executed in dark Flemish oak, so that an intense illumination was specially desirable.

The tobacconist's, shown in Fig. 3, affords a second example of the open shop-window lighting, but in this case the window was exceptionally deep rather than high. In addition to the lights employed to illuminate the interior of the store, advantage is also taken of lamps placed in line round the top of the window, which serve the packed away in an easily accessible cabinet.

Yet another example of the use of the open system is the carpet-store shown in Fig. 4, where a uniform illumination is secured by a series of lights with reflectors spaced along the top of the window, and Fig. 5 once more illustrates the use of concealed lights to bring the goods in the window into prominence without offending the eye.

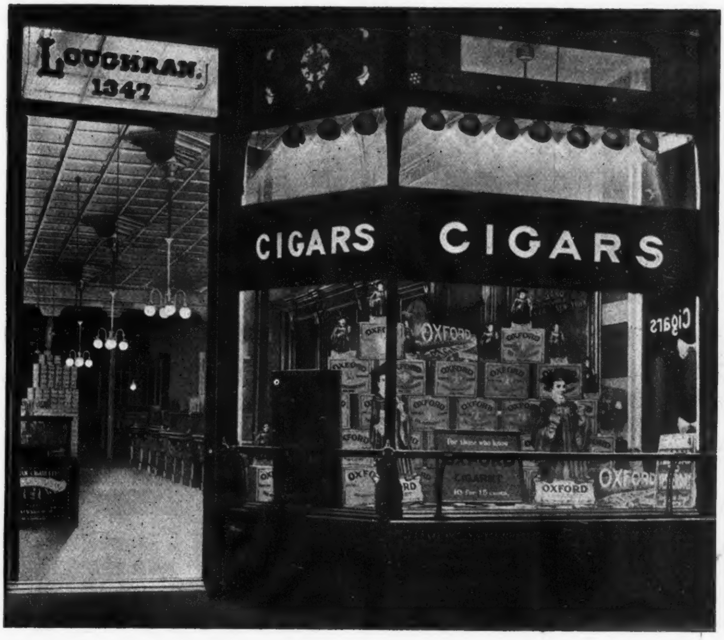


FIG. 3.—Tobacco store, Washington, U.S.A. Night view. Twelve minute exposure.

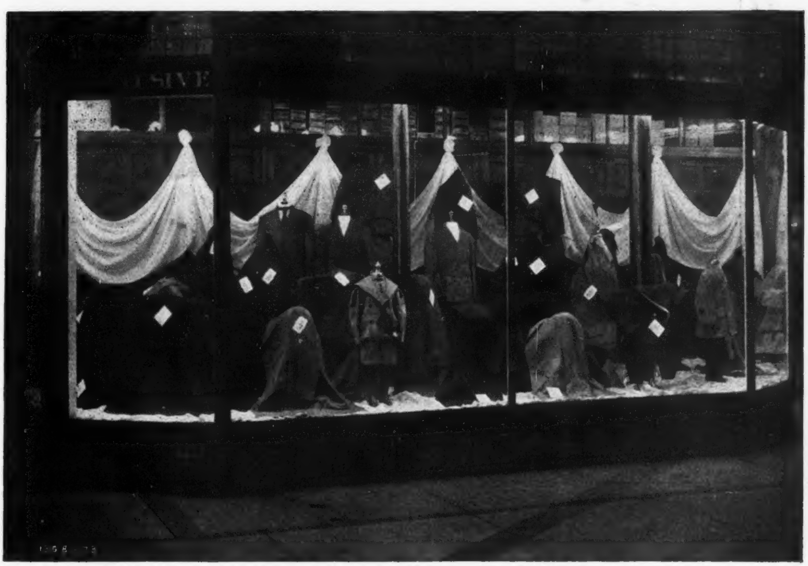


FIG. 5.—Display of Clothing Illuminated by Concealed Lights.

In all these windows the same general principles are aimed at. In each case it is desired to produce an even diffused illumination, and at the same time to conceal the sources producing it in such a way that the direct rays from them do not enter and dazzle the eyes of customers on the pavement.

Provided this is accomplished the salesman is justified in using what would be regarded as an abnormally high illumination for other purposes. For in order to attract the attention of passers-by, and to induce them involuntarily to form the habit of looking into this particular window, it is essential to adopt some method of lighting which both shows the goods to the best advantage and causes the window to "stand out" amidst its surroundings.

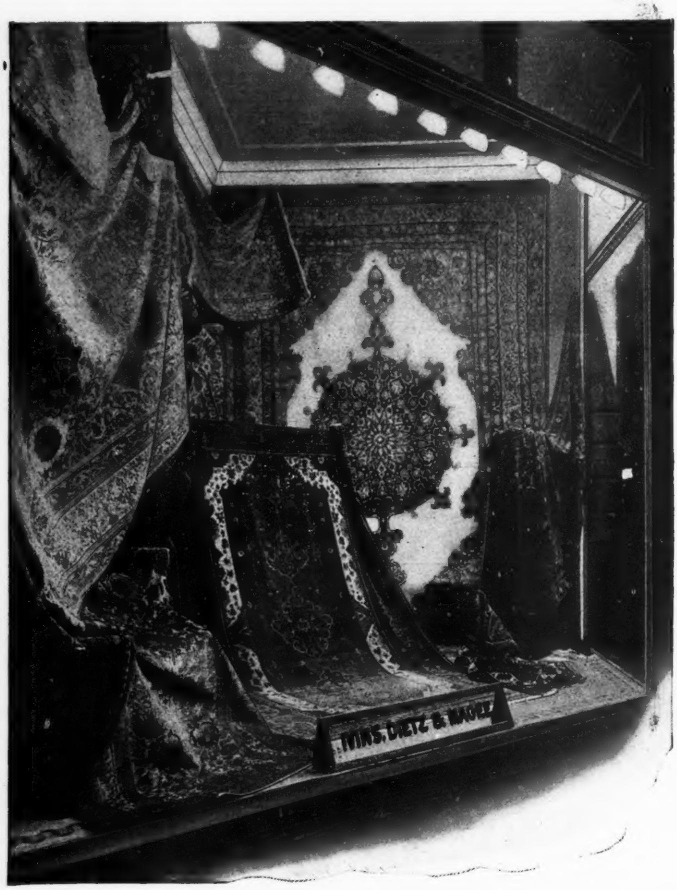


Fig. 4.—Show window of Carpet Store illuminated by means of Reflex Gaslights.

The Need for Good Illumination from the Moral Standpoint.

At first view the connexion between the forthcoming International Congress on Moral Education and Illumination would seem to be somewhat remote; and yet, so all-pervading are the indirect effects of the conditions of illumination under which we live, that it may fairly be said that good lighting is an absolute essential from the moral standpoint.

A very close association can be shown to exist in our minds between darkness and evil. This is exemplified in our modes of speech when we speak of "dark deeds," the "Prince of Darkness," the "Powers of Darkness," &c. The fear of the dark which is deeply implanted in the mind of almost every child is possibly but another manifestation of the same instinct, and it is a familiar method—and many would consider a foolish and cruel method—of punishing a child to shut it up in the dark. It may, indeed, be suggested that the knowledge that the terrifying darkness can be easily and immediately displaced by merely turning a switch must exert a distinctly encouraging influence upon the mind of a child, and generally stimulate its confidence.

A very obvious and practical aspect of the question is furnished by the well-known influence of good street-lighting, which is recognized by the police to have been of incalculable service in diminishing crime, by diminishing the possibilities of concealment. So well is this recognized that in many cases the police have exerted a powerful influence in problems of street-lighting and in decisions regarding all-night lighting, &c. It is common advice to those leaving their house shut up without a caretaker to leave a few small lights burning continuously as a preventive against burglary.

But it seems justifiable to draw more general deductions than this as to the effect of inadequate lighting. It is a recognized fact that where only a miserable dim illumination is possible dirt and disease accumulate, rendering it virtually impossible for those living under its influence to live a wholesome life. Quite apart from this, too, continual darkness is apt to cause people to become careless about matters which they would be ashamed to neglect in the light of day. Besides, inefficient illumination has occasionally led to tragic mistakes; there are cases on record in which the contents of a bottle of poison have been drunk by mistake, simply because it was taken for granted in the darkness that the bottle sought for was in its accustomed place.

Probably, however, the sheer *ability to conceal* arising from the presence of imperfectly illuminated regions has in itself an indirect influence upon moral character. A person about to do something that he knows, or suspects to be wrong, involuntarily chooses the darkness for his act, and it may legitimately be inquired whether the habitual and involuntary association of the dark conditions with the possibility of undetected wrongdoing does not in itself predispose towards evil.

Especially is this true of children. When a child is engaged upon some mischievous act, however trifling it may be considered to be, he goes away into some dark corner to do it; in such a case we may look upon the darkness, and especially darkness that can only be dissipated with some effort or inconvenience, as a temptation. Even in the schoolroom the system of illumination has a very distinct influence upon the ease or difficulty of the teacher's task, from this point of view alone. If there exist ill-lighted corners in which he cannot clearly see what the children are doing, they soon become a centre of disturbance.

And lastly we cannot afford to neglect what is often regarded as a very potent moral force, namely the estimation in which we are held by others. This influence is proportionally weakened in conditions in which the sense of sight, one of the senses by which we gain information about each other, is seriously handicapped. This is, of course, particularly true of personal habits of cleanliness, &c., but it is also true of habit in general. Broadly, the impossibility of securing good illumination at will must tend to exert an unfavourable influence by weakening one of the links which connects individuals and facilitates intercourse between them.

Photometry in Central Station Testing.

(H. A. Ratcliff, A M.I.E.E., paper on 'Work and Equipment of a Testing and Standardising Dept.,' Nottingham Convention, 1908.)

THERE is no doubt that the sooner every electricity department is equipped with a reasonable amount of photometric apparatus the sooner will the results obtained by the use of such equipments reveal the absolute necessity for further improvement of the existing methods for converting electrical energy into light. Money is therefore well spent on photometric apparatus.

A Novel Type of Decorative Glow-Lamps.

WE notice in a recent number of *The Electrical World* of New York an interesting illustration of the application of electric glow-lamps to purely decorative purposes.

These lamps are made to imitate various fruits: strawberries, oranges, pears, &c., and are then distributed among the foliage of corresponding baskets and trees, and yield a gentle diffused glow. The wires in all such decorations are concealed in the trunks and branches of the various trees, and the contents of the tree can be supplied with current by a single plug contact. Outfits of this kind are in great demand for Christmas trees, and for decorative use in clubs, restaurants, &c.

It is interesting to notice how incandescent lamps are finding application for purely decorative purposes quite apart from their use for illuminating. It is stated that very pleasing effects can be attained by the use of the ingenious device here described, and it is quite possible that in the future the management of light in this way will form one of the most powerful weapons in the hands of the artist or decorator.

One point, however, that must be realized in all such cases is that the criteria by which the effect is judged are quite distinct from those operating in the case of lights used in the ordinary way to *illuminate*, and that restraint must be exercised in the amount of light employed. One would suppose that in such a case as that above, for instance, in which the eye is intended to look straight at the source of light, the designer must be content to allow a considerable loss of light if artistic requirements demand it, and to aim at securing a soft and pleasing glow rather than glitter and sparkle.

SPECIAL SECTION.

Some well-known Photometrical Laboratories.

II. Photometry at the National Physical Laboratory.

BY CLIFFORD C. PATERSON AND E. H. RAYNER.

THE development of work and equipment at a National Photometric Laboratory is so intimately bound up with the question of light standards and the methods of interpreting them into convenient forms of substandards for everyday use, that no apology should be needed here for entering with considerable minuteness into the details of the practice which is being followed at the National Physical Laboratory in connexion with this work. We propose to divide the description of the Photometric Section into two parts: (1) That dealing more especially with standard work; (2) that connected with the more ordinary testing of lamps. It is a matter of regret that up to the present moment it has not been possible to undertake much in the way of equipment for that more romantic branch of photometric work which entails the use of globe photometers and integrators of the Matthews or Russell-Leonard patterns for the measurement of lights of high candle-power. Nor, unfortunately, has the photometry of gas lights as yet been

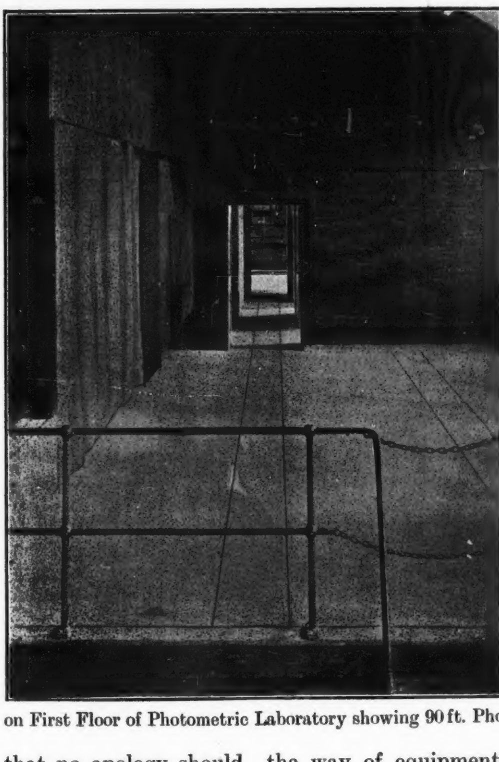


FIG. 1.—View on First Floor of Photometric Laboratory showing 90 ft. Photometer Track.

developed in a manner which will ensure relatively the same high order of accuracy as has been attained in the case of electric lights. It has rather been the policy since the department was initiated in 1903 firmly to establish the question of standards on a sound basis, devoting such funds as were available to the installation of apparatus which would enable these to be used and repeated to a very high degree of accuracy. The opening of new buildings partially devoted to photometric work in 1906 gave much greater scope than the somewhat cramped quarters first occupied, and the department now has a total floor area of over 4,000 square feet.

Buildings.

The Photometric block is 90 ft. long and 25 ft. wide, with ground and first floors. The windows have been made small, and are placed high up in the rooms, so as to give, inside the rooms, a maximum amount of useful wall area in cases where a large amount of natural illumination is not required. The ground floor has been set aside chiefly for life-test work and repetition photometry. The first floor has a large room for arc lamp and similar testing, an office and workshop accommodation, and a room set aside chiefly for standard work. The test rooms on this floor average 18 ft. high. It will be seen from a photograph taken on the first floor (Fig. 1) that the gangway along the centre enables a photometric track to be employed which is virtually 90 ft. long. It is, of course, impracticable to have the ordinary photometer bars this length, but a rail track has been laid along the gangway, and by mounting on rollers the long tables which carry the photometer benches (see Fig. 2) it is possible to move them to different fixed points and employ the ordinary 2 or 3 meter bars for fine adjustment. It is not of course, likely that the long track will be in continual use, but it is

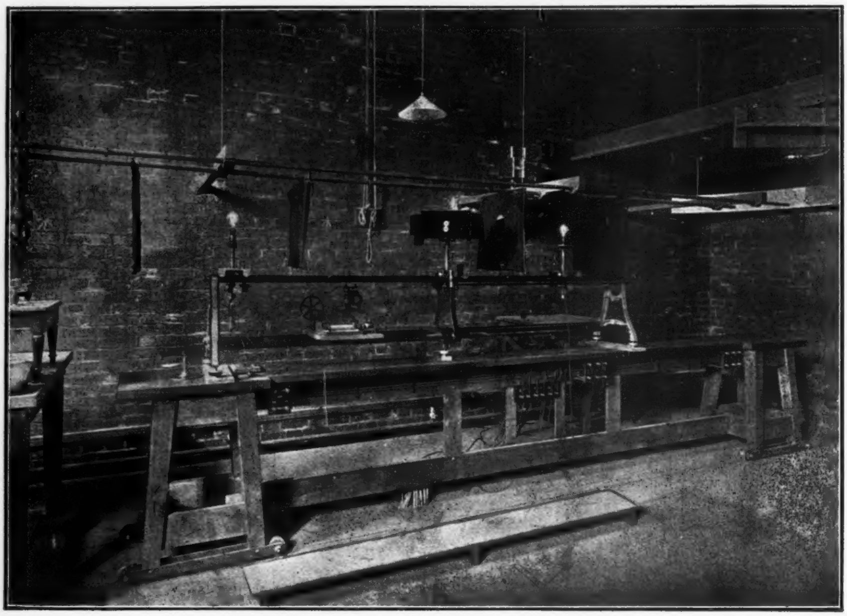


Fig. 2.—View of Photometer Bench in Standards Room.

expected to prove valuable for the investigation, for instance, of Purkinje effects, and for the measurement of the distribution of illumination over the beams from parabolic reflectors, or similar apparatus where the candle-power is very high. This work is at present prospective and has not yet been initiated.

