LIGHTING JOURNAL

a lighting case history
better seeing with polarized light
statistical testing of lamps

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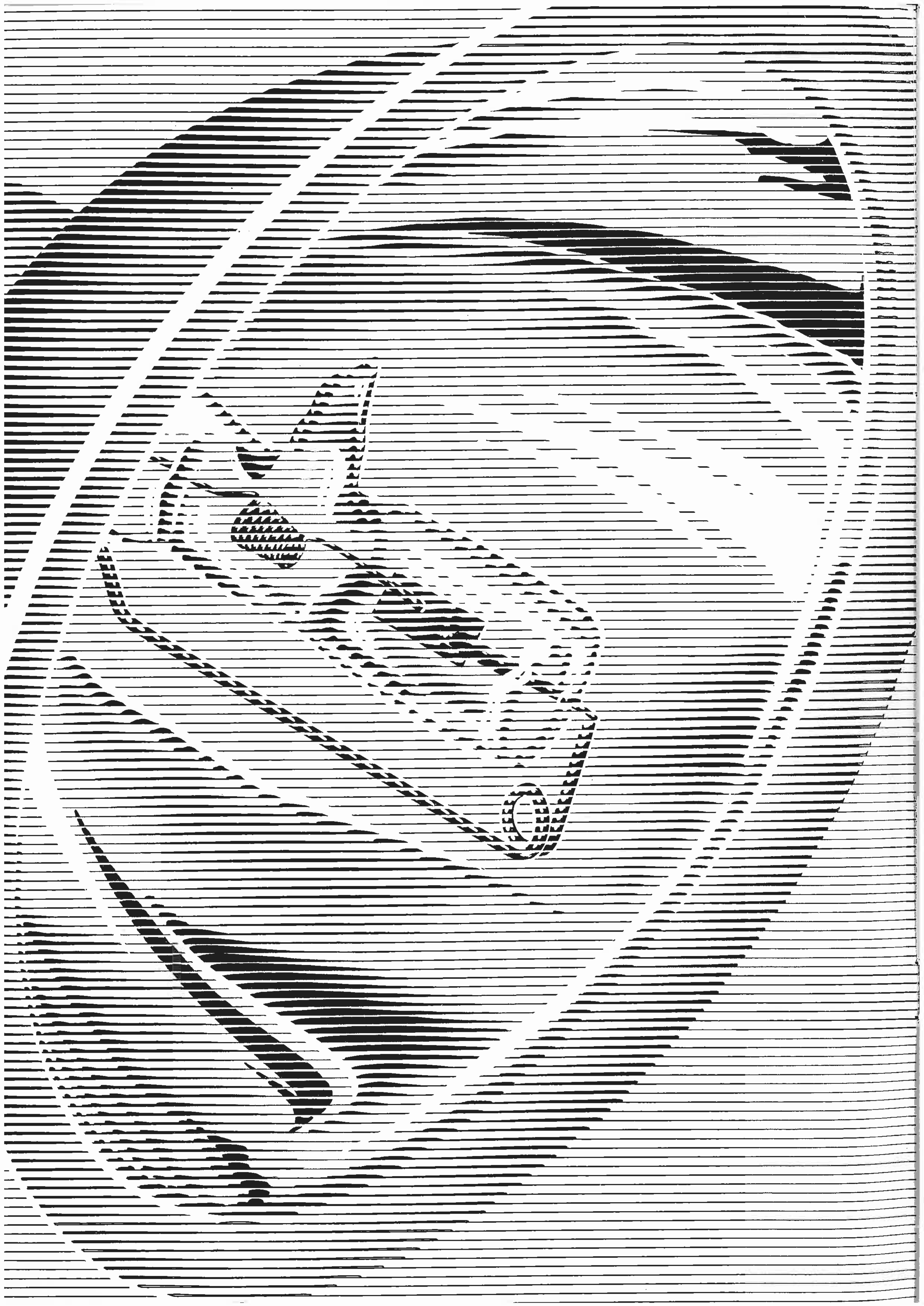

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Cover picture shows the Isora Leaf-lite ceiling in the South of Scotland Electricity Board's grid control centre at Kirkintilloch. Atlas Atlantic fittings are mounted above the ceiling and in the peripheral troffer.

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It is a truism that as soon as a textbook on any technical subject is published it is out of date, largely due to the fact that no one man can hope to be completely au fait with all the developments in his field. This is particularly true of the lighting industry where new lamps are constantly being developed and continually spark off new lighting techniques.

We therefore make no apology for including in this issue of the *Journal* a review of the latest contribution to lighting knowledge. The new edition of Lamps and Lighting edited by Henderson and Marsden contains contributions by 32 experts within the Thorn Lighting organisation. With each chapter written by a specialist, this book is as nearly up to date as it is humanly possible to be.

Mr W R Stevens, the writer of the review, is one of the most distinguished figures in the lighting world, a past president of the Illuminating Engineering Society and current president of the International Commission on Illumination (CIE).

This issue also contains a report on the floodlighting of Coventry Cathedral, a prize-winning scheme by two younger members of the Thorn Lighting staff; and an article describing how a difficult lighting problem was handled by one of the company's senior lighting engineers.

In the near future we are likely to hear a great deal about methods of reducing veiling glare so that the contribution on polarized light by Simons and Bedöcs is timely. Lamp quality testing and developments in tungsten halogen, the subject of other articles, concern us all; while it is hoped that the addition of Italian and Spanish translations to the pages of abstracts will commend the *Journal* to a wider circle of European readers.

profile: W K Lumsden MIllumES

Ken Lumsden came to lighting comparatively late in his career but has more than justified his choice of vocation by becoming an important figure not only in Thorn Lighting but also in the IES and in the international lighting field.

Born in Newcastle upon Tyne in 1928, he was educated at the Royal Grammar School, then evacuated to Penrith in Cumberland. He began work with the Dunlop Rubber Company in Newcastle in 1943. Three years later he was called up, entering the RAF on November 5th; he says he was pleased to note the fireworks which marked the occasion!

After release he worked for a number of companies in clerical capacities, but the interest in electrical engineering aroused by his service experience—he had worked on Meteor aircraft as an electrician—induced him to join Atlas Lighting in 1953. By 1959 he had become Senior Lighting Engineer in the London Lighting Engineering Department and was promoted to Chief Lighting Engineer for the Eastern Region in 1962. He was appointed Chief Lighting Engineer of Atlas Lighting in 1967 and now holds the same post in Thorn Lighting.

In addition to having served on the IES Council and the IES Education Committee, he is secretary of the CIE Committee TC 3-5, Lighting in the Environment, the activities of which were described in the last issue of *Lighting Journal*. He is an examiner for the City and Guilds in illuminating engineering, has lectured to many professional bodies and presented papers to the IES and the First European Lighting Congress in Strasbourg.

He collaborated with Lou Bedöcs to produce the first asymmetric fluorescent fitting and has become associated with the Flow of Light, Designed Appearances and Luminance Design methods of interior lighting. He is at present involved in the application of polarizing materials to lighting fittings and to the development of other methods of reducing direct and reflected glare. His leisure activities are reading and swimming.