Standard Work.

A view of the Standards Room is given in Fig. 2. The bench and measuring apparatus in this room are used for all work in which the highest accuracy is required, such, for instance, as the intercomparison of flame standards or the standardization of glow-lamps for electric sub-standards. The walls are entirely blackened, and all lights or reflections are carefully screened from the observer's eyes. The highest accuracy aimed at in the measurement of the candle-power of electric sub-standards, say, for instance, in the case of international comparisons of light standards with other laboratories, is one part in 1,000. This last figure can only, of course, be written small, and must be taken from the average of a good many observations. The lights to be compared must also be very nearly of the same colour. In order to obtain the last figure, voltage measurements must be correct to about one part in 10,000—so that the greatest care is necessary in the use and checking of the electrical measuring apparatus. The latter consists primarily of a Crompton Potentiometer for current and voltage measurement, and also a reflecting electrostatic voltmeter with a scale at 12 ft. radius from the instrument, and about 16 ft. long. One volt on this scale is represented by a distance of 2½ in. (see Fig. 3). This instrument must be calibrated from time to time at the point of use, against the potentiometer, in order to allow for a slow upward creep which takes place, due to the elastic fatigue of the suspension.

It will not perhaps be out of place here to describe in detail the method used for the ordinary measurement of candle-power, and to point out the various photometric errors which have to be avoided in connexion with this work. The most obvious method of comparing lamps, and that which is often described in elementary text-books, is to set up a standard lamp at one end of the bench and the test lamp at the other. A point is found somewhere between them at which a Bunsen, Lummer-Brodhun, or similar photometer head shows a balance, and the candle-power of the test lamp is deduced from the standard by taking the ratio of the squares of the distances. This method, however, is liable to several sources of error.

1. Photometer screen error.
2. Zero error of photometer head.
3. Unequal reflections from extraneous objects at the two ends of the bench.
4. Observer's personal error.

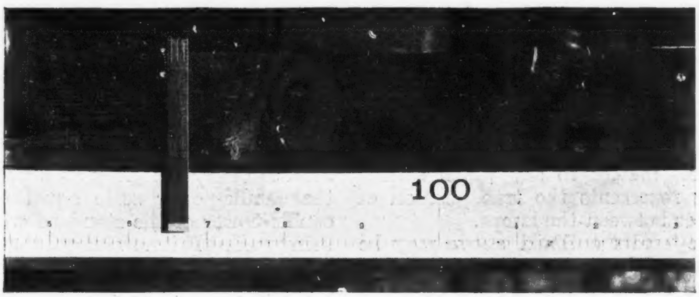


FIG. 3.—Portion of Wide Scale Reflecting Voltmeter from 95 to 103 Volts, with 6 ft. rule to give relative size.

Under 1, it is common knowledge that a photometer screen must be reversed, in order to eliminate the inequality of the two sides. It is often supposed, however, that the reversal of the screen is a panacea for all the troubles. As a matter of fact it only cures errors under the first heading and leaves the others untouched.

2. The zero error of the photometer head is large or small according as the pointer which runs over the scale is much or little out of the true centre line of the photometer screen.

3. For work requiring great accuracy care is needed in guarding against reflections from the screens which are put up to shield the photometer from extraneous light. Even velvet reflects or diffuses some light, and the same amount may not be reflected at both ends of the bench.

4. The fourth and usually the largest error is the personal one. One observer consistently sets either higher or lower than another, and it is a difficult matter to say which setting really represents the true position of balance between the lamps.

The errors outlined above may be eliminated by two methods. Either a second set of readings may be made with the position of the lamps interchanged, and the average taken—or a substitution method may be employed. The former is often useful when flame standards are being compared, the latter is nearly always preferable for the measurement of electric lamps, whether the measurements are wanted to a standard or to a commercial accuracy.

The exact substitution method which is employed for general work at the National Physical Laboratory is carried out on benches in which it is possible to clamp the right-hand lamp-carriage to the photometer carriage by means of an adjustable bar. A standard electric lamp of known candle-power is first fixed at the left-hand end of the bench. The scale of the bench is divided in millimeters the whole length, and a square law scale is also engraved on it. The main divisions of the square law scale are arranged so that at a point on the bench above any given division, there is an illumination of 10 candle meters when a lamp of candle-power equal to the number of the division is placed on zero at the left-hand end of the bench. Thus, suppose we have a standard of 13·5 candle-power

$$\text{Illumination, } I = \frac{CP}{d^2}$$

$$I = 10 \text{ candle meters.}$$

$$\therefore d = \sqrt{\frac{13{\cdot}5}{10}} \text{ meters} = 1{\cdot}162.$$

Hence opposite the reading 1·162 mm. on the one scale there is a division marked 13·5 candles on the other. The lower scale is thus graduated from 0 to 90 candle-power in a 3 meter bench. A "comparison lamp" (that is to say a lamp of suitable colour and voltage, but of no particular candle-power) is fixed on the right-hand carriage. This lamp merely serves as a temporary sub-standard for transferring from the standard to the test lamp. The photometer head is clamped rigidly at a point on the candle-power scale equal to the candle-power of the standard which is being used. It is now known that there is an illumination of 10 candle metres on the screen. The comparison or reference lamp is now moved nearer or further from the photometer until an exact balance is obtained. At the point of balance the connecting bar between this carriage and the photometer head is firmly clamped, and the photometer carriage being unclamped from the bench, the two saddles move together with a definite fixed distance between them. It is desirable to note this fixed distance on the millimeter scale and set up one or two other standards, repeating the process in order to see if the fixed distance always comes out the same. Having finally decided from several standards what the fixed distance should be, the clamping bar is finally adjusted, and the test lamps are set up one after another in the place of the standards. With any test lamps, wherever the point of balance is obtained, the candle-power is read off direct on the square law scale, without

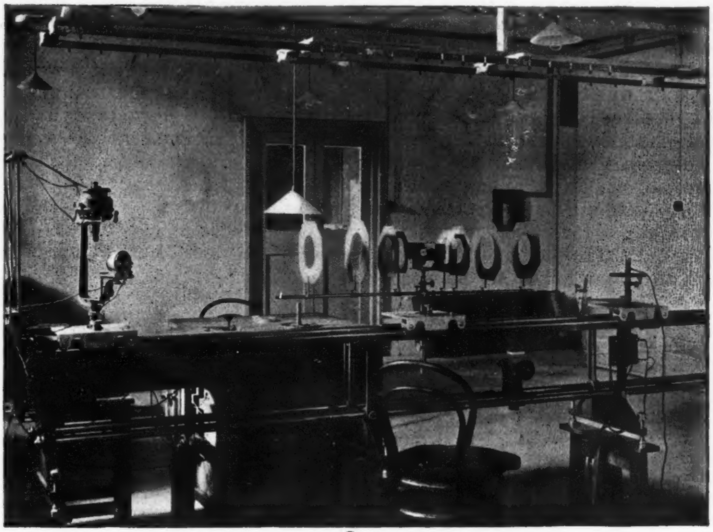


FIG. 4.—Photometer Bench for Life Tests on Glow Lamps (screens partially removed)

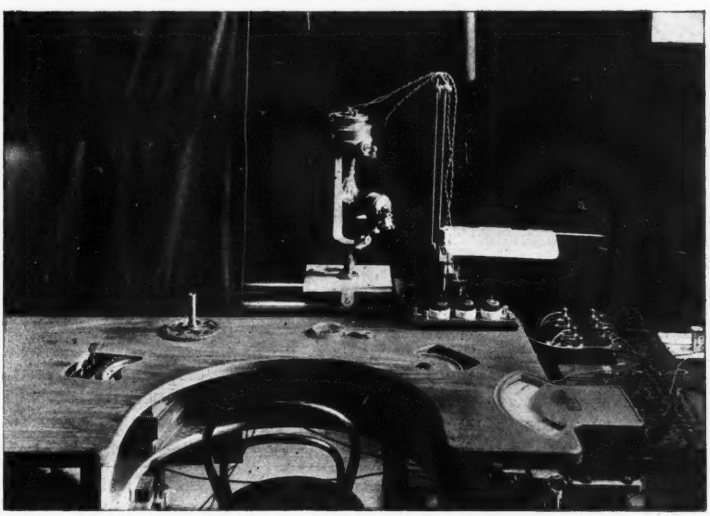


FIG. 5.—Table with Measuring Instruments for Bench shown in Fig. 4.

any calculation being necessary. It will also be appreciated that by such a substitution method all the errors mentioned earlier are for practical purposes eliminated. Errors due to judging wide differences of colour are not, of course, entirely eliminated by this method, but there is an opportunity of avoiding serious errors due to this cause, by choosing a comparison lamp the colour of which lies midway between those of the two sources to be compared. The colour difference between any two lights to be compared is thus halved for any setting. Lummer-Brodhun photometers of the contrast type are used for all ordinary work, and, as far as the authors' experience goes, although only one eye can be used in the observations, the latter are less tiring and more accurate than those with other instruments which have been tried. In their opinion one observation with a Lummer-Brodhun head (contrast type) is equivalent to two or three with a Bunsen or other similar type where the object is to obtain merely equality of illumination over a surface.

Before leaving the subject of comparison of standards, it should be mentioned that the observer at the photometer head never sees his own readings until they are all taken and entered up, so that he has no chance of being unconsciously biassed in one direction or another. His only business is to sit at the photometer and take none but photometric observations. Standardizations of glow-lamps are never completed in one set of readings, but the lamps are put up and standardized on three or four separate occasions. By this means it is possible to determine the candle-power of good electric standards to an accuracy approaching 2 parts in 1,000.

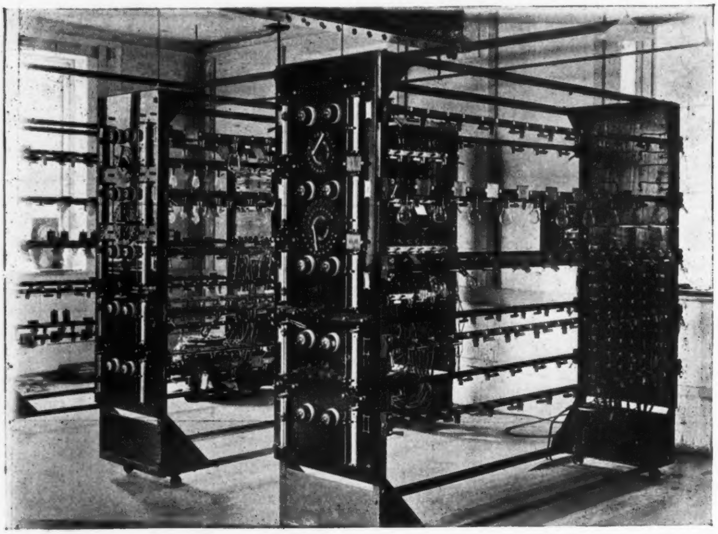


FIG 6.—Racks for Life Tests on Glow Lamps.

Life Tests on Glow-Lamps.

A further branch of work which is now fully developed is the testing of glow-lamps for useful life.* There is hardly space in an article of this description to discuss the advantages

* The "useful life" of an incandescent lamp is taken to be the number of hours required before the candle-power falls below 80 per cent of its initial value.

and disadvantages of various forms of life tests on glow-lamps. All kinds of tests are, of course, carried out, but that which is most systematized is the test to the Engineering Standards Committee's Specification.

The question of initial tests on a batch of glow-lamps is a simple matter. 5 per cent of a consignment is put through the photometers and tested for candle-power and watts at rated voltage. The values found are plotted on a target diagram which shows at once how near the selected lamps fall to their rated value.*

The matter of life tests, however, requires more than commercial accuracy. The photometer work is semi-standard and necessitates making electric measurements to a higher accuracy than 1 part in 1,000. A similar degree of accuracy is required in the adjustments of pressure during the life test. It is not always appreciated that for a 100 volt carbon filament lamp running at 3·1 watts per candle the useful life varies approximately as the twentieth power of the voltage, and as the sixth power of the watts per candle. It is for this reason that it is useless to pick out one or two lamps at random from a batch and run them at normal voltage in order to see what life they give. The only really satisfactory method of testing whether or not a filament is of high-grade quality is to set it up on a life test at some definite value of watts per candle at which it is known that good filaments will give a certain length of life. Such a table of watts per candle is given in the Engineering Standards Committee's Specification on Carbon-filament Glow-lamps. For instance, a 16 candle-power 110 volt lamp should give a 400 hours useful life if set up at 3·1 watts per candle. The same lamp should burn 800 hours if started at

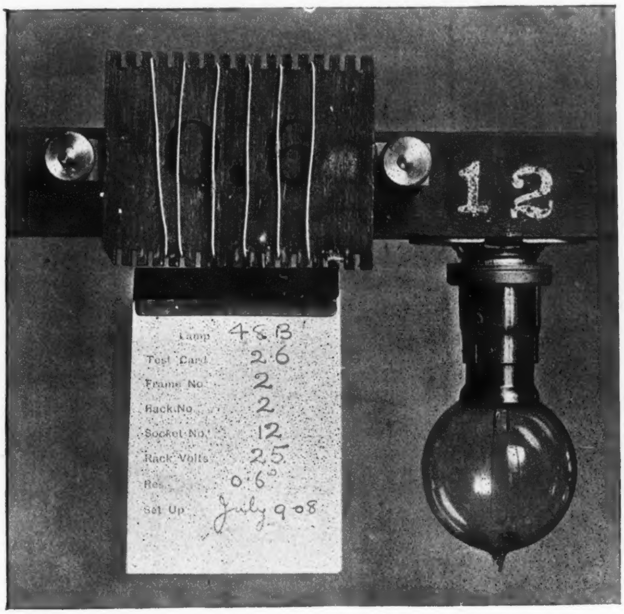


FIG. 7.—View of Life Test Lamp, Resistance and Card as fixed on the Racks.

* A target diagram is one in which the ordinates are proportional to the candle-power of the lamps, and the abscissæ to the watts consumed.

3·5 watts per candle. For a 220 volt lamp the corresponding figures are 3·7 and 4·1. The method of testing at definite watts per candle has the advantage that it is only necessary to test a very few lamps out of a consignment for life. (The E.S.C. Specification gives 5 out of 2,000, as a minimum). A photograph of the bench (made by Messrs. Alex. Wright & Co.) on which life test measurements are carried out is shown in Fig. 4. The principle of photometry which is employed is the same as that described earlier in this article.* The electric measuring instruments are shown as installed in Fig. 5, and are all of the direct deflection type. They consist of a large laboratory precision voltmeter made specially by Messrs. Elliott Bros., and a special compensated wattmeter and voltmeter by Siemens & Halske, enabling watts to be read direct without an additional correction for the current taken by the voltmeter or the volt coil of the wattmeter. The bench measurements are all made with direct current from a 300 volt battery installed for the purpose. The measurement of the candle-power of lamps at intervals during the life test is, of course, a simple matter. In order, however, to find the exact volts at which a lamp is giving its correct watts per candle, it is put into the bench and measured three times, the correct voltage being found by successive approximation, special numerical difference tables having been made out to accelerate the operation.

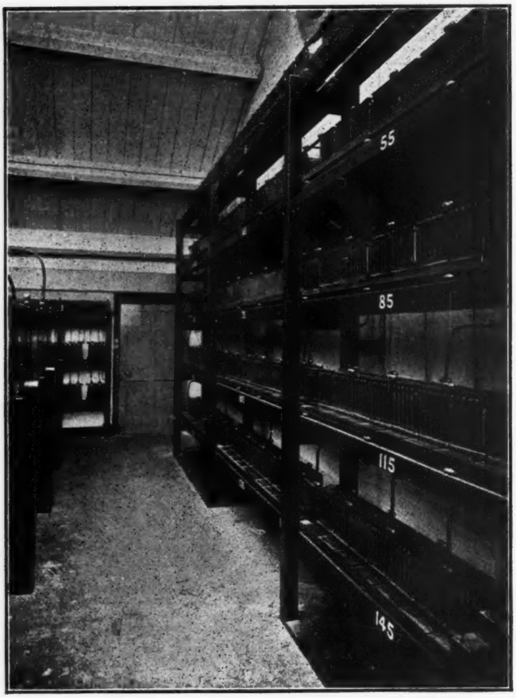


FIG. 8.—Battery for Photometric Work.

* Special screening arrangements have been installed, and are partly illustrated in the figure. They enable the photometer bench to be used in a room with ordinary whitened walls without fear of external light affecting the observations.