dans cette édition

2 PROFIL: W. K. Lumsden, M.Illum.E.S.
Ken Lumsden est venu à l'éclairage relativement tard mais a plus que justifié son choix puisqu'il est devenu une personnalité importante dans l'éclairage, pas seulement chez Thorn Lighting, mais à l'IES et dans le domaine international.
Né à Newcastle upon Tyne en 1928, il fit ses études à la Royal Grammar School et commença à travailler à la Compagnie Dunlop à Newcastle en 1943. En 1946, il fut appelé dans l'armée et entra à la RAF.
Après sa démobilisation, il travailla pour différentes compagnies mais l'intérêt qu'il portait à l'engineering électrique suscité par son expérience militaire—il avait travaillé sur les avions Météors en tant qu'électricien—l'amena à rejoindre Atlas Lighting en 1953. En 1959 il était devenu ingénieur éclairagiste principal pour la zone de Londres et fut nommé Ingénieur Eclairagiste en Chef pour la région de l'Est en 1962. Il devint Ingénieur Eclairagiste en Chef d'Atlas Lighting en 1967 et occupe le même poste à la Thorn Lighting.
En plus de ses activités au Conseil de l'IES et au Comité de l'Education de l'IES, il est le secrétaire du Comité CIE TC 3—5, Eclairage dans l'Environnement, dont les activités ont été décrites dans notre dernier numéro. Il a fait des conférences dans de nombreux organismes professionnels et présenté des documents à l'IES et au Premier Congrès Européen pour l'Eclairage à Strasbourg.

7 CAS D'UN PROJET D'ECLAIRAGE *par* **I. F. McLean, Ingénieur Eclairagiste en Chef du Bureau Régional de l'Est de Thorn Lighting.**
Bien que, dans de nombreux cas, la conception des projets d'éclairage soit d'ordre mécanique, l'ingénieur éclairagiste doit fournir une contribution importante lorsque les constructions imposent des considérations esthétiques et architecturales primordiales. Il est vital qu'il soit consulté très tôt de façon à éviter des décisions qui pourraient compromettre des effets soigneusement calculés.
Dans le cas décrit ci-dessous, l'ingénieur éclairagiste a été impliqué du début à la fin. Cela illustre le genre de problèmes rencontrés dans de tels projets et le procédé qu'il est recommandé de suivre.
La succursale Bishopsgate de la National Westminster Bank dans la Ville de Londres est un édifice de la haute époque Victorienne considéré comme d'un très grand intérêt architectural. L'intérieur est dominé par trois dômes de verre peu profonds laissant passer la lumière naturelle du jour et il possède un plafond en plâtre très travaillé auquel il ne fallait pas toucher. L'éclairage existant consistait en des suspensions à lampes multiples portant des lampes à filament de tungstène dans des diffuseurs opales suspendus aux voûtes et était tout-à-fait inadéquat.
Lors d'une réunion entre l'architecte de la Banque et des ingénieurs, il fut décidé d'utiliser les corniches profondes pour faire de l'éclairage indirect, mais le problème de fournir une lumière suffisante pour le travail restait non résolu.
Trois projets distincts furent realisés énsuite, le premier prévoyant des chemins lumineux continus d'appareils fluorescents montés longitudinalement sur le plafond, le second utilisant des suspensions cylindriques dans lesquelles étaient logées des lampes Kolorlux et le troisième dans lequel un anneau de lampes Kolorlux était installé autour de "l'oeil" de chacun des dômes. Ce projet avait deux avantages majeurs: il était extrêmement discret et du fait que la maintenance du matériel d'éclairage pouvait se faire par le dessus, il était économique.
Le troisième projet fut accepté et l'on décida de la taille et de la puissance des lampes. Des appareils spéciaux conçus pour loger des lampes Kolorlux de 125W dans des réflecteurs VF 200 furent montés pour éclairer par les "hublots" autour de l'oeil de chaque dôme. Un prototype fut réalisé, des tests photométriques permirent de vérifier les calculs de l'ingénieur éclairagiste et une maquette temporaire fut installée et approuvée. L'ingénieur éclairagiste maintint un contrôle étroit sur l'installation, corrigeant les difficultés sur le terrain à mesure qu'elles apparaissaient et finalement livra une installation satisfaisante à l'architecte.

12 CONTROLE STATISTIQUE DES LAMPES ELECTRIQUES *par* **J. R. Scarr, Directeur des Normes, Département Engineering, Thorn Lighting, à Enfield.**
Maintenir la qualité de produits tels que les lampes électriques pose de nombreux problèmes techniques et économiques par suite de la complexité des matériaux et des procédés de fabrication utilisés. Le produit ouvré est réalisé aux Normes Nationales et Internationales tandis que la qualité des composants est déterminée par des spécifications internes.
Bien que la méthode la plus économique de contrôle soit de le faire sur les machines pendant la fabrication, de tels contrôles ne sont pas toujours praticables et, dans certains cas, des défectuosités peuvent se produire après le refroidissement de la lampe; on a donc recours à des contrôles statistiques sur des échantillons choisis au hasard. Pour éviter le risque de choisir les mauvais échantillons, on doit prendre les précautions suivantes:
1) S'assurer que l'inspecteur ne manifeste aucune tendance au parti pris. On doit ramasser les produits au hasard.
2) Evaluer quantitativement le risque et le faire accepter comme raisonnable par toutes les parties concernées.

Lors du contrôle d'échantillons extraits de lots de plusieurs milliers de lampes, un échantillonnage minimum adéquat doit être décidé et un niveau de qualité acceptable admis. Dans de tels cas, on a coutume de diviser les défectuosités en deux catégories: "les défectuosités essentielles" qui nuisent au fonctionnement de la lampe et "les défectuosités minimes" qui, bien que non souhaitées, ne gênent pas le fonctionnement. Si la quantité acceptable de défectuosités par échantillon est dépassée, le lot entier est rejeté et chaque lampe doit faire l'objet d'un examen.

18 CRITIQUE DE LIVRE: Lamps and Lighting (Lampes et Eclairage), S. T. Henderson & A. M. Marsden (Edward Arnold, £5.75 net); *par* **W. R. Stevens, B.Sc., M.I.E.E., F.Illum.E.S. Mr. Stevens est Président de la Commission Internationale d'Eclairage.**
Ce nouveau volume couvre tout le domaine de l'éclairage en 34 chapitres, commençant avec les aspects fondamentaux et se développant sur les lampes, la conception et la fabrication des luminaires, les projets d'éclairage et la discussion, et la description d'un grand nombre d'installations techniques d'éclairage. Excepté un excellent chapitre sur la lumière du jour, il est presque entièrement consacré à l'éclairage et à l'engineering électrique et comprend 602 pages y compris l'index.
Chacun des 34 chapitres est rédigé par un spécialiste dans son domaine et la mise en pages et l'édition d'un tel volume nécessitent un soin et une habileté considérables. Les éditeurs y sont parvenus et, un rédacteur au moins, dont le chapitre avait été presque réduit de moitié, a depuis lors admis que ce raccourcissement avait été une amélioration. De nombreux auteurs, tous membres de l'Organisation Thorn, avaient participé à l'édition originale publiée il y a un peu plus de dix ans, mais à aucun d'entre eux on n'a demandé d'écrire sur le même sujet. Ceci montre clairement la puissance de l'Organisation et aussi le sens commun des auteurs.
Le style est concis et il y a une absence louable de délayage. Le livre, bien qu'il ne soit pas destiné au débutant, est cependant écrit dans un anglais classique, dans un style clair et bref. Le système d'unité S.I. des appareils est utilisé tout le long du livre et les seules concessions faites aux systèmes plus anciens le sont dans le glossaire.
Dans un travail de cette importance, on doit s'attendre à trouver quelques points de critique ou de désaccord, et il y a un ou deux petits points qui demandent à être éclaircis. Par exemple, le terme "Sensibilité relative de l'oeil" est utilisé au lieu de ce qui a été internationalement convenu "Efficacité Lumineuse Spectrale" et il y a ici et là confusion entre un diffuseur "parfait" et "uniforme". Une critique plus sérieuse est que le bibliographie est plutôt courte et qu'il n'y a pas de références. Un développement de ces deux points serait utile dans ce qui est probalement appelé à devenir un livre standard et un travail de référence. On a l'impression générale d'un manuel d'érudition considerablé qui sera de grande valeur pour beaucoud de lecteurs; le seul danger est que, après l'avoir lu, on risquera d'imaginer que l'on sait tout sur l'éclairage.