Having found the correct volts, special arrangements have to be made to ensure that this is the voltage at the terminals of the lamp throughout the life test. For this purpose life test frames, illustrated in Fig. 6, have been constructed at the Laboratory. The lamp sockets are fixed at 8 in. centres on iron angles which can be rotated so as to enable lamps to be supported either in an upright, pendant, horizontal, or any other position. An alternating current of 55 cycles and 240 volts feeds an auto-transformer connected to each rack. A large number of tappings from the transformer enables any pressure to be obtained in steps of 5 volts. A number of independent turns enable additional 1 volt and 2 volt steps to be added, so that it is only necessary to use a small resistance in series with any rack. The lamp sockets are arranged ten to a rack, there being 10 racks to each frame. The voltage at which a lamp has to be run being usually slightly different from all the others in the rack, it is necessary to arrange that a resistance can be inserted in series with each lamp to make up for the difference between the rack volts and the lamp volts. This amount is usually something under one volt. Some 2,000 resistances have been made up for this purpose, varying by tenths of an ohm from 0·1 up to 5·5 ohms. They consist simply of lengths of Eureka wire wound over

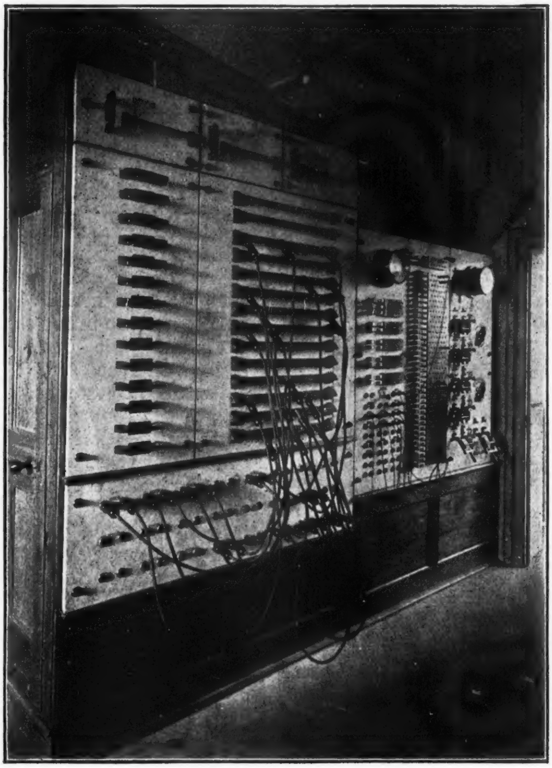


FIG. 9.—Distributing Panels, Photometric Laboratory.

wooden combs, the ends of the wire being brought to brass connecting tags which clamp up under the terminals provided on the racks for the purpose. A view of the whole arrangement is shown in Fig. 7, and is simlar in its general design to that installed at the Electrical Testing Laboratories in New York.

The controlling panel shown in the front of the frame in Fig. 7 has a selector switch for putting a voltmeter across any one of the racks. The voltmeter is a large type instrument by Elliott Bros., which has been specially designed for the purpose, and which is kept checked against the laboratory standards. A difficulty arises in using an instrument of this type, which takes current, since, if there happens to be only one lamp in a rack, in series with which is a regulating resistance, the current taken by the voltmeter (being comparable with that taken by the lamp) causes the voltage at the lamp terminals to be lower when the voltmeter is in circuit than when it is disconnected. Hence the lamp will be somewhat overrun on the life test. To obviate this a number of resistances have been made up equal to the resistance of the voltmeter. One of these is always across each of the racks when the volts are not being measured. The selector switch is arranged so that at the same time as the voltmeter is put across a rack the dummy voltmeter resistance is open-circuited, so maintaining the current constant through the rheostat in series with that rack.

The alternating voltage for the lamps on life test is automatically maintained constant by means of a Tyrrill Regulator, which maintains the pressure well within the limits of plus or minus one half per cent.

The battery chiefly used for photometric work is illustrated in Fig. 8. It consists of 150 cells by the E.P.S. Co. of 45 amp. hour capacity. Tappings are brought down from this battery to a distributing board on the landing of the photometric section (see Fig. 9 right-hand board). There are tappings every 10 volts from the battery, with 4 volt sub-divisions at the ends, enabling any desired voltage up to 300 to be obtained in 4 volt steps. The tappings are brought to horizontal bars behind the ebonite protective covering on the switch-board. The circuits, 23 in number, from various points in the rooms, terminate in plug sockets on the left-hand lower panel. By means of these sockets any desired connexion can be made by means of flexible leads to the battery bars. The switches, &c., on the right-hand panel are merely arrangements for charging sections of the battery alone.

An International Hint of Candle-power.

As will be seen elsewhere in this issue Dr. Glazebrook has communicated to the British Association a note of considerable interest as regards the present movement towards simplifying the hitherto accepted relations between the units of light in different countries.

It has been recently proposed by the National French Committee of the Electrotechnical Commission that the British candle should be raised 2 per cent, and the United States candle lowered 2 per cent, while the French candle is maintained at its intermediate value, thus bringing the three units into supposed practical agreement. Under these circumstances the Hefner unit would still, of course, differ very widely from the common unit, and it would perhaps be too much to expect Germany to make the inconveniently large change required to fall into line. She would, however, at least benefit by the proposed arrangement to the extent of there being *only two* existing units in use in future.

However, naturally, the recent communication from the National Physical Laboratory, according to which the relations up till now regarded as correct between the British and the foreign units require modification, entirely alters the aspect of affairs, and it is possible that a different decision may now be adopted.

REVIEWS, ABSTRACTS, AND REPRODUCTIONS.

The Effects of Ultra-Violet Light on the Eye.

(Discussion of paper by Drs Schanz and Stockhausen, read before the Verband Deutscher Elektrotechniker, June 12th and 13th; abstracted from the *Elektrotechnische Zeitschrift*, August 27th).

THE paper by Drs. Schanz and Stockhausen, abstracted in the September number of *The Illuminating Engineer*, gave rise to a most animated discussion, fully confirming the opinions expressed by several speakers as to the importance of some of these physiological questions to the engineer.

HERR AXMANN opened the discussion, and corroborated the effect of severe exposure to ultra-violet rays on the eyes. When working with the Uviol lamp at the glass-works in Jena, he and other workers had at first supposed that ordinary window-glass offered sufficient protection. But the resulting inflammation of the eyes soon convinced them of the contrary. As a result of spectroscopic investigations they had evolved a glass that answered the required purpose. The speaker exhibited a specimen; it was not green nor yellow in appearance, but rather of an orange tint. It did not, however, interfere with ordinary vision when the wearer became accustomed to its use. This glass was specially devised to prevent the passage of rays in the neighbourhood of 400 $\mu\mu$, which he agreed with Dr. Schanz in considering the most dangerous.

In ordinary circumstances, however, the effects of ultra-violet light were not serious; they even exerted a beneficial action on some eyes. In this connexion the speaker mentioned the case of a lady who suffered from a form of cataract so severely that it was necessary to lead her to the chair on which she sat. Yet after treatment with ultra-violet rays she recovered her sight sufficiently to be able to walk about in comfort.

HERR HERAEUS remarked that one matter of great interest not studied by the authors was the comparison of the strength of ultra-violet radiation in daylight and in artificial illumination; very possibly diffused daylight was at least as rich as artificial sources in this way.

HERR HAAGN followed up this suggestion by describing some experiments which showed that the rays of the sun, like those from the quartz-lamp, contained a considerable amount of radiation near 400 $\mu\mu$. Although numerical comparison was admittedly difficult, he hardly thought that the human eye, which had become accustomed to daylight for thousands of years, could be so easily injured by ultra-violet light as Dr. Schanz seemed to fear. In any case practical experience was the only guide.

DR. KÜCH, the inventor of the quartz-lamp, had, indeed, initially suffered from inflammation of the eyes, but, subsequently, by the use of suitable glass screens, and by screening all stray light, he had been able to experiment with the lamp during a period of several years without experiencing any diminution in visual acuity or other evil results.

DR. ZSCHIMMER stated that he had worked in co-operation with the Ophthalmological Hospital and Medical School of Jena, and had come to the conclusion that the whole question required further exact study, and was not as yet ripe for discussion. In particular he had remarked that physiological experiments were rarely accompanied by the necessary quantitative data as to the intensity the light, &c.

There could be no doubt of the inflammation caused by exposure to sources very rich in ultra-violet rays; on the other hand, he thought that it was rash to conclude from this that the ultra-violet light in ordinary sources of light—glow-lamps, incandescent mantles, and so on—was to be regarded as a source of danger. He specially deprecated hasty conclusions on the matter, because these were liable to be taken up and exaggerated in the non-technical press, with the result that the general public became unreasonably nervous.

HERR BLAU expressed his agreement with the suggestion of Herr Heraeus with regard to the desirability of a comparative study of the ultra-violet element in daylight and artificial illuminants. (It is interesting to note that since this discussion a paper by W. Voege on this aspect of the subject has been published: see *The Illuminating Engineer*, September.) If ultra-violet light were really injurious it would seem as necessary to make window-panes of specially absorbing glass as to make lamp-globes of such a material.

He found it very difficult to credit the statement that the "euphos" glass only absorbs 3 per cent of the visible rays; the percentage seemed more likely to approach 30 per cent.

HERR AXMANN described the influence of the atmosphere on the quality of the sun's rays. Before reaching us, the short waves present in such radiation were very largely absorbed by the atmosphere. Thus it came about that in the mountains, at a height of, say, 1,000 metres, the light produced special effects, that were absent on the horizon.

In meeting such exceptional conditions, glass opaque to ultra-violet light might be very necessary: he, himself, when working with ultra-violet light and using blue glasses, had suffered from inflammation of the eyes; but the use of the special Jena glass had completely relieved him of the trouble. Even the newest and most powerful sources, however, such as the Uviol and quartz lamps, were not very dangerous when comparatively distant from the eyes. Thus at a distance of 1·30 to 1·50 metres the rays are absorbed by the air to such an extent as to cease to be really effective. The *very* short waves are absorbed even in distances of 1 to 2 centimetres.

Only specially sensitive or sick people required protection for the eyes when subjected to diffused illumination from such lights.

HERR BRESLAUER referred to the fact that blue glasses were of actual benefit in protecting the eyes from snow blindness. Yet such glasses have been described as quite ineffective for the purpose of obstructing the passage of ultra-violet rays. How was it possible, therefore, to reconcile this statement with the contention that snow blindness was due to the action of these rays?

HERR ZSCHIMMER replied to this question. He quoted Prof. Hertel of Jena as his authority for the statement that the trouble with the eyes experienced at high altitudes was probably mainly caused by certain of the visible rays, the yellow, green-yellow, and blue light, though the ultra-violet light also contributed slightly.

Herr Zschimmer also referred to the difficulty of making a suitable variety of glass opaque to ultra-violet light. The glass exhibited by Herr Axmann was really intended for photographic purposes merely. What was really wanted was a neutral glass, omitting only the undesirable elements, both visible and invisible. Even dark glasses allowed some ultra-violet light to pass.

Unfortunately the majority of glasses not only allowed ultra-violet light to pass, but did not exert uniform absorption, and it would be a great discovery if any one could produce a colourless glass capable of rigidly cutting off the light at the ultra-violet margin, as Dr. Stockhausen's glass was said to do. After examining hundreds of colours in the Jena glass works, they had almost come to the conclusion that such a performance demanded the discovery of a new element. All known colouring materials, instead of sharply cutting off the spectrum at a certain point, gave curves of gradually increasing absorbtion, and even so the elimination of ultra-violet light was only attained by the sacrifice of 20 to 30 per cent of the useful visible light.

However, the subject was receiving more and more careful study at the hands of physiologists, and he would not fail to bring this discussion before the notice of those at work in Jena, in order that their progress might be hastened.

HERR GÖRGES regarded the present discussion as anything but superfluous, and thought it very gratifying that these questions were at last being threshed out. He had recently come across the statement in a newspaper that "the ordinary glow-lamp was simply poison to the eye." Such statements naturally caused much disquiet to the general public. It was fully time that we inquired into the matter and ascertained, definitely, whether the ordinary glow-lamp was used in an injurious way or no.

HERR SCHANZ, speaking with reference to the relative amounts of ultra-violet energy in daylight and sunlight, mentioned snow blindness as analogous to "opthalmia electrica," the inflammation caused by looking at the electric arc. He also referred to the work of Widmark, Schulek, Bisch-Hirschfeld, Hertel, Hess, Herzog, &c., all of whom have confirmed the injurious effect of ultra-violet light, and mentioned that, at the hygienic section of the "Naturforscherversammlung," general agreement was expressed on this question.

The essential point was that a glass was now available capable of protecting the eyes from such radiation; ultra-violet rays were an impurity in ordinary light, the removal of which was desirable from the physiological standpoint.

Herr Heraeus considered that the existence of snow blindness in polar regions was no criterion as to the injurious effect of ultra-violet rays in ordinary daylight. As a basis of comparison between daylight and artificial illuminants, ordinary everyday conditions should be assumed, and it was desirable that spectrographic comparisons should be shown side by side.

Herr Stockhausen said that his contentions were based on exact measurement. Naturally direct sunlight and light from the blue sky contained ultra-violet light, but very little of this arrived at the eye in the case of diffused (and reflected) daylight, by which ordinary operations were carried out.

Herr Blau and Herr Haagn repeated their conviction that, from the point of view of ultra-violet light, diffused daylight must be considered at least as dangerous as ordinary artificial illuminants.

Herr Stockhausen dealt with some objections that had been raised as regards the times of exposure allowed in obtaining his spectrographs. He explained that the visible result in such a case depended upon the opening of the slit, the surface-brightness of the illuminant examined, the intensity of the light, and the time of exposure. Any one having experience of spectro-photography would bear him out when he stated that it was not possible to retain all these quantities simultaneously constant, though they had made many experiments varying one or other of the quantities in question.

Spectrographs were only intended to exhibit results qualitatively, as there was no existing method of obtaining quantitative results that was not open to some objection or other.

Herr Norden and Herr Haagn agreed as to the difficulty of comparing daylight and artificial illuminants by existing methods: the latter, however, thought that it could be shown, at least, that artificial illuminants were no more dangerous than daylight. Herr Zschimmer referred to the very exact measurements of Prof. Hertel.

Some other discussion on the possibility of exact quantitative measurements, by Herr Blau, Herr Retschinsky, and Herr Stockhausen (who considered the method of Prof. Hertel unsatisfactory) followed.

Herr Teichmüller regarded the discussion as very valuable, and thought there was a danger of engineers erring in the direction of making the *visible* intrinsic brilliancy of illuminated signs, &c., too bright. He thought that there was also room for advice from physiologists as to the desirable limit of brilliancy. The journal might not be so absolutely wrong in asserting that "electric glow-lights are poison to the eye," and the careful study of these questions by engineers was much to be desired.

Further Comments on the Subject.

Since the publication of the above discussion, a letter from Prof. Blondel has appeared in the *Elektrotechnische Zeitschrift* of Sept. 24th, putting forward an interesting suggestion.

Prof. Blondel, from his own experience, is inclined to believe that artificial light may prove to be more tiring to the eyes than daylight, notwithstanding the fact that the latter may contain a stronger ultra-violet element. This may be explained on the supposition that the eye, when using artificial light, is in general using a lower order of brilliancy altogether than in the daytime, and is therefore in a different physiological condition.

At this relatively low illumination the "rods" in the eye play a more important part than in the daytime, when our vision is mainly accomplished by the "cones"; hence it may be that in this condition they are more susceptible to the fatiguing variety of light.

Prof. Blondel states that he himself has suffered from inflammation of the eye, and during his recovery found he was able to read in comfort by daylight, when he was unable to do so by the aid of artificial illuminants. Subsequently he found that he was able to read by the light from a glow-lamp run at a consumption of 3·5 watts per candle, but that the light from a lamp taking 2·5 watts per candle proved too fatiguing, and he therefore supposes that this difference was due to the greater proportion of short wave-length energy in the latter case.

Recent Developments in Electric Lighting.

By W. Wedding.

(Paper read at the Annual Meeting of the Verband Deutscher Elektrotechniker, abstracted from the *Elektrotechnische Zeitschrift*, July 30th, 1908.)

This paper gives an account of the present state of electric illumination, and describes a series of elaborate tests on a number of the most recent types of incandescent lamps with metalized carbon, Tantalum, and Wolfram filaments respectively.

These lamps differ both as regards materials used and methods of manufacture, and have, therefore, been classified by the author in three distinct classes. The actual number of lamps, in each case grouped accordingly in the three classes, was as follows:—

First Class—Metallized-Carbon Lamps.

Ten 16 H.K. lamps for 107 volts.
Ten 50 H.K. lamps for 110 volts.
Ten 25 H.K. lamps from the A.E.G.

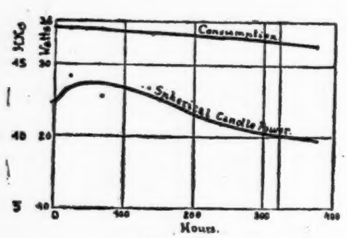


Fig. 1.