25 UNE MEILLEURE VISION AVEC LA LUMIERE POLARISEE *par* **R. H. Simons, B.Sc., A.R.C.S., F.Illum.E.S.** *et* **L. Bedocs, M.Illum. E.S. Mr. Simons et Mr. Bedocs travaillent dans le Groupe de Développement d'Eclairage à Enfield dont Mr. Simons est Directeur.**
Il peut être difficile de lire des caractères imprimés sur du papier brillant parce que la lumière réfléchie par la surface peut créer un éblouissement. Une des méthodes qui permette de l'éviter est d'utiliser les propriétés de la lumière polarisée.
La lumière se déplace en ondes qui sont orientées dans des plans perpendiculaires à la direction du déplacement, mais qui sont au hasard les uns par rapport aux autres. Si on peut faire vibrer ces ondes dans des plans parallèles, la lumière est dite polarisée. Quand la lumière est réfléchie par une surface brillante, horizontale et non métallique, une partie de cette lumière est polarisée horizontalement, la lumière qui passe à travers la surface étant partiellement polarisée dans un plan vertical. L'angle sous lequel la polarisation est maximum est appelé angle de Brewster. La proportion d'une lumière polarisée verticalement passant à travers la surface peut être augmentée en y ajoutant plusieurs couches de matériaux translucides.
Les écrans polarisants linéaires ne permettent qu'à la lumière polarisée sous un certain angle de les traverser. Ils sont par conséquent utiles comme verres de soleil mais incommodes pour d'autres usages car ils réduisent la quantité totale de lumière qui atteint l'oeil. Si un polariseur à couches multiples était utilisé à la place d'un diffuseur dans un appareil d'éclairage, une grande partie de la lumière serait polarisée verticalement avant d'atteindre la surface des livres et des papiers situés au-dessous d'elle. Par conséquent, les composants de la lumière réfléchie (polarisée horizontalement) seraient réduits. Le pourcentage de polarisation varie avec l'angle d'élévation, mais la lumière polarisée verticalement est transmise dans toutes les directions en azimuth améliorant ainsi les contrastes visuels.
Blackwell a démontré qu'une augmentation de 1% du contraste peut donner un gain de 15% de performance visuelle et qu'une amélioration de 3 à 4% du contraste peut être visuellement équivalente à une augmentation de 50 à 60% de l'illumination. La basse luminance d'un polariseur vu sous un grand angle permet un meilleur contrôle de l'éblouissement direct que la plupart des diffuseurs prismatiques. La réalisation des projets d'éclairage utilisant des appareils de ce type ne présente pas de difficulté.

in dieser ausgabe

2 KURZBIOGRAPHIE: W. K. Lumsden, M.Illum.E.S.
Ken Lumsden ist relativ spät in seiner Karriere zum Beleuchtungssektor gekommen. Seitdem hat er aber seine Berufswahl mehr als gerechtfertigt und ist eine wichtige Persönlichkeit geworden, nicht nur bei Thorn Lighting, sondern auch bei der IES und auf dem internationalen Beleuchtungsgebiet.
Er ist 1928 in Newcastle upon Tyne geboren und ging auf der Royal Grammar School zur Schule. In 1943 fing er bei der Dunlop Rubber Company zu arbeiten. Er wurde 1946 eingezogen und ging zur RAF.
Nach seiner Entlassung arbeitete er für einige Firmen als Angestellter, aber sein Interesse an der Elektrotechnik, aufgeweckt während seiner Dienstzeit—er hat als Elektriker mit Meteor-Flugzeugen gearbeitet—bewegte ihn 1953 bei Atlas Lighting anzufangen. 1959 wurde er schon Hauptbeleuchtungstechniker bei dem Londoner LED (Lighting Engineering Department) und er wurde 1962 zum Chefbeleuchtungstechniker für den Osten befördert. Er wurde 1967 Chefbeleuchtungstechniker bei Atlas Lighting und hat auch denselben Posten bei Thorn Lighting.
Neben seiner Tätigkeit im IES Council und im CIE Bildungsausschuss ist er Sekretar des CIE-Ausschusses TC 3–5, 'Beleuchtung in der Umwelt', dessen Tätigkeit in unserer letzten Nummer beschrieben worden ist.
Er ist Prüfer für Beleuchtungstechnik bei den City and Guilds und hat Voträge gehalten vor vielen Kongressen. Er hat auch Beiträge vor der IES und dem Ersten Europäischen Beleuchtungskongress in Strassburg geliefert.