Second Class—Tantalum Lamps.

Twelve 16 H.K. lamps, twelve 25 H.K. lamps, and five 50 H.K. 110 volt lamps from Messrs. Siemens & Halske.

Third Class—Wolfram Lamps.

Forty-nine 25 H.K. lamps, thirty-six 32 H.K. lamps, fifty-four 50 H.K. lamps, eight 100 H.K. lamps are for 100 volts, and also one 32 H.K., twenty-three 50 H.K. and four 100 H.K. 220 volt lamps.

The majority of lamps were tested on a voltage fluctuating considerably, but there was no possibility of their being subjected to shock, except when they were put in and replaced. During the first test all the lamps were burning in a downward position, and the horizontal intensity was measured. Afterwards, every lamp was put into the globe photometer, in order to determine the mean spherical candle-power in each case, and thus to enable a comparison of the lamps under equal conditions to be made. All other photometrical measurements were made by the aid of the globe photometer.

Class I.—Metallized Carbon Lamps.

The advantage claimed for these lamps is based on the fact that the filament, in contradistinction to that of the ordinary carbon lamp, possesses a positive temperature co-efficient, and the author gives several diagrams illustrating this property.

In Figs. 1 and 2 are given the results of some life tests, showing the decrease in consumption and candle-power during life.

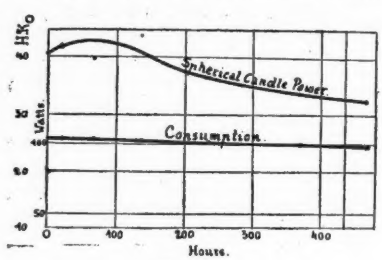


Fig. 2.

Class II.—Tantalum Lamps.

As regards efficiency the tantalum lamp seems to be more favourably placed than the metallized filament lamp, but on the other hand the cost price of the metallized carbon lamp is the lower of the two. Only time can show what part is to be played by these two classes of lamps in the lighting industry in the future. There can, however, be no doubt of the importance of obtaining a lamp which is both efficient and able to withstand shock.

One point remarked upon by the author is that the useful life, and the period of

TABLE I.

Nature of Lamp.	Initial Candle-power.		Initial Consumption.	Watts per H.K.		Reducing Factor.	Useful Life.	Average Consumption.	Mean Spherical Intensity.	Mean Watts per H.K.	Average Time in Hours before first Breakage of Filament.	Number of Lamps Tested.
	Horizontal $H.K._h$	Spherical $H.K._o$		Horizont'l $W/H.K._h$	Spherical $W/H.K._o$	$\frac{H.K._h}{H.K._o}$		Watts.	$H.K._o$	$W/H.K._o$		
Metallized Carbon	16·8	13·34	35·14	2·09	2·63	1·257	322	34·2	12·02	2·85	—	10
	52·9	40·2	102·9	1·95	2·56	1·31	434	100·7	37·7	2·66	—	10
	24·3	17·8	55·0	2·26	3·09	1·365	733	54·7	17·2	3·18	—	10
Tantalum ...	15·1	11·6	26·1	1·73	2·26	1·300	867	27·3	13·1	2·09	769	12
	23·1	17·5	39·7	1·72	2·26	1·315	1552	41·4	18·2	2·27	1493	12
	51·0	38·4	86·6	1·69	2·26	1·330	1685	85·7	38·9	2·2	1787	5
Wolfram. No.												
1	26·3	20·0	28·1	1·07	1·40	1·317	1651	27·8	16·4	1·69	1651	8
2	27·1	17·5	35·3	1·30	2·02	1·549	> 1372	35·6	19·0	1·87	> 1038	5
3	27·9	20·3	30·2	1·08	1·49	1·375	665	31·0	22·8	1·36	550	12
4	27·7	18·7	29·2	1·05	1·56	1·482	—	—	—	—	—	10 (Alternating current)
5	27·9	18·9	29·1	1·05	1·56	1·482	> 867	29·0	18·3	1·59	> 867	10
6	28·5	22·8	36·1	1·27	1·58	1·248	1819	36·0	22·3	1·61	1727	10
7	30·3	21·0	48·6	1·60	2·31	1·437	669	50·7	24·1	2·10	80	1 (220 V)
8	31·5	22·4	30·9	0·97	1·37	1·405	> 1236	30·5	20·8	1·46	> 1236	6
9	35·3	28·7	40·0	1·14	1·40	1·23	1217	38·9	26·0	1·49	1011	10
10	36·5	26·0	39·2	1·07	1·51	1·405	> 1137	38·7	26·3	1·47	> 1060	6
11	37·5	28·2	38·8	1·03	1·37	1·327	1492	38·5	24·2	1·59	1492	8
12	50·3	36·1	56·9	1·13	1·56	1·390	> 1201	56·6	34·4	1·65	> 1201	6
13	50·8	35·8	63·8	1·26	1·78	1·415	—	—	—	—	—	6 (220 V)
14	54·2	40·8	58·7	1·08	1·44	1·330	1014	61·1	44·3	1·37	990	12
15	54·3	41·2	60·1	1·11	1·46	1·320	756	60·2	36·6	1·64	756	8
16	55·8	44·5	67·9	1·22	1·52	1·252	1111	66·9	43·8	1·53	1098	4 (220 V)
17	56·6	36·4	71·3	1·25	1·96	1·560	> 806	70·9	35·4	2·00	> 806	5 (220 V)
18	57·7	43·2	70·2	1·21	1·62	1·335	> 1142	71·0	40·5	1·75	> 1080	8 (220 V)
19	58·7	37·9	64·7	1·10	1·71	1·549	> 1732	64·6	39·2	1·65	> 1725	5
20	99·8	79·2	111·1	1·11	1·40	1·262	1766	110·5	67·8	1·63	1766	4
21	116·5	97·5	126·6	1·09	1·30	1·197	413	124·1	101·0	1·23	263	4 (220 V)

time up to the first breakage of a tantalum filament are nearly identical; after a filament has once been ruptured and welded together again, other failures usually follow one another in quick succession, and the lamp gives way altogether.

Class III.—Wolfram Lamps.

The results of the experiments on these lamps, together with those on tantalum and metallized filament lamps previously referred to are summarized in Table I. The author remarks that the results in some cases show that a certain number of the wolfram lamps issued are imperfect; they blacken rapidly, and lose 20 per cent of their original candle-power comparatively soon. This is true, for instance, of the lamps referred to in the eighth row.

The majority of the lamps, however, actually burn out before reaching the limit of useful life (*i.e.*, a drop of 20 per cent in candle-power), and the actual life is often well over 1,000 hours. On the other hand, it must be confessed that when the lamps are subjected to constant shocks, such as may occur under practical conditions, these good results may not be realized.

In summarizing the recent progress in electric illuminants, the author recognizes three main stages of progress that may be said to be now either realized, or shortly about to be.

Firstly, we have reduced the consumption of power of glow-lamps from 3·4 to 1·2 watts per H.K.

Secondly, by the aid of metallic filaments, we have produced practical glow-lamps of over 50 H.K., which can compete successfully with the smaller arc-lamps.

Thirdly we may now expect a progressive diminution in the initial cost and costs of renewal of metallic filament lamps.

Lastly Prof. Wedding considers that it would be short-sighted to assume from the present condition of glow-lamp manufacture that we ought to return to distribution at 110 volts, and that the ultimate solution of the present difficulties will be found in the manufacture of a serviceable and yet efficient 220 volt 16 candle-power lamp.

An Electric Light Moth-Trap.

ACCORDING to *The Electrical Review* of New York, the municipal authorities of Littau, in Saxony, have been putting the electric arc-lamp to a novel use.

From time to time the forests of Central Europe are said to suffer from the ravages of moths from Russia, the larvæ of which strip the trees of their foliage, and Saxony has recently been suffering from a plague of this description. The authorities have therefore erected a powerful arc-lamp equipped with a reflector and placed over a deep receptacle fitted with exhaust fans. In this way they hoped to trap and destroy large numbers of the moths, and so prevent the laying of the eggs from which the caterpillars come in such numbers.

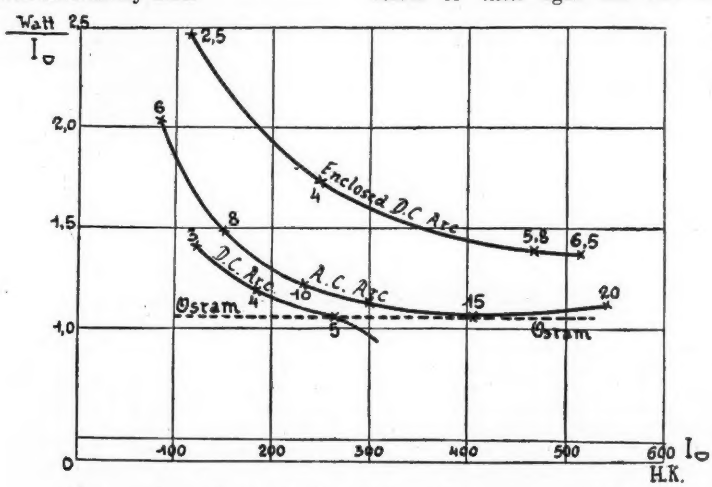
The results are said to have been amazingly successful. The moths attracted by the glare come fluttering in thousands along the beam of light from the arc-lamp, are sucked into the receptacles and subsequently destroyed. On the first night no less than three tons of moths were captured, and it has been decided to build other traps and extend the present efforts.

A Comparison of the Running Costs of Small Arc Lamps and High Candle-Power Osram Lamps.

By H. Remané.

(Paper read at the Annual Meeting of the Verband Deutscher Elektrotechniker; abstracted from the *Elektrotechnische Zeitschrift*, Aug. 20.)

Until recently two distinct types of electric illuminants were available. Each fulfilled separate functions, and was suitable for particular purposes, for which the other was inadequate. The intensity of the arc-lamps and glow-lamps on the market did not, as a rule, fall below several hundred H.K., or above about 50 H.K. respectively, and, owing to their high running cost, glow-lamps of candle-power higher than 50 H.K. had not been extensively used.



The numbers attached to the points on the curve represent the current in Amperes taken by the various arc lamps.

Fig. 1.

Some source of light intermediate in intensity between these values was therefore desirable, and this want led to the introduction of the "miniature" arc-lamps of various kinds. The Nernst lamp, with an intensity of 100 to 200 H.K., and the mercury-vapour lamp are likewise to be reckoned among illuminants in this class.

The rapid extension of such sources of moderate candle-power proved the value of a lamp ranging from 100 to 400 H.K., the initial cost of which is only about a third of that of an ordinary arc-lamp. An attempt was made to meet these conditions by cheapening the regulating mechanism of arc-lamps, but naturally the steadiness of the lamp suffered. The length of the enclosed arc being particularly adapted to this simplification, miniature lamps were mainly constructed on the enclosed plan, but their unsteady character and the colour of their light did not favour their adoption except for out-door illumination.

Nor did the Nernst lamp entirely answer its purpose, for it was only suitable for high voltages and direct currents, and very complicated in design.

As, furthermore, all the illuminants referred to had a comparatively low efficiency, the question arose, whether it would not be desirable to replace these illuminants by high candle-power Osram lamps. As the efficiency and mean horizontal intensity of such lamps is higher than that of small and medium-sized arc-lamps in the lower hemisphere, it was anticipated that an Osram lamp giving about 400 H.K. might replace

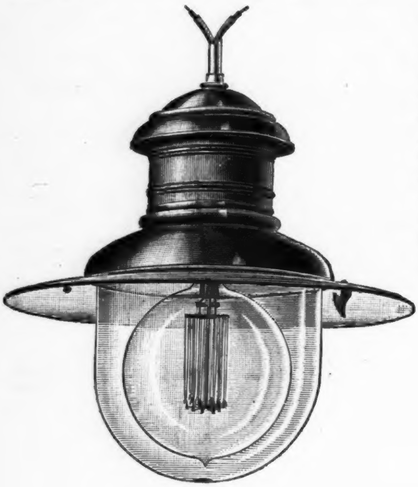


Fig. 2.

small arc-lamps, of the same intensity. Osram lamps giving 200 to 400 H.K. have therefore now been put upon the market.

Fig. 3.

In Fig. 1 are shown some calculated figures comparing the efficiencies, as regards the lower hemisphere, of the Osram lamps and arc-lamps of different intensities.

The Osram lamp is now being made in standard sizes corresponding to 200, 300, and 400 H.K. for voltages from 110 to 130 and 200 to 250 volts, the efficiency being 1·0–1·1 watt per H.K., and the useful life on the average 800 hours.

A number of these lamps have recently been tested in the laboratories of the Auergesellschaft, Berlin, and the results obtained are shown in the accompanying tables. The mean spherical candle-power amounted to 70 per cent of the mean horizontal. Thus the mean efficiency referred to the mean spherical candle-power is 1·39 watt per H.K. The mean candle-power over the lower hemisphere proved to be 82 per cent of the mean horizontal intensity thus corresponding to an efficiency of 1·33 watts per H.K.

Fig. 4.

High candle-power Osram lamps are suitable for interior illumination, and have also been adopted for out-door use.

Standard types of these are shown in Figs. 2, 3 and 4.

In order to consider the Osram lamp and the arc-lamp under exactly equal conditions, the total running costs of both have been compared with reference to the lower hemisphere. Some results are shown in Fig. 5 and in the accompanying tables. The cost of energy has been assumed to be 45 Pf. per Kilowatt-hour for consumers deriving energy from a central station, and 10 Pf. in the case of private plants. The initial costs of the lamps are as follows :—

200 H.K.	9 marks
300 H.K.	12 "
400 H.K.	15 "

With regard to the running cost of arc lamps, the cost of renewal of the carbons only has been added to the cost of energy, leaving out of account repairs and depreciation, whereas in the case of the Osram lamp the cost of renewal of lamps referred correspondingly to the known useful life has been taken into consideration.

TABLE I.

High Candle-power Osram Lamp. A. Candle-power and Efficiency.

Signature of Lamp.	Mean Horizontal Candle-power. H.K.	Mean Spherical Candle-power H.K.○	Mean Hemispherical Candle-power H.K.		Watts per Candle-power. W/H.K.		
			Fittings for Indoor Use. I.	Fittings for Outdoor Use. II.	Lamp without Reflector. W/H.K.◡	W/H.K.◡ I.	W/H.K. II.
I_1	100	79	112	105	1·40	0·98	1·05
II_2	200	158	224	209	1·39	0·98	1·05
III_3	300	238	337	316	1·39	0·98	1·05
IV_4	400	316	447	414	1·39	0·98	1·06

TABLE IA.—B. Running Costs.

Signature of Lamp.	Mean Horizontal Candle-power H K.	Running Cost per Burning Hour in Pfennigs.			Running Cost per 1,000 H.K. Hours in Pfennigs.				Cost of Energy.
		Current.	Renewal of Lamps.	Total.	Mean Horizontal.	Spherical.	Hemispherical. Fittings for Indoor Use. I.	Hemispherical. Fittings for Outdoor Use. II.	
I_1	100	4·5	0·625	5·125	51·3	64·9	45·7	48·8	45 Pf. per KW hrs.
II_2	200	9·0	1·12	10·12	50·6	64·1	45·2	48·5	
III_3	300	13·5	1·5	15·0	50·0	63·1	44·5	47·5	
IV_4	400	18·0	1·87	19·87	49·68	62·9	44·3	48·0	
						Mean	44·9	48·2	
						Mean from I. & II.	46·5		

TABLE IB.—C. Running Costs.

Signature of Lamp.	Mean Horizontal Candle-power H K.	Current.	Renewal of Lamps.	Total.	Mean Horizontal.	Spherical.	Fittings for Indoor Use. I.	Fittings for Outdoor Use. II.	Cost of Energy.
I_1	100	1·0	0·625	1·625	16·25	20·6	14·5	15·5	10 Pf. per KW hrs.
II_2	200	2·0	1·12	3·12	15·62	19·8	13·9	14·9	
III_3	300	3·0	1·5	4·5	15·0	18·9	13·3	14·2	
IV_4	400	4·0	1·87	5·87	14·69	18·6	13·1	14·2	

TABLE II.

Small D.C. Open Arc Lamps with Ordinary Carbons.

A. Candle-power and Efficiency.

Signature of Lamp.	Current in Amperes.	Voltage across Arc.	Supply Voltage.	Consumption of One Lamp Watts.	Hemispherical Candle-power H.K.◡	Watts per Candle-power. W/H.K.◡	Percentage of W/H.K. consumed by Osram Lamps of same Candle-power. I.	Percentage of W/H.K. consumed by Osram Lamps of same Candle-power. II.
I_3	3	42 to 45	110	165	112	1·47	150	140
II_4	4	42 ,, 45	110	220	187	1·17	119	111
III_5	5	42 ,, 45	110	275	262	1·05	107	100
IV_6	6	42 ,, 45	110	330	356	0·93	95	88·5
V_7	7	42 ,, 45	110	385	457	0·84	86	80

TABLE IIa.—B. Running Costs.