7 ENTWICKLUNG EINES BELEUCHTUNGS-SYSTEMS *von* **I. F. McLean, Leiter der Abteilung für Beleuchtungstechnik, Eastern Regional Office, Thorn Lighting.**
Obgleich die Planung eines Beleuchtungssystems in vielen Fällen mechanisch ist, spielt der Beleuchtungstechniker eine wichtige Rolle in Gebäuden, wo Architektur und Ästhetik ausschlaggebend sind. In solchen Fällen muss der Beleuchtungstechniker sehr früh zum Rate gezogen werden, um zu vermeiden, dass Entscheidungen getroffen werden, die einen sorgfältig geplanten Effekt zerstören könnten.
In dem unten beschriebenen Falle war der Beleuchtungstechniker vom Anfang an dabei. Hier sieht man, was für Probleme in solchen Projekten vorkommen und das Verfahren, das normalerweise anzuwenden wäre.
Die Bishopsgate-Zweigestelle der Londoner National Westminster Bank ist ein hochviktorianisches Gebäude vom grossen baukünstlerischen Interesse. Innen ist das Gebäude von drei gläsernen Gewölben beherrscht, die das Tageslicht durchscheinen lassen, und die mit sehr viel Stuck versehene Decke durfte nicht beschädigt werden. Der Raum wurde von den Gewölben hängenden Hängelampen mit mehreren in Opal-Lichtstreuungskörpern eingebauten Wolframfadenlampen beleuchtet, und diese Beleuchtung war sehr ungenügend.
Unter Beratung mit den Architekten und Technikern von der Bank hat man sich entschlossen, die Vertiefungen im Stuck für die indirekte Beleuchtung zu gebrauchen, aber das Problem einer ausreichenden Arbeitsbeleuchtung war noch nicht gelöst.
Drei verschiedene Systeme wurden vorgeschlagen. Das erste wäre ununterbrochene Reihen von Fluoreszenzarmaturen an der Decke entlang. Das zweite wäre grosse zylindrische Hängelampen mit eingebauten Kolorlux-Lampen. Die dritte vorgeschlagene Lösung wäre ums 'Auge' der Gewölben herum angebrachte Ringe von Kolorlux-Lampen. Die letzte Lösung hat zwei grosse Vorteile. Das System wäre sehr unauffällig und der Wartungsaufwand wäre auch gering, weil es möglich wäre, die Anlage von oben herab zu unterhalten.
Es wurde fürs dritte System entschieden und die Grösse und Stärke der Lampen wurden festgesetzt. Besondere Beleuchtungsarmaturen, für 125W Kolorlux-Lampen in VF 200 Reflektoren geeignet, wurden eingebaut, um durch die Beleuchtungsfenster ums 'Auge' jedes Gewölbes durchzuleuchten. Ein Prototyp wurde gebaut und photometrisch geprüft, um die Richtigkeit der Berechnungen der Beleuchtungstechniker nachzuprüfen. Ein Versuchsmodell wurde dann montiert und es erwies sich als zulässig. Der Beleuchtungstechniker hat die Anlage streng kontrolliert und hat alle Schwierigkeiten an Ort und Stelle beseitigt, sobald sie vorkamen. Am Ende wurde dem Architekten ein gut geeignetes System überreicht.

12 STATISTISCHES PRÜFEN VON ELEKTRISCHEN LAMPEN *von* **J. R. Scarr, Manager, Standards Engineering Department, Thorn Lighting, Enfield**
Das Aufrechterhalten der Qualität von Produkten wie elektrischen Lampen verursacht viele technische und wirtschaftliche Probleme wegen der Vielfältigkeit der Materialien und Herstellungsverfahren. Das Endprodukt wird nach nationalen und internationalen Normen hergestellt, aber die Einzelteile werden nach hausinternen Normen angefertigt.
Obgleich die billigsten Prüfmethoden die sind, die an den Maschinen während der Herstellungsverfahren ausgeführt werden können, ist dies nicht immer möglich. Und in manchen Fällen kommen Fehler vor nur nach Abkühlung der Lampen. Deswegen wird man dazu geführt, ein statistisches Prüfen von Stichproben auszuführen. Um zu vermeiden, dass die falschen Proben genommen werden, müssen folgende Massnahmen beachtet werden:
1) Die Proben werden wahllos genommen, um Vorurteile des Prüfers auszuschalten.
2) Der Parameter für die Defekte muss quantitativ eingeschätzt werden, und alle Beteiligten müssen übereinstimmen, dass dieser annehmbar ist.

Beim Prüfen von Probelampen, die von Mengen von mehreren Tausenden kommen, müssen eine annehmbare Probenmenge und eine annehmbare Qualitätsabweichung (acceptable quality level—AQL) festgesetzt werden. In solchen Fällen wird zwischen zwei Sorten von Fehlern unterschieden, einmal 'wichtige' Fehler, einmal 'kleinere' Fehler. 'Wichtige' Fehler sind die, die die Leistung der Lampen beeinträchtigen, und 'kleinere' Fehler sind die, die zwar unerwünscht sind, die aber die Leistung der Lampen nicht vermindern. Wird die annehmbare Zahl von Fehlern in der Probenmenge überschritten, dann wird die gesamte Serie abgewiesen und jede Lampe wird einzeln geprüft.

18 BUCHBESPRECHUNG: Lamps and Lighting, S. T. Henderson & A. M. Marsden (Edward Arnold, £5.75 net); *von* **W. R. Stevens, B.Sc., M.I.E.E., F. Illum.E.S. Mr. Stevens ist Vorsitzender der Commission Internationale d'Eclairage.**
Dieses neue Band behandelt den ganzen Beleuchtungsektor innerhalb von 34 Kapiteln. Es fängt mit Grundsätzen an und geht dann durch Lampen, die Planung und Herstellung von Beleuchtungssystemen und Beleuchtungstechnik. Darauf folgen Beschreibungen von verschiedenen Beleuchtungsverfahren und Beleuchtungsanlagen. Ausgenommen ein sehr gutes Kapitel über Tageslicht werden fast ausschliesslich elektrische Beleuchtung und Beleuchtungstechnik besprochen. Das Buch hat 602 Seiten samt Register.
Jedes der 34 Kapitel ist von einem Fachmann auf seinem Gebiet geschrieben und die Zusammensetzung und Redaktion eines solchen Bandes erfordert viel Mühe und Erfahrung. Dies ist den Herausgebern gelungen und mindestens einer von den Autoren, dessen Kapitel um die Hälfte gekürzt worden ist, hat seitdem zugegeben, dass sein Beitrag dadurch besser geworden ist.
Viele von den Autoren, die alle Mitarbeiter der Firma Thorn sind, haben Beiträge für die Originalausgabe, die vor etwas mehr als 10 Jahren erschien, geliefert, aber keiner wurde diesmal gebeten, dasselbe Thema nochmals zu bearbeiten. Hier sieht man die Stärke der Firma und auch die Vernunft der Autoren.
Im ganzen hat man den Eindruck, es handle sich hier um ein sehr vollständiges Nachschlagewerk, das vielen Lesern von Nutzen sein wird. Die einzige Gefahr wäre vielleicht, dass man das Buch lesen könnte und dann sehr leicht Den Eindruck bekommen, er wüsste absolut alles über die Beleuchtungstechnik.