Signature of Lamp.	Hemispherical Candle-power as given in Table II.	Running Costs per Burning Hour (repairs and depreciation not included). Cost of Energy. Pfennigs.	Renewal of Carbons. Pfennigs.	Cost of Attendance on Lamp. Pfennigs.	Total Pfennigs.	Cost of Energy per Unit.	Running Costs per 1,000 H.K.◡ Hours. Pfennigs.	Percentage of Cost of Osram Lamps on basis of same Candle-power. I.	II.
I_3	112	7·43	1·20	0·30	8·93	45 Pf. per KW Hour	79·8	174	163
II_4	187	9·90	1·30	0·30	11·50		61·5	136	127
III_5	262	12·35	1·40	0·30	14·05		53·7	120	112
IV_6	356	14·83	1·50	0·30	16·63		46·8	105	98
V_7	457	17·30	1·60	0·30	19·20		42·0	95	87

TABLE IIb.—C. Running Costs.

Signature of Lamp.	Hemispherical Candle-power as given in Table II.	Cost of Energy. Pfennigs.	Renewal of Carbons. Pfennigs.	Cost of Attendance on Lamp. Pfennigs.	Total Pfennigs.	Cost of Energy per Unit.	Pfennigs.	I.	II.
I_3	112	1·65	1·20	0·30	3·15	10 Pf. per KW Hour	28·1	194	181
II_4	187	2·20	1·30	0·30	3·80		20·3	146	136
III_5	262	2·75	1·40	0·30	4·45		17·0	125	116
IV_6	356	3·30	1·50	0·30	5·10		14·3	108	100
V_7	457	3·85	1·60	0·30	5·75		12·6	96	89

TABLE III.—Enclosed D.C. Arc with Clear Inner Globe and Diffusing Outer Globe.
A. Candle-power and Efficiency.

Signature of Lamp.	Current in Amperes.	Supply Voltage.	Voltage across Arc.	Consumption. Watts.	Hemispherical Candle-power H.K.◡	Watts per Candle-power. In Watts H.K.◡	Percentage of W/H.K. consumed by Osram Lamp of same Candle-power. I.	II.
I	2·5	110	75	275	112	2·46	251	234
II	4·0	110	75	440	262	1·68	171	160
III	5·8	110	81	640	465	1·38	141	131
IV	6·5	110	80	715	517	1·38	141	131

TABLE IIIa.—B. Running Costs.

Signature of Lamp.	Hemispherical Candle-Power as given in Table III. H.K.◡	Running Costs per Burning Hour. Current. Pfennigs.	Renewal of Carbons and Inner Globe. Pfennigs.	Cost of Attendance on Lamp. Pfennigs.	Total. Pfennigs.	Running Costs per 1,000 H.K. Hours. In Pfennigs.	Percentage of Cost of Osram Lamp on Basis of same Candle-power. I.	II.	Cost of Energy.
$I_{2\cdot5}$	112	12·4	0·30	0·015	12·72	114	250	234	45 Pfennigs per K.W. hour.
$II_{4\cdot0}$	262	19·8	0·30	0·015	20·12	77	172	160	
$III_{5\cdot8}$	465	28·8	0·30	0·015	29·12	62	139	130	
$IV_{6\cdot5}$	517	32·2	0·30	0·015	32·52	62	140	129	

TABLE IIIb.—C. Running Costs.

Signature of Lamp.	Hemispherical Candle-Power as given in Table III. H.K.◡	Current. Pfennigs.	Renewal of Carbons and Inner Globe. Pfennigs.	Cost of Attendance on Lamp. Pfennigs.	Total. Pfennigs.	In Pfennigs.	I.	II.	Cost of Energy.
$I_{2\cdot5}$	112	2·75	0·30	0·015	3·07	27·4	189	177	10 Pfennigs per K.W. hour.
$II_{4\cdot0}$	262	4·40	0·30	0·015	4·72	18·0	132	124	
$III_{5\cdot8}$	465	6·40	0·30	0·015	6·72	14·5	111	102	
$IV_{6\cdot5}$	517	7·15	0·30	0·015	7·47	14·5	110	101	

TABLE IV.

A.C. Open Arc with Ordinary Carbons and Diffusing Outer Globe.

A. Candle-power and Efficiency.

Signature of Lamp.	Current in Amperes.	Supply Voltage.	Voltage across Arc.	Number of Lamps in Series on 110 Volt.	Consumption of One Lamp. Watts.	Hemispherical Candle-power. H.K.◡	Watts per Candle-power. In Watts. H.K.◡	Percentage of Watts/H.K. consumed by Osram Lamp of same Candle-power. I.	II.
I_6	6	110	29	3	168	82·5	2·04	208	194
II_8	8	110	29	3	222	150	1·48	151	141
III_{10}	10	110	29	3	276	225	1·22	124	116
IV_{12}	12	110	30	3	340	300	1·13	115	107
V_{15}	15	110	30	3	425	405	1·05	107	100
VI_{20}	20	110	31	3	605	540	1·12	114	106

TABLE IVA.

A.C. Open Arc with Ordinary Carbons and Diffusing Outer Globe.

B. Running Costs.

Signature of Lamp.	Hemispherical Candle-power as given in Table IV.	Running Cost per Burning Hour.* Current. Pfennigs.	Renewal of Carbons. Pfennigs.	Cost of Attendance on Lamp. Pfennigs.	Total. Pfennigs.	Running Costs per 1,000 H.K.◡ Hours. In Pfennigs.	Percentage of Cost of Osram Lamp on Basis of same Candle-power. I.	II.	Cost of Energy.
I_6	82·5	7·55	1·0	0·3	8·85	107	234	219	45 Pfennigs per K.W. hour.
II_8	150	10·00	1·1	0·3	11·40	76	167	156	
III_{10}	225	12·40	1·2	0·3	13·90	62	137	128	
IV_{12}	300	15·30	1·4	0·3	17·00	57	128	120	
V_{15}	405	19·10	1·5	0·3	20·90	51	115	106	
VI_{20}	540	27·20	1·6	0·3	29·10	54	122	112	

* The fact that three lamps can be run in series on 110 volts must be borne in mind.

TABLE IVB.—A.C. Arc with Ordinary Carbons.

C. Running Costs.

I_6	82·5	1·68	1·0	0·30	2·98	36·1	249	233	10 Pfennigs per K.W. hour.
II_8	150	2·22	1·1	0·30	3·62	24·1	170	159	
III_{10}	225	2·76	1·2	0·30	4·26	18·9	136	127	
IV_{12}	300	3·40	1·4	0·30	5·10	17·0	128	120	
V_{15}	405	4·25	1·5	0·30	6·05	14·9	114	105	
VI_{20}	540	6·05	1·6	0 30	7·95	14 7	112	103	

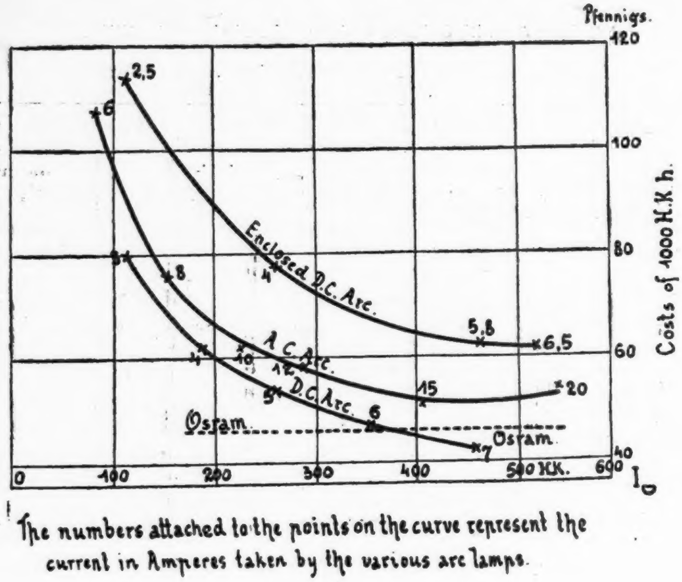


FIG. 5.

The Chicago Acetylene Congress.*

* Abstracted from *The Acetylene Journal*, Chicago, September, 1908.

THE Annual Congress of the International Acetylene Association was held in Chicago and opened on Monday, August 10th, of this year.

The address of the President, MR. M. J. CARNEY, was optimistic; he referred to the spread of the illuminant in the rural districts, and said that the public were now beginning to get accustomed to the use of acetylene, and to lose that suspicion as its to reliability and safety that had been recognized to exist earlier in its career. Some stress was, however, laid by several speakers on the need for good workmanship and the injury done to the industry by the issue of imperfect apparatus and the sacrifice of reliability to cheapness.

MR. KIRCHBERGER, in his paper on the '**Ethics of Selling Goods**,' wisely deprecated the putting forward of claims of an exaggerated nature, which the non-technical consumer was obviously unable to refute, but which in the long run were proved to be incorrect, and recoiled upon the salesman.

MR. C. UMBACH, speaking from the standpoint of the manufacturer of acetylene fixtures, also spoke of the tendency to sell goods cheap at all costs, and insisted that it was more essential that the generators, &c., sold should be properly tested previously, and guaranteed to be perfect in construction.

These points, particularly vital to users of acetylene, were dealt with by MR. MERRILL from the standpoint of insurance companies, who had originally viewed acetylene very dubiously indeed.

The influence of the stringent insurance rules on the industry is now understood to have been beneficial. According to the report of the Insurance Committee of the Association, however, the National Board of Fire Underwriters have now decided to relax the existing regulations in several particulars, especially as regards permission to install acetylene generators indoors, and to store carbide in bulk up to 100-pound drums, instead of in the form of two-pound cans as was formerly prescribed.

Among the papers read at the Convention we note that of MR. W. J. STINSON, who contended that, both as regards initial cost and upkeep, acetylene had the advantage over other systems of town illumination, and had been largely employed in small towns.

Some discussion also centred round a paper by MR. J. M. BROCK on **'Burner Troubles and their Remedy.'** The majority of those present appear to have put forward the view that little or no trouble of this kind was experienced in the case of up-to-date burners. MR. CARROL stated that he had never experienced any trouble after the gas had been allowed to pass through a filter of wool or felt on its way to the burner.

The question of pressure was also discussed, and it appeared to be agreed that the best pressure was in the neighbourhood of about three inches of water; it was moved that a committee be appointed to consider the advisability of modifying the existing pressure of 2½ inches, as at present prescribed by the Society.

MR. A. F. JENKINS spoke of the value of acetylene for outdoor illumination and its advantage over petrol air and gasoline plants under wet and stormy conditions.

MR. A. CRESSY MORRISON read a paper advocating the **Use of the Acetylene Light by Medical Men,** on account of the presumed resemblance of its spectrum to daylight. The accentuation of one or another colour, he suggested, tended to prejudice the physician's judgment, and the simplicity and portable nature of many acetylene lights were also advantageous.

MR. O. F. OSTBY spoke of the **Future of Dissolved Acetylene,** and its value for head-lights and in light-houses, and MR. NORDVALL, of Stockholm, gave some figures as to the cost of the coast beacons in Sweden. In that country, he said, there were about twelve to fifteen hundred small beacons in use, and the introduction of acetylene, he claimed, had saved the Government about 300 dollars a year for each beacon, thus making in all a very considerable amount. Hence the Government had now decided to entirely supersede oil by acetylene, and the same course was being followed in Norway, Denmark, Finland, Russia, Ireland, Italy, Spain, and Germany.

The application of dissolved acetylene, in accordance with the scheme of MR. DALEN, chief engineer to the Gas Accumulator Co., Ltd., of Stockholm, enables lights on buoys, light ships, &c., to be turned on and off automatically at given intervals, with the result that they can now be left to themselves for long periods of time, without any personal supervision whatever. This, it is claimed, reduces the running costs very materially, but without unduly increasing the initial expense. By the aid of a special valve Mr. Dalen automatically extinguishes lights at dawn and relights them at dusk; it is interesting to observe that in addition his system permits the production of flashes at suitable intervals, by the actual extinguishing, instead of merely the obstruction of the light. In the case of lights that are being constantly flashed at regular intervals all through the night, this, of course, represents a very considerable saving. Another means of saving consists in the use of a special pilot flame which consumes only 10 litres (*i.e.*, about 0.4 cubic feet) in twenty-four hours, as contrasted with the pilot flames used in connexion with generating systems, which consume 3 cubic feet of gas in the same time, and in addition are usually in duplicate or triplicate.

The "sun valve," by the aid of which the automatic extinction and lighting of buoys, &c., is accomplished, appears to depend upon the action of the increase in temperature of a body, having an absorbing surface, when exposed to solar radiation. The increase in temperature so caused, and the subsequent expansion operates a valve opening and closing the gas inlet. It is claimed that on the average a saving of 30 to 40 per cent of the gas generated is accomplished in this way.

Some of the papers read before the Congress, which it will be seen cover a wide ground, and to which more detailed reference may subsequently be made, are as follows:—

Town-Lighting by Acetylene, by W. J. Stimson.
The Manufacturing of Acetylene Fixtures, by C. Ummach.
Frost-proof Generator Houses, by P. A. Rose.
Personal Experiences with Artificial Illuminants, by H. E. Shaffer.
Burner-troubles, the Cause and the Remedy, by J. M. Brock.
The Ethics of Selling Goods, by M. Kirchberger.
Some Industrial Uses and Possibilities of Acetylene, by A. F. Jenkins.
The History and Present Status of the Oxy-Acetylene Process in America, by A. Davis.
Acetylene in New Fields, by Prof. G. G. Pond.
The Freezing of Acetylene Generators and How to Obviate, by A. T. Mertes.
Medical Diagnosis under Artificial Light, by A. Cressy Morison.
The Value of Co-operation with the Insurance Underwriters, by W. H. Merril.
The Present and Future of Dissolved Acetylene, by O. O. Ostby.

Conclusive Evidence of the "Overshooting" of Tungsten Lamps.

By J. S. FREEMAN.

(*Electrical World*, N.Y., Aug. 15th.)

THE author refers to the interesting fact, which has recently received attention from J. B. Taylor (*Elec. World*, N.Y., May 23rd), that the light from a tungsten lamp, unlike ordinary carbon filament lamps, appears to flash up to an abnormal brilliancy for a very short interval of time after the lamp is switched on; this, however, does not seem to occur when the lamp is switched off and then again lighted while still in a hot state.

FIG. 1.—Overshooting of Cold Tungsten Lamp.

Mr. Freeman investigates the question by the aid of the oscillograph. During the investigations a 22-volt tungsten lamp was placed within an enclosed tube in the oscillograph box so that the light could shine through a small aperture on to the revolving film. Arrangements were then made to secure simultaneously a record of the current and the spot of light from the lamp, upon the oscillograph film.

In this way the result shown in Fig. 1 was obtained. The intensity of the light, as exhibited by the whiteness of the band at the top of the figure, rises beyond its subsequent value for a short time after the lamp is turned on. The current likewise attains a high initial value, jumping from A to B, and subsequently gradually dies away to its normal value from C to D, where the lamp is switched off.

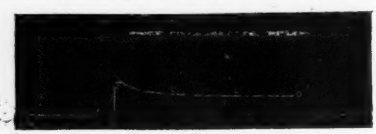


FIG. 2.—Warm Tungsten Lamp.

From Fig. 1 the author draws the conclusion that the total excess of brilliancy lasts for about one-fifth of a second, and the period of greater brightness is about one-tenth. The filament arrives at incandescence in the short time of about one-sixtieth of a second only, and retains its high temperature for about one-thirtieth of a second after the current is turned off.

Fig. 2 shows conditions similar to those exemplified in Fig. 1, but on account of the initial warm state of the lamp the "overshooting" does not appear. The author mentions that the apparent greater rise in current is merely due to the oscillating mirror being set differently so as to reproduce the current-curve on a larger scale.

FIG. 3.—Action of Carbon Lamp.

Fig. 3 represents the entirely distinct conditions occurring in the case of the carbon lamp. In this case the current *rises* gradually from its initial value of 0·15 amps. at B to its final value of 0·3 amps. (C to D). About one-fifth of a second was required for the conditions to become normal.

In Fig. 4 is shown an interesting record of the fluctuations in the light of a 25-volt tungsten lamp, taking place synchronously with the pulsations of a 25-cycle alternating current. On closing the circuit there were 3·4 effective amperes, but under normal conditions only 0·3 amperes passing through the lamp.