25 BESSER SEHEN DURCH POLARISIERTES LICHT *von* **R. H. Simons, B.Sc., A.R.C.S., F.Illum.E.S.,** *und* **L. Bedocs, M.Illum.E.S. Mr. Simons und Mr. Bedocs sind in Enfield in der Arbeitsgruppe fur Beleuchtungsentwicklung tätig. Mr. Simons ist Leiter dieser Gruppe.**
Es kann schwierig sein, das was auf Glanzpapier gedruckt wird, zu lesen, und zwar weil das von der Seite reflektierte Licht zu einem blendenden Glanz werden kann. Durch die Anwendung der Eigenschaften vom polarisierten Licht kann dieses Problem beherrscht werden.
Lichtwellen bewegen sich in Ebenen, die eine rechtwinkelige Orientierung in Verhältnis zur Bewegungsrichtung des Lichts haben, die aber keine bestimmte Orientierung zueinander haben. Wenn diese Wellen in Parallelebenen vibrieren, dann wird das Licht als 'polarisiert' bezeichnet. Licht, das von einer glänzenden, horizontalen Nichtmetallfläche reflektiert wird, wird teilweise horizontal polarisiert und das Licht, das durch diese Fläche kommt, wird teilweise vertikal polarisiert. Den Polarisationswinkel, der die meiste Polarisation ergibt, nennt man den Brewsterwinkel. Der Anteil des vertikal polarisierten Lichtes, das durch die Fläche kommt, kann vergrössert werden, wenn diese Fläche um mehrere Schichten halbdurchsichtigen Materials dicker wird.
Linearpolarisationsscheiben lassen nur die Lichtwellen durch, die einen bestimmten Polarisationswinkel haben. Sie sind deswegen für Sonnenbrillen gut geeignet. Sie sind aber nicht so gut fur andere Zwecke, weil das Licht, das bis zum Auge kommt, vermindert wird. Mit einem Mehrschichtenpolarisator anstatt eines Lichtstreuungskörpers in einer Beleuchtungsarmatur wäre ein erheblicher Anteil des Lichtes schon vertikal polarisiert, bevor es die horizontalen Oberflächen der unten liegenden Bücher und Papiere trifft. Aus diesem Grunde wäre dann der Anteil reflektierten (horizontal polarisierten) Lichtes vermindert. Der Grad der Polarisation variiert und hängt von dem Erhöhungswinkel ab, aber vertikal polarisiertes Licht ist durch den ganzen Azimutbogen vorhanden, und dies verbessert den Kontrast und erleichtert die visuelle Arbeit.
Blackwell hat gezeigt, dass eine Kontrasterhöherung von 1% die visuelle Leistungsfähigkeit um 15% steigern kann und dass eine Erhöhung von 3 bis 4% den visuellen Wert einer Bleuchtungssteigerung von 50 bis 60% haben kann. Von höheren Gesichtswinkeln gesehen ermöglicht der niedrige Glanz einer Schichtenpolarisators eine bessere Beherrschung des direkten Glanzes als die meisten prismatischen Methoden. Was die Planung von Systemen und Anlagen anbetrifft, entstehen keine Schwierigkeiten mit solchen Armaturen.

en esta edición

2 PERFIL BIOGRAFICO: W. K. Lumsden, M.Illum.E.S.

Ken Lumsden se incorporó al campo de la iluminación en fecha relativamente avanzada de su carrera profesional, pero ha justificado sobradamente su elección vocacional y se ha convertido en una importante figure no sólo en Thorn Lighting sino también en IES (Illumination Engineering Society) así como en el campo internacional de la iluminación. Nacido en Newcastle upon Tyne en 1928, se educó en la Royal Grammar School, y comenzó a trabajar con la Dunlop Rubber Company, en Newcastle, en 1943. En 1946 fue llamado a quintas e ingresó en la RAF.
Una vez licenciado trabajó para varias empresas en tareas administrativas, pero la experiencia conseguida durante el tiempo que estuvo en filas dentro del campo de la ingeniería eléctrica—trabajó como electricista en aviones Meteors—le convencieron