FIG. 4.—Behaviour of Tungsten Lamp at 25 cycles.

The filament, it will be noticed, begins to brighten at the maximum point of the wave and itself reaches a maximum about one-eighth of a cycle further on; similarly the minimum brightness is not at zero.

CORRESPONDENCE.

The Temperature of the Sun.

Redaktion der Zeitschrift 'The Illuminating Engineer.'

In No. 8 (August) Ihrer gesch. Zeitschrift finde ich eine Bemerkung, welche sich mit dem Inhalt meines Vortrages: 'Ueber die Temperatur mit welcher Glühlampen strahlen' beschäftigt. Herr Wanterno hält mir entgegen, dass ich den Wert für die Sonnentemperatur zu klein gefunden habe, weil ich die Absorbtion in der Atmosphäre der Erde nicht genügend berücksichtigt hatte. Zunächst handelt es sich in meiner Untersuchung keineswegs darum die Sonnentemperatur zu finden. Ich wollte bloss durch ein Beispiel zeigen, wie das Wien'sche Gesetz zur Ermittlung hoher Temperaturen anzuwenden ist. Andrerseits muss ich aber bestreiten, dass die gefundene Temperatur von den neuesten diesbezüglichen Untersuchungen erheblich abweicht, vielmehr geben alle ernst zu nehmenden Untersuchungen aus der neuesten Zeit im Mittel ungefähr die von 6,000 Grad als den wahrscheinlichen Wert der mittleren Temperatur der Chromosphäre der Sonne an.

Bedenken wegen der Absorbtion der Medien, welche zwischen dem strahlenden Körper und dem Bolometer liegen, sind gewiss gerechtfertigt, aber die Absorbtion in der Erdatmosphäre ist noch lange nicht so ausschlaggebend fur die Diskussion des gewonnenen Resultates, wie die selektive Absorbtion in den einzelnen Teilen des Spektrographen selbst. Ausserdem ist der von mir angenommene Wert von λ max. in Bezug auf die Strahlung der Sonne derjenige, welchen z. B. Dr. Scheiner als ausserhalb der Atmosphäre geltend angibt.

Mir war das Alles sehr wohl bekannt und ich habe es deshalb vermieden einen präzisen Wert für die Temperatur der untersuchten Lampen anzugeben.

Für die Veröffentlichung dieser Zeilen bestens dankend zeichne ich

hochachtungsvoll

KARL SARTORI.

Wien, 29 August, 1908.

To the Editor of 'The Illuminating Engineer.'

SIR,—In the August number of your valued journal I observe several remarks bearing on the contents of my paper on 'The Temperature of Incandescence of Glow-Lamps.' Mr. Wanterno contends that I have estimated the temperature of the sun at too low a value through not having sufficiently taken into consideration the absorption of the earth's atmosphere.

I may remark that my paper contains no attempt to determine the temperature of the sun, and that I merely wished to show, by way of example, how the Law of Wien can be applied to estimate high temperatures. Moreover, I must point out that it is not correct to assume that the temperatures determined, as a result of the most recent investigations on this subject, are very different from this value. On the contrary, all the most recent and reliable investigations yield a mean value for the probable temperature of the solar chromosphere in the neighbourhood of 6,000°.

Consideration of the absorption of the medium, lying between the radiating body and the bolometer is certainly justified, but the absorption due to the earth's atmosphere is less material in the discussion of results obtained than the selective absorption in different portions of the spectrometer itself. Apart from this the value for λ max. quoted by me for the maximum of the energy-curve of solar radiation, is that deduced by Dr. Scheiner for radiation as occurring *outside* the atmosphere.

All this was quite familiar to me, and I therefore abstained from giving any exact value for the temperature of incandescence of the glow-lamps examined.

Thanking you for the publication of these remarks, I remain,

Yours truly,

KARL SARTORI.

Vienna, Aug. 29, 1908.

The Absorption of Arc-Lamp Globes.

Laboratories of Applied Electricity,
The University, Liverpool.
September 21st, 1908.

DEAR SIR,—I have read with great interest the article by Prof. J. T. Morris on 'Tests on Recent Flame Lamps.' There are many interesting points in his paper, but I should like to refer to the figures he gives for the absorption of globes.

I have obtained no results approaching most of his figures for absorption, when testing an arc-lamp. The only result which tends to approximate to them was with an open arc with a large opaline globe, in which the apparent absorption, as measured by determining the mean hemispherical candle-power, was 68 per cent. This figure agrees fairly closely with the 57 per cent given by M. Blondel in some tests on open arcs under similar conditions.

Much as I should like to believe that the results of Prof. Morris for the light emitted by an arc as given in his Table III. are to be accepted, I cannot think they are correct. If the light emitted by an arc-lamp has to be found, surely the most direct way of finding it is to measure it. It does not seem justifiable to measure the light given by a naked lamp and then to assume that if a globe, the absorption of which has been measured with a different kind of light and under dissimilar conditions, is placed round the arc, the light given out will be reduced by the same fraction as in the absorption test.

It is, of course, possible that the enclosure of the arc may alter its character to such an extent that what appears to be absorption may really be actual reduction in light given by the arc itself. A very simple observation will show that this is not a complete explanation of the very large absorption which undoubtedly occurs. If an ordinary arc is enclosed in a globe with a hole in it, the patch of light corresponding to the hole is many times brighter than the surrounding surface, and although I have not made any measurements, I think that such measurements would indicate an absorption much more nearly 80 than 20 per cent.

As to the reasons for this great apparent absorption as compared with the figures obtained by Prof. Morris by measurements with an incandescent lamp, I think there are several. The arc light is a naked light, and does not come from a filament enclosed in a glass bulb, and the selective absorption of the glass would not be greatly increased by the addition of another globe. The absorption of a clear glass globe may reach 30 per cent, and I have a test result given by Prof. Ayrton, in which an apparently clear globe absorbed 47 per cent. Further, the fumes from a flame arc must make an atmosphere inside the globe which is more or less opaque; then, again, there are contrivances, such as ash trays, &c., which altogether block the light sometimes in the direction of maximum effect. Some of these sources of loss it is, of course, almost impossible to eliminate, but I feel certain that a more careful design of the globe, possibly a more careful choice of glass for the globe, would lead to a large increase in the working efficiency of the flame lamp.

The curves given by Prof. Morris in his paper are, I think, curves without globes in the case of the open flame lamps.

I should like, in conclusion, to express my great appreciation of the valuable work Prof. Morris has done in testing these lamps.

Yours very truly,
E. W. MARCHANT.

To the Editor of 'The Illuminating Engineer.'

DEAR SIR,—I desire to express my thanks to Dr. Marchant for his appreciation and for his kind criticism of my recent article in your journal on 'Flame-Arcs.' In reply I must own that I was not entirely satisfied with the tests of absorption of the globes, and hence marked them as approximate only.

In view, however, of the great divergence between Dr. Marchant's results and my own, I am endeavouring to put the matter to a crucial test, and shall hope to send you the results for your kind inclusion in your next issue. But I would draw attention to the fact that *all* the tests recorded were made, as stated, with the globes on, and therefore under working conditions, consequently an error in the correction for absorption does not affect the practical results, but only the corrected mean spherical candle-power. This latter is, nevertheless, a most important scientific quantity.

I entirely agree with Dr. Marchant that greater care should be exercised in the design of globes and in the choice of the kind of glass used.

I am, yours sincerely,
J. T. MORRIS.

The Effect of Ultra-Violet Light on the Eyes.

DEAR SIR,—I have followed with interest the discussion that has been taking place on this subject; but there appear to me to be two points, on which general conclusions may be formed, that deserve special attention.

In the first case I should like to point out that, although photographic experiments, spectrophotographs, &c., may be useful in order to furnish a qualitative examination of the sources of light, it is at least open to question whether any *quantitative* estimations of physiological effect can be based on such a method. Some of Voege's experiments, for instance, seem to me merely to show that, for a given intensity of illumination, daylight is richer in photographically active rays than almost all artificial illuminants. But it does not follow that these are the particular rays that are physiologically undesirable, and it seems conceivable that rays in the spectrum may exist which have but little effect on a photographic plate, and yet give rise to marked physiological effects.

Secondly, I think one must be cautious in drawing conclusions too readily from so-called "natural phenomena." Occasionally people ridicule the idea that artificial illuminants ought to be screened down to a low intrinsic brilliancy, on the ground that the sun itself is far brighter than them.

Yes. But we are not obliged to look straight at the sun, and, indeed, would suffer severely if we habitually did so; on the other hand, it is often extremely difficult so to place artificial sources of light that we do not look straight at them occasionally, and therefore it is more important to protect our eyes in this case.

The same holds good about ultra-violet rays. Even supposing daylight is richer in these rays than artificial light, probably our methods of using the latter may lead us to expose our eyes much more severely.

I am, yours faithfully,
ATHOS.

Trade Notes, Catalogues Received, &c.

Ships' Searchlights.

Messrs. Siemens Bros. send us some particulars of their latest types of searchlight-projectors. Searchliggts are now regarded as part of the equipment of all types of vessels. On warships they are essential for the purpose of locating the enemy by night and for signalling, and in the merchant service they are of use in the navigation of difficult waters and for picking up buoys,

&c. An example of one of the types of projectors of the above firm is shown in the accompanying illustration.

Projectors can be supplied with or without electrical control of the training and elevating motions, and all the usual special attachments, and with diameters of 10, 12, 14, 16, 20, and 24 inches. In the merchant service the 12 in. and 16 in. sizes are most usual.

We have received a notice of *Electrical Engineering*, by Mr. H. A. Simmons, A.M.I.E.E., which is to be issued by *Messrs. Cassell & Co.* in fourteen fortnightly parts, commencing from September 24th of this year.

The B.T.H. Meridian Lamp.

We have received from the British Thomson-Houston Co. a catalogue giving particulars of the B.T.H. Meridian Lamp and the various fixtures intended for use with it.

The lamp is at present made in only one size, giving approximately 55 candle-power, and consuming 120 watts. Lamps are made for voltages from 100-125 and 200-250.

Messrs. *The Union Electric Company, Ltd.*, send us a variety of lists, Nos. 1403, 1404, 1405, dealing with guide attachments and cradles and hoisting gear for arc lamps, resistances for arc lamp circuits. Another list deals with a newly developed contact-voltmeter, relays, signal bells and lamps, &c.

Messrs. *The Robertson Electric Lamp Co.* send us some particulars of their exhibit at the forthcoming Manchester Electrical Exhibition, which is to be on the same lines as that at Olympia, and to include actual demonstrations of glow-lamp monufacture.

We have received a pamphlet issued by *Messrs. Seren & Co., of Vienna*, relating to a new method of acetylene generation by the aid of specially prepared "briquettes," which are claimed to enable the evolution of acetylene from the carbide to take place under very favourable conditions.

The generators are made in two sizes, intended for use in an ordinary dwelling-room or for supplying an entire house, and capable of giving gas to three open-flame burners for about seventeen hours or six open-flame burners for seventeen hours respectively.

We have also to acknowledge a list of the hanging fixtures for carbon and metallic filament lamps, sent us by the *Siemens-Schukert-Werke*, of Vienna; some particulars of the *Jandus Regenerative Flame Arc;* and a list of decorative fixtures from *Messrs. Waring & Gillow.*

A Course in Illumination.

We have received a copy of the prospectus of the Northampton Institute for the forthcoming year, and were interested in the account of the course conducted by Dr. C. V. Drysdale on 'The Production and Utilization of Light,' in which the scientific principles underlying the manufacture of light for illuminating purposes receive detailed attention.

The lectures referred to are supplemented by a course on 'The Chemistry of Incandescent Lighting,' and laboratory work on photometry.

It is gratifying to find that in this instance, at least, the study of illumination occupies a definite place in the college curricula, and there are indications that the subject of illumination is about to receive attention on similar lines in other quarters.

Review of the Technical Press.

PHOTOMETRY.

THE most interesting item among the photometric papers of the past month is the communication of **Dr. Glazebrook** to the British Association meeting regarding the STANDARD AT THE NATIONAL PHYSICAL LABORATORY.

Hitherto it has been specified that the standard conditions of moisture should be taken as 10 litres of water-vapour per cubic metre of air, measured with an ordinary unventilated wet and dry bulb hygrometer. It now appears that, on the Assmann instrument, which is used on the Continent, the 10 litres referred to would be registered as 8. In future the laboratory propose to adopt the Assmann instrument, but to keep the value of the light-standard the same; all that is necessary is to adopt the new method of specifying the water-vapour.

A most interesting result of this discovery is that the corrected values of the relations connecting the British candle-power with the Hefner and Bougie decimale become simplified to the convenient whole numbers 0·9 and 1·0 respectively. It is also stated that the adoption of the new method of specifying the water-vapour will, to a great extent, explain the old want of agreement between the results of direct comparison between the standard lamps, and the results of comparison by the aid of glowlamps interchanged between the various laboratories; a small difference of somewhat over 1 per cent. will, however, still remain unaccounted for, and this is still the subject of investigation.

In view of the alteration in the relation between the units of different countries, the recent proposition of the NATIONAL FRENCH COMMITTEE of the INTERNATIONAL ELECTROTECHNICAL COMMISSION to bring the British, French, and American standards into closer agreement, by raising the British candle 2 per cent, and lowering the United States candle 2 per cent (see *Electrical World*, N.Y., September 5th), will have to be reconsidered.

Among other articles dealing with the subject of photometry mention may be made of the translation of the recent publication of **Kruss** on INTEGRATING PHOTOMETERS, which appears in the American *Gaslight Journal*.

There are also short notes on several new forms of photometers. Thus the *Elektrischer Anzeiger* (Sept. 10th) describes A NEW FORM OF PORTABLE PHOTOMETER due to **Blondel**. The instrument utilizes a diminutive Lummer-Brodhun prism arrangement, of a special pattern, forming a "contrast" field, which is afterwards highly magnified. The alteration in brightness of the field of view is accomplished by means of an arrangement of screens, and the whole is specially designed so as to be of a portable nature, and easily adapted to measurements in the street, &c. For the purpose of measuring illumination, a small glow-lamp, with a linear filament, fed from a portable accumulator, is employed.

We also note in the *Journal für Gasbeleuchtung* (Sept. 19th, p. 891) a short note of A NEW FLICKER PHOTOMETER devised in Russia. Little detail is given, but the essential point of the instrument seems to lie in a device to secure that the alteration in brightness of the field of view takes place according to a sinusoidal law. The object of this is to avoid the sudden changes of light and shade occurring in the ordinary flicker-photometer, which are said to be fatiguing to the eyes. It might naturally be supposed, however, that it is in this very sharpness that the sensitiveness of such an instrument exists, and that any attempt to render the flicker more "restful" in this way could only impair the sensitiveness.

ILLUMINATION.

As usual a considerable number of papers dealing with broad aspects of illumination have appeared in the American press. **Marshall** (*Electrical World*, Sept. 12th) advocates the INSPECTION OF THE ILLUMINATION OF PREMISES by supply companies, as well as the examination of wiring. He hardly supposes that the company should go so far as to refuse to supply current to an inadequately arranged system of lighting as would be done in the event of the wiring being unsatisfactory; but he thinks that a friendly inspection of installations previous to connecting up might often enable the engineer to make a few suggestions which would save much subsequent friction. He also refers to the value to a central station of a complete illuminating engineering staff for the special purpose of advising and assisting consumers.

In another article the same author discusses the functions of THE ILLUMINATING ENGINEER. As not infrequently occurs in such discussions the author eventually comes round to the relation of the illuminating engineer to the architect on the goodwill of whom much of the success or otherwise of his efforts must depend. Mr. Marshall has no doubt of the illuminating engineer's ability to assist in this way, and even states that he has never met a case in which an architect has called in the assistance of an independent illuminating expert without gaining benefit thereby.

On the other hand **Mr. Basset Jones**, speaking from THE ARCHITECT'S STANDPOINT (*Elec. Review*, N.Y., Sept. 12th), seems to consider that some illuminating engineers are apt to make unreasonable demands. For instance, it is hardly fair to expect the architect to subjugate his scheme to the wishes of the engineer in order that the latter may gain the maximum efficiency from his lights. Efficiency is rarely the only consideration. Arguing by analogy, Mr. Basset Jones points out that no sanitary engineer would expect the architect to design the house to suit his views, or object because he adopted some system which deprived the hot-water apparatus of some fraction of its possible efficiency. Mr. Basset Jones likewise deprecates the incursions of the illuminating engineer into the department of the æsthetic pure and simple, and hints that in many cases he has not as yet received the education to enable him to appreciate what is good art and what is not.

The Illuminating Engineer of New York, as usual, contains a number of articles dealing specifically with illumination. Amongst these we note an article by **N. McBeth** on THE ILLUMINATION OF A CLOTHING STORE, and a well-illustrated article dealing with SPECTACULAR EFFECTS IN INDOOR-LIGHTING, showing some novel imitative method of decoration. A recent paper by **A. Cressy Morison** discusses the best light from the point of view of DIAGNOSIS BY THE MEDICAL MAN. Naturally in examining the conditions of the skin, and noting symptons of inflammation &c., a light approaching to daylight is desirable, otherwise certain colours may be inconveniently accentuated, and thus give rise to deceptive effects. For instance, a preponderance of red in the spectrum of an illuminant is apt to cause an appearance of inflammation when none really exists. Mr. Morison recommends acetylene, on account of the presumed resemblance of its spectrum to that of daylight.

K. Norden (*E.T.Z.*, Sept. 10th) considers some theoretical points arising in the derivation of ILLUMINATION FROM THE MERCURY VAPOUR LAMP. As the mercury lamp is far from a point-source light, being a tube of very considerable dimensions, the ordinary inverse-square law does not apply to the lamp as a whole, and the calculation of the resulting illumination at any point presents some complications.

The author shows how to calculate the illumination at any such point in a plane parallel to the axis of the tube. He also deals with the errors that are liable to be introduced in the photometry of this source owing to its deviation from the theoretical point-source, some of which are very marked. For instance, it was found that when the distance of the lamps from the photometer was varied from 0·6 to 2·85 metres, a difference in the apparent candle-power of as much as 34 per cent occurred.

The *Zeitschrift für Beleuchtungswesen* reproduces an article by **E. W. Weinbeer** who works out the SHAPE OF REFLECTORS in order to secure a UNIFORM GROUND ILLUMINATION. A recent number of the *Journal of Gaslighting* abstracts the paper by **Nichols** before THE ILLUMINATING ENGINEERING SOCIETY on 'DAYLIGHT AND ARTIFICIAL ILLUMINATION.'

A very interesting discussion has raged round the paper by **Schanz** and **Stockhausen** at the VERBAND DEUTSCHER ELEKTROTECHNIKER on the EFFECTS OF ULTRA-VIOLET LIGHT ON THE EYE. Many conflicting views were expressed. The most general view, however, seems to have been that, since daylight contained a stronger ultra-violet element than ordinary artificial illuminants, the injury due to the latter could not justly be ascribed to the effects of ultra-violet light. On the other hand, injury might, of course, be due to other causes, too severe contrast, too great intrinsic brilliancy of visible rays, &c. In the case of such sources as the quartz mercury-vapour lamp, protection from the ultra-violet light is, however, recognized to be necessary.

It was also pointed out that much additional work in this subject must be necessary before it could be said to be ripe for discussion, and some speakers deprecated the publication of hasty conclusions which were afterwards taken up by the press, and gave rise to an anxiety in the minds of the public for which there was no reasonable ground. Others, however, expressed the view that since suggestions of this nature had been made from time to time, it was most desirable in the interests of the electrical industry that the matter should be debated and some idea formed as to how far such fears were justified.

In the last number of the *E.T.Z.* **Prof. Blondel** contributes a letter describing some of his experiences. He agrees with the suggestions of Schanz and Stockhausen, that the fatigue of the eye is due to ultra-violet, or rays of short wavelength, and thinks that this may possibly be explained on the ground that, though daylight contains more energy of this description than most artificial lights, yet, owing to the relatively low standard of intensity prevailing with artificial illumination, our vision is mainly accomplished by the aid of the "rods" in the eye, which is not the case in bright daylight, so that the physiological conditions are altered. He himself suffered from inflammation of the conjunctiva, and found subsequently that while his eyes could bear a lamp taking 4 or 3·5 watts per candle, a lamp taking 2·5 watts per candle, and therefore giving a whiter light, gave rise to eye-trouble. Even the use of low efficiency lamps, however, was only possible after the inflammatory symtoms had subsided to some extent, and the author was at first unable to work by artificial light with comfort.

Electric Lighting.

The number of articles published within the last month dealing with electric lighting is more extensive than ever. Particular attention may be drawn to the two "Special Illumination Numbers" of *The Electrical World* and *The Electrical Review* of New York of September 5th and 12th respectively. In these and other American journals appear a vast number of papers by **A. A. Wohlauer S. E. Doane, F. W. Wilcox, L. P. Sawyer,** and others dealing with the Progress and Development of the Tungsten Lamp. Most of these deal with the subject in a general manner, as is natural in an issue of this nature, reviewing the most recent developments and giving tables of comparison between the costs of lighting by the tungsten lamps and gas; there are also some collected opinions of supply companies in different parts of America on the effect of the introduction of the lamps on business. These are almost invariably favourable, and there do not seem to be any signs of the uncertainty as to the influence of the lamps on the revenue of supply companies observable in this country. Actual experience of the behaviour of the lamps seems to be equally favourable: thus F. W. Wilcox attributes an average life of 2,000 hours without appreciable blackening, to osram street lamps at 1·25 watts per candle.

Dr. Louis Bell reviews the progress of the tungsten lamp abroad; **A. A. Wohlauer** and **F. W. Willcox** review the Present State and Future Prospects of the Flame Arc.

Among other articles in these special numbers we note some particulars on the Helion Lamp by **H. C. Parker** and **W. G. Clarke**. It is stated that there is now no difficulty in making lamps for either 110 or 220 volts. Originally filaments were found to be very sensitive to the effects of gases occluded in the cement used to mount the leading in wires into the glass; it was found difficult to exhaust the lamps sufficiently well to prevent the filaments deteriorating subsequently. More recently, however, the authors seem to have succeeded in producing filaments that are even capable of burning in the open air, and it is stated that a filament burned at a temperature of about 1800 degrees under these conditions does not suffer appreciably thereby. Even when the temperature is carried up to 2500 degrees, with the result that silicon dioxide is formed in a molten condition, the filament is said to be uninjured. Filaments can also be immersed in water and withdrawn without being injured. During the initial period of the life of a lamp there is a slow rise in candle-power owing to the gradual burning away of the material in the carbon core on which the outer "helion" skin is formed.

D. McF. Moore likewise publishes some partciulars of the Tube-light, as Applied to the Colour-Matching Department in some printing-mills. It is stated that for this purpose the lamp is even preferable to daylight, for daylight itself gives distinctly different results at different times in the day, while the Moore lamp is always the same. A tubular reflector is now fitted upon the lamp in cases in which it is desired to concentrate the light downwards, and conditions of illumination are claimed equivalent to 0·25 watts per square foot illuminated by one candle.

Among the articles and papers that have appeared in other countries mention may be made of that by **Remane**, which is now published in full in the *Elektrotechnische Zeitschrift*. The author discusses the Effect of Overrunning on the Metallic Filament Lamps and gives a series of very interesting data as to the exact effect of a given rise of P.D. upon the life and "output" of an osram lamp taking 1·1 watts per H.K. For instance, he finds that the useful life of a 100 volt lamp run on P.D.'s of 100, 105, and 110 volts is 1,800, 900, and 370 hours respectively, so that a rise in P.D. of 10 per cent reduces the useful life to about a fifth of its normal value.

GAS, OIL, AND ACETYLENE LIGHTING.

Special interest attaches to the discussion by **W. H. Y. Webber** (*G.W.*, Sept. 12th) of the articles by Prof. J. T. Morris that appeared in the last two numbers of *The Illuminating Engineer.* Mr. Webber regards the results obtained as most interesting, and remarks on the value of two such articles dealing impartially with both electric and gas-lamps, in the same journal. Nevertheless, he disagrees with some of the conclusions of Prof. Morris, particularly the suggestion that light from a street-lamp ought to be confined to angles below the horizontal in order to illuminate the pavement.

Mr. Webber also denies the suggestion that the horizontal beam from an incandescent gas-lamp is picked out in testing a lamp because the light is a maximum in this direction. This system is merely a development of the old conditions designed to test quality of gas; when comparing lights of widely different character, however, it is clearly open to possible objection. While sympathizing with Prof. Morris's demand for a calorific basis of testing Mr. Webber expresses a lively fear of legislation on the subject, and prefers that the change should take place gradually and naturally.

N. H. Humphrys (*J. G. L.*, Sept. 1st.), criticizes the recent report of A. A. VOYSEY ON THE CITY LIGHTING. One point on which he insists is the impracticability of basing comparisons of cost solely on the illumination of the pavement; thus if a street is illuminated effectually already, and we succeed (even without extra expense) in securing double the existing illumination we are not entitled to present results in such a way as to suggest that we have halved the cost of lighting the street.

Other contributions deal with STREET-LIGHTING BY GAS notably the recent paper by **Prof. Drehschmidt** of Berlin, which appears in both the German and English gas journals of recent date. In the space available it is only possible to comment very briefly on this paper which, however, contains a great deal of interesting practical information and some valuable data as to the practice in street-lighting in Berlin. The paper is accompanied by full details of the polar curves of distribution of light of the sources employed and the distribution of light upon the pavement and roadway.

The Gas World (Sept. 12th) also contains a brief summary of the discussion that has been taking place in the German gas technical press on THE RELATIVE MERITS OF PRESSSURE-GAS AND PRESSURE-AIR; also some particulars of a lamp that seems to have some interesting features at the present moment when the use of pressure-gas for public lighting is becoming universal. The Chipperfield lamp in question utilizes a system of raising the pressure in the lamp that is applicable to any existing lantern, thus reducing scrapping that is usually necessary when conversion to pressure-gas takes place.

Lastly mention may be made of the summary of the papers read before the International Acetylene Association in Chicago this year and described in recent numbers of *The Acetylene Journal.* Of the papers that have as yet been published in full special interest attaches to a description of a new device for enabling liquid acetylene to be applied to buoys, &c., and securing their automatic extinction at definite intervals.

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A Proposed New International Candle (*Elec. World*, N.Y., Sept. 5)

Glazebrook, R. T. The Photometrical Standard of Light at the National Physical Laboratory (Communication to the Meeting of the British Association at Dublin).

Hildebrand, J. A New Form of Koenig Spectrophotometer (*Zeit. f. Elektroch.* 14 pp., 349-352, June 26, 1908; *Science Abstracts*, August).

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Marshall, A. J. Illumination Inspection (*Elec. World*, N.Y., Sept. 12).
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McBeth, N. The Illumination of a Clothing Store (*Illuminating Engineer*, N.Y., Aug.).

Norden, K. Beleuchtungsberechnungen für Quecksilberdampflampen (*E. T. Z.*, Sept. 10).

Thurston Owens, H. Street-Lighting in Brooklyn, N.Y. (*Progressive Age*, Sept. 1, 1908).
Weinbeer, E. W. Die Konstruktion von Reflektoren für vorgeschriebene Bodenbeleuchtungen (*Z. f. B.*, Sept. 10).
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Spectacular Effects in Interior Lighting (*Illuminating Engineer*, N.Y., August).

ELECTRIC LIGHTING.

Auerbacher, L. J. The Flaming Arc-lamp Abroad (*Elec. World*, N.Y., Sept. 5).
Bell, Louis. The Tungsten Lamp Situation Abroad (*Elec. World*, N.Y., Sept. 5).
Bussmann, O. Neues über die Quarzlampe (*Elek. Anz.*, Sept. 10).
Chamberlain, W. Luminous Arc-lamps (*Elec. Rev.*, N.Y., Sept. 12).
Doane, S. E. The Twelvemonths' Achievement of the Tungsten Lamps (*Elec. Rev.*, N.Y., Sept. 12).
Editorial. The Luminous Overshooting of Tungsten Lamps (*Elec. Rev.*, N.Y., Aug. 22).
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Ladoff, I. Recent Problems in the Voltaic Arc (*Ill. Eng.*, N.Y., August).
Moore, D. McF. Tube-lighting (*Elec. Rev.*, N.Y., Sept. 12).
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Sawyer, L. P. The Effect of the Tungsten Lamp upon Electric Lighting (*Elec. World*, N.Y., Sept. 12).
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Tungsten Lamp Economy (*Elec. Rev.*, N.Y., Sept. 12).
Wohlauer, A. A. The Present Status of the Flame Arc (*Elec. World*, N.Y., Sept. 5).
The Effect of Metal Filament and Arc Lamps on the Eyes (*Elec. Engineering* Aug. 27).
The Manufacture of Metallic Filament Lamps (*Elec. Engineering*, Sept. 3).
Lampado ad Arco Blondel (*L'Ellettricita*. Sept. 3).
Kuzel Tungsten Filament Patents (*Elec. World*, N.Y., Aug. 22).
Metallic Filament Patents (*Elec. World*, N.Y., Aug. 29, pp. 433, 437).
Series Illumination by Tungsten Lamps (*Elec. World*. N.Y., Aug. 29).
The Tungsten Lamp Situation (*Elec. World*, N.Y., Sept. 5).
Die neueren Bogenlampen, A. Bogenlampen mit kohlen-Elektroden (*Zeit. f. Bel.*, Aug. 30, Sept. 10, Sept. 20).
Cooper-Hewitt Lamp Progress (*Elec. Rev.*, N.Y., Sept. 12).
The Convention of the Michigan Electric Association (*Elec. Rev.*, N.Y., Aug. 29).
The Ohio Electric Light Association (*Elec. Rev.*, N.Y., Sept. 5).

GAS, OIL, AND ACETYLENE LIGHTING.

Drehschmidt, H. Pressure-gas Incandescent Inverted Lighting in Berlin, *J. f. G.*, Aug. 22; *J. G. L.* Sept. 1; *G. W.*, Sept. 12).
Editorial. Morris and Webber on High Power Lamps (*G. W.*, Sept. 19).
Humphreys, N. H. Public Lighting in London and Elsewhere (*J. G. L.*, Sept. 1).
Morris, J. T. Tests on Incandescent Gaslamps (Correspondence, *G. W.*, Sept. 5).
Gebault. Eclairage des Vitrines (*Rev. des Eclairages*. Sept. 15).
Körting, E. Public Lighting by Pressure Gas (*J. f. G.*, Sept 12, pp. 842 to 844).
Talbot, F. A. Liquid Gas (*The World's Work*, Sept. 12).
Webber, W. H. Y. Professor J. T. Morris on High Power Gas and Electric Arc Lamps (*G. W.* Sept. 19).
The Relative Merits of Pressure Gas and Pressure Air (*G. W.*, Sept. 12).
The Chipperfield High Pressure Lamp (*G. W.*, Sept. 12).
Beleuchtung mit Flüssigen Leuchtmaterialen, &c. (*Z. f. B.*, Aug. 30).
Various Patents relating to Incandescent Mantles, &c. (*Z. f. B.*, Sept. 10 and 20).
The Annual Meeting of the International Acetylene Association at Chicago (*Acetylene Journal*);

CONTRACTIONS USED.

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

Gas, Oil, and Acetylene Lighting.

Special interest attaches to the discussion by **W. H. Y. Webber** (*G.W.*, Sept. 12th) of the articles by Prof. J. T. Morris that appeared in the last two numbers of *The Illuminating Engineer.* Mr. Webber regards the results obtained as most interesting, and remarks on the value of two such articles dealing impartially with both electric and gas-lamps, in the same journal. Nevertheless, he disagrees with some of the conclusions of Prof. Morris, particularly the suggestion that light from a street-lamp ought to be confined to angles below the horizontal in order to illuminate the pavement.

Mr. Webber also denies the suggestion that the horizontal beam from an incandescent gas-lamp is picked out in testing a lamp because the light is a maximum in this direction. This system is merely a development of the old conditions designed to test quality of gas; when comparing lights of widely different character, however, it is clearly open to possible objection. While sympathizing with Prof. Morris's demand for a calorific basis of testing Mr. Webber expresses a lively fear of legislation on the subject, and prefers that the change should take place gradually and naturally.

N. H. Humphrys (*J. G. L.*, Sept. 1st.), criticizes the recent report of A. A. Voysey on the City Lighting. One point on which he insists is the impracticability of basing comparisons of cost solely on the illumination of the pavement; thus if a street is illuminated effectually already, and we succeed (even without extra expense) in securing double the existing illumination we are not entitled to present results in such a way as to suggest that we have halved the cost of lighting the street.

Other contributions deal with Street-Lighting by Gas notably the recent paper by **Prof. Drehschmidt** of Berlin, which appears in both the German and English gas journals of recent date. In the space available it is only possible to comment very briefly on this paper which, however, contains a great deal of interesting practical information and some valuable data as to the practice in street-lighting in Berlin. The paper is accompanied by full details of the polar curves of distribution of light of the sources employed and the distribution of light upon the pavement and roadway.

The Gas World (Sept. 12th) also contains a brief summary of the discussion that has been taking place in the German gas technical press on The Relative Merits of Presssure-Gas and Pressure-Air; also some particulars of a lamp that seems to have some interesting features at the present moment when the use of pressure-gas for public lighting is becoming universal. The Chipperfield lamp in question utilizes a system of raising the pressure in the lamp that is applicable to any existing lantern, thus reducing scrapping that is usually necessary when conversion to pressure-gas takes place.

Lastly mention may be made of the summary of the papers read before the International Acetylene Association in Chicago this year and described in recent numbers of *The Acetylene Journal.* Of the papers that have as yet been published in full special interest attaches to a description of a new device for enabling liquid acetylene to be applied to buoys, &c., and securing their automatic extinction at definite intervals.

List of References:—

PHOTOMETRY.

Blondel, A. A New Photometer (*Elek. Anz.*, Sept. 10).

Editorials. The British Photometric Standard (*J.G.L.*, Sept. 22).

A Proposed New International Candle (*Elec. World*, N.Y., Sept. 5)

Glazebrook, R. T. The Photometrical Standard of Light at the National Physical Laboratory (Communication to the Meeting of the British Association at Dublin).

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Z f. B.—*Zeitschrift für Beleuchtungswesen.*

PATENT LIST.

PATENTS APPLIED FOR, 1908.

I.—ELECTRIC LIGHTING.

17,509. Arc-lamp (C.S.). Aug. 20. Regina Bogenlampenfabrik G. m. b. H. and P. Hanisch, 322, High Holborn, London.
17,527. Magnetic blow-outs for lamps. Aug. 20. A. Zöller, 18, Southampton Buildings, London.
17,562. Combined terminal and cord-grip for lamp holders. Aug. 21. E. Phillips, 109, Westminster Road, Hansworth, Birmingham.
17,626. Electric light fitting. Aug. 22. G. W. de Tunzelmann, 4, Queen Anne's Chambers, Westminster.
17,706. Adaptable instantaneous carrier for shades for incandescent lamps. Aug. 24. W. A. G. Hill, 116, Waterloo Street, Oldham.
17,742. Holders (glass, porcelain, &c.) for metallic filaments (C.S.). Aug. 24. I.C. April 21, 1908, Germany. Lichtwerke G. m. b. H., 18, Southampton Buildings, London.
17,787. Electroliers. Aug. 25. H. Collett and E. J. Perry, Carlton Buildings, Paradise Street, Birmingham.
17,806. Plunger connection for wiring bayonet-joint lamps. Aug. 25. E. A. Bresman, 71A, Pershore Street, Birmingham.
18,233. New system of fitting incandescent lamps (C.S.). Aug. 31. I.C. Jan. 10, 1908, France. G. Weissmann, 20, High Holborn, London.
18,278. Incandescent lamps (C.S.). Aug. 31. J. Kremenezky, 18, Southampton Buildings, London.
18,342. Glow-lamps. Sept. 1. G. Davis, Queen Anne's Chambers, Westminster. (Addition to 29,620/06).
18,408. Suspending electric lights adjustably. Sept. 2. G. Thomson, 122, George Street, Edinburgh.
18,832. Arc lamps (C.S.). Sept. 8. H. Liske and A. Zöller, 18, Southampton Buildings, London.
18,900. Lamp holders. Sept. 9. A. Bates, 24, Temple Row, Birmingham.
18,946. Metal filaments (wolfram, molybdenum, uranium, tantalum, &c.). Sept. 9. W. Heinrich, 18, Southampton Buildings, London.
19,052. Supports for lamp filaments (C.S.). Sept. 10. F. R. Pope and M. W. O'Connell, 322, High Holborn, London.
19,118. Oxide-coated metal holders for metallic filament lamps (C.S.). Sept. 11. T. McKenna, 31, Basinghall Street, London. (From Glühlampenwerk Anker, G. m. b. H., Germany.)
19,150. Fittings. Sept. 11. A. T. Woodhall and A. Emery, 70, Chancery Lane, London.

II.—GAS LIGHTING.

17,316. By-pass nipples for gas-burners. Aug. 18. B. Bonniksen and H. Fletcher, 18, Hertford Street, Coventry.
17,321. Lighting incandescent street lamps, &c. Aug. 18. T. L. Cuttell and The Anti-Vibration Incandescent Lighting Co., Ltd., 33, Chancery Lane, London.
17,596. Incandescing bodies (C.S.). Aug. 21. M. von Unruh, 47, Lincoln's Inn Fields, London.
17,617. Incandescent bodies or burners. Aug. 21. E. A. Turner, 38, Chancery Lane, London.
17,675. Reflector for inverted gas light (C.S.). Aug. 22. E. Hindrichs, 345, St. John's Street, London.
17,818. Mantles of rare earths for lighting and heating. Aug. 25. W. G. Potter, 14, Ingleton Street, Brixton Road, London.
18,093. Inverted burners for gas, &c. Aug. 28. W. G. Potter, 14, Ingleton Street, Brixton Road, London.
18,094. Lamps for burning carburetted air for lighting, &c. Aug. 28. W. G. Potter, 14, Ingleton Street, Brixton Road, London.
18,248. Inverted burners for street lighting (C.S.). Aug. 31. C. C. Carpenter, 6, Bream's Buildings, Chancery Lane, London.
18,860. Gas lighting and extinguishing apparatus. Sept. 8. Sir E. H. Elton and R. Stephens, 27, Chancery Lane, London. (Addition to 15,067/06.)
18,887. }
18,901. } Incandescent burners. Sept. 9. G. Helps, Izons Croft, Ansley, Atherstone.
18,949. Inverted incandescent burner. Sept. 9. D. Anderson and J. Worsfold, 18, Farringdon Road, London.
19,094. Burner. Sept. 11. G. Helps, Izons Croft, Ansley, Atherstone.
19,228. Incandescent burners. Sept. 12. T. E. Price, 18, Southampton Buildings, London.

III.—MISCELLANEOUS

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

17,256. Petroleum incandescent lamps (C.S.). Aug. 17. O. Gronbladh, 36, Chancery Lane, London.
17,302. Lamp brackets. Aug. 18. R. W. Griffiths, 102, Bradford Street, Birmingham.
17,382. Lamps. Aug. 18. J. T. M. Burgess, Prudential Buildings, Corporation Street, Birmingham.
17,540. Light-controlled lighting switch (C.S.). Aug. 21. Sir H. Norman and T. B. Reader, Honeyhanger, Haslemere, Surrey.

17,733. Improvement on candles, paraffine, spirit or other lamps for better light. Aug. 24. A. Krakow, 57, Clifton Street, Finsbury Square, London.
17,853. Oil lamps. Aug. 25. J. C. Angus, Birkbeck Bank Chambers, London.
17,881. Reflectors for search lights, &c. Aug. 25. C. A. Parsons, G. G. Stoney and E. Bennett, 18, Southampton Buildings, London. (Addition to 16,599/07.)
18,163. Luminous sign or advertising device. Aug. 29. C. Wilson and C. Beaven, Brook Green Works, Hammersmith.
18,172. Controlling lighting or extinguishing of gas, or actuation of electric switches at predetermined times (C.S.). Aug. 29. H. W. Harris, 55, Chancery Lane, London.
18,508. Illuminating interiors without producing shadows (C.S.). Sept. 3. F. Lutthlen, 65, Chancery Lane, London.
19,096. Billiard light pendant. Sept. 11. F. Kissel, Salisbury Hotel, Boscombe.
19,183. Electroliers and gasoliers. Sept. 12. R. S. Woods, 4, St. Ann's Square, Manchester.
19,188. Mantles (gas and electric). Sept. 12. W. G. Potter, 14, Ingleton Street, Brixton, London.

COMPLETE SPECIFICATIONS ACCEPTED OR OPEN TO PUBLIC INSPECTION.

I.—ELECTRIC LIGHTING.

14,059. Lighting and heating of vehicles (C.S.). I.C. July 6, 1906, Germany. Accepted Aug. 26, 1908. H. Grob, 37, Essex Street, Strand.
18,688. Incandescent lamps. Aug. 19, 1907. Accepted Aug. 19, 1908. T. W. Lowden, Westinghouse Building, Norfolk Street, Strand.
19,562. Incandescent lamps (C.S.). I.C. April 15, 1907, Germany. Accepted Sept. 2, 1908. Deutsche Gasglühlicht Akt.-Ges. (Auerges.). 55, Chancery Lane, London.
19,672. Metallic filaments for glow lamps (C.S.). I.C. Aug. 2, 1907, Germany. Accepted Sept. 9, 1908. Ges. für Verwertung Chemische Produkte. m. b. H., 55, Chancery Lane, London.
21,197. Fittings for tubular incandescent lamps. Sept. 24, 1907. Accepted Sept. 2, 1908. D. Assersohn, 7, Southampton Buildings, London.
23,786. Incandescent lamps. Oct. 28, 1907. Accepted Aug. 19, 1908. E. A. Gimingham, Birkbeck Bank Chambers, London.
24,027. Arc lamps (C.S.). I.C. Sept. 7, 1907, Germany. D. Trinar and K. von Dreger, 7, Southampton Buildings, London.
24,635. Arc lamps. Post dated April 3, 1908. Accepted Sept. 16, 1908. W. A. Legge, 65, Chancery Lane, London.
27,412A. Arc lamps. Jan. 13, 1908. Accepted Sept. 16, 1908. H. Bevis and A. E. Angold, Peel Works, Adelphi, Salford. (D.A. Dec. 12, 1907.)
620. Lamp clusters (C.S.). Jan. 10, 1908. Accepted Sept. 16, 1908. W. Fairweather, 65, Chancery Lane, London. (From Benjamin Electric Manufacturing Co., U.S.A.)
3,388. Incandescent lamps (C.S.). I.C. Aug. 7, 1907, U.S.A. J. W. Howell, 83, Cannon St., London.
4,568. Arc lamps (C.S.). Feb. 28, 1908. Accepted Aug. 19, 1908. C. A. Taylor and E. R. A. Broom, trading as The New Century Arc Light Co., Norfolk House, Norfolk Street, Strand.
8,421. Filaments for incandescent lamps (C.S.). I.C. May 13, 1907, Germany. Accepted Sept. 16, 1908. Wolfram-Lampen Akt.-Ges., 7, Southampton Buildings, London.
9,502. Arc lamps (C.S.). I.C. May 2, 1907, Germany. Accepted Aug. 26, 1908. Allgemeine Elektricitäts Ges., 83, Cannon Street, London.
11,599. Incandescent filaments from vegetable oil and resins (C.S.). I.C. Sept. 6, 1907, Germany. K. Rittersberg and H. Rubert, 67, Knesebeckstrasse, Charlottenburg, Germany.
12,630. Pocket lamp (C.S.). June 12, 1908. Accepted Sept. 9, 1908. P. M. E. Bourgeois and C. H. Bourgeois, 65, Chancery Lane, London.
12,968. Filaments for glow-lamps. June 17, 1908. Accepted Sept. 9, 1908. H. Kuzel, 322, High Holborn, London. (Addition to 28,154/04.)
14,910. Protective covers for glow lamps (C.S.). I.C. June 1, 1908, Germany. Accepted Sept. 16, 1908. Siemens-Schuckertwerke G. m. b. H., Queen Anne's Chambers, Broadway, Westminster.
17,419. Arc-lamp electrodes (C.S.). I.C. Sept. 3, 1907, U.S.A. G. M. Little, Westinghouse Building, Norfolk Street, Strand.
17,421. Arc-lamps (C.S.). Aug. 20, 1907, Germany. Körting and Matheson Akt.-Ges., 24, Southampton Buildings, London.
17,535. Arc-lamps (C.S.). I.C. Aug. 21, 1907, Germany. Allgemeine Elektricitäts Ges., 83, Cannon Street, London.
17,618. Refractory conductors (C.S.). I.C. Aug. 24, 1907, U.S.A. W. C. Arsem, 83, Cannon St., London.
17,619. Refractory conductors (C.S.). I.C. Aug. 24, 1907, U.S.A. C. T. Fuller, 83, Cannon St., London.
17,620. 17,621. } Refractory conductors (C.S.). I.C. Aug. 24, 1907, U.S.A. W. D. Coolidge, 83, Cannon St., London.
18,054. Incandescent lamps (C.S.). I.C. Sept. 16, 1907, U.S.A. W. C. Arsem, 83, Cannon St., London.

II.—GAS LIGHTING.

17,998. Support for incandescent mantles. Aug. 8, 1907. Accepted Aug. 19, 1908. I. Sherwood, 40, Howard Street, Birmingham.
19,100. Incandescent mantles. Aug. 24, 1907. Accepted Aug. 26, 1908. J. Bernheimer and A. Gut, 6, Lord Street, Liverpool.
24,405. Inverted incandescent lamps or lanterns. Nov. 4, 1907. Accepted Sept. 16, 1908. F. Blank, 70, Chancery Lane, London.
24,878. Lanterns for gas-lamps. Nov. 9, 1907. Accepted Sept. 16, 1908. J. Gunning, Birkbeck Bank Chambers, London.
25,240. Inverted incandescent burners. Nov. 14, 1907. Accepted Aug. 26, 1908. Sunlight and Safety Lamp Co., Ltd., and T. B. Smith, 5, Corporation Street, Birmingham.

27,778. Holders for mantles. Dec. 17, 1907. Accepted Sept. 16, 1908. W. B. Brooker, 62, Stanley Road, Bootle, near Liverpool.

7,309. Controlling gas supply to lamps at a distance (C.S.). I.C. July 23, 1907, Germany. Accepted Sept. 9, 1908. G. Himmel, 18, Southampton Buildings, London.

7,318. Controlling gas supply to lamps at a distance (C.S.). I.C. Feb. 3, 1908, Germany. Accepted Sept. 16, 1908. G. Himmel, 18, Southampton Buildings, London. (Addition to 7,309/08.)

7,840. Lighting attachments for gas and acetylene burners (C.S.). I.C. Aug. 10, 1907, U.S.A. Accepted Sep. 2, 1908. C. J. Larkin, 72, Cannon Street, London.

9,276. Inverted incandescenl lamps (C.S.). April 29, 1908. Accepted Aug. 26, 1908. M. Graetz, 18, Southampton Buildings, London.

9,892. Pressure-controlled igniters (C.S.). May 6, 1908. Accepted Sept. 9, 1908. E. Zickwolff, 31, Bedford Street, Strand.

12,487. Lighting and extinguishing burners by varying pressure in mains (C.S.). I.C. June 11, 1907. Accepted Sept. 16, 1908. J. R. Dupov, 53, Chancery Lane, London.

14,307. Inverted incandescent lamps for railway carriages, &c. (C.S.). I.C. Sept. 7, 1907, Germany. The Firm Ehrich & Graetz, 111, Hatton Garden, London.

15,549. Incandescent mantles (C.S.). July 22, 1908. Accepted Sept. 16, 1908. S. Cohn, 11, Southampton Buildings, London.

III.—MISCELLANEOUS

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

20,288. Candle emitting coloured light. Sept. 11, 1907. Accepted Aug. 19, 1908. R. Scheuble, 18, Southampton Buildings, London.

23,818. Control of light-producing agents (arcs, limelight, &c.) for optical lanterns. Oct. 29, 1907 Accepted Aug. 26, 1908. G. Robson, 21, Rochdale Road, Leyton, Essex.

27,581. Lamps for churches, &c. Dec. 14, 1907. Accepted Aug. 19, 1908. M. Shrensky, 55, Market Street, Manchester.

1,206. Lighting lamps and lanterns. Jan. 18, 1908. Accepted Sept. 2, 1908. H. S. Cooke, 502, City Road, Edgbaston, Birmingham.

1,277. Burning paraffin wax, &c., for illuminating, &c. (C.S.). Jan. 18, 1908. Accepted Sept. 2, 1908. The New Transvaal Chemical Co., Ltd., and P. Destefani, 7, Southampton Buildings, London.

4,461. Filaments for lighting and heating (C.S.). I.C. June 10, 1907, France. Accepted Sept. 16, 1908. G. Michaud and E. Delasson, 7, Southampton Buildings, London.

5,209. Acetylene flare lights (C.S.). March 7, 1908. Accepted Aug. 19, 1908. C. C. Wakefield, 111, Hatton Garden. (Addition to 11,758/05.)

17,788. Matter for impregnating torches (C.S.). I.C. Aug. 25, 1907, Germany. T. Toccaceli, Carlton. Buildings, Paradise Street, Birmingham.

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.

An Association of Car-Lighting Engineers was formed in Chicago on Aug. 24th and 25th ; the object of the Association appears to be the study of all matters connected with the illumination of trains and tramcars, and a number of prominent railroad electrical enigneers will participate.

The *Electrical Testing Laboratories* of New York write to us to state that the meeting of lamp-testers recently held in that city, and mentioned on p. 784 of *The Illuminating Engineer*, was attended by the inspectors in the employ of this company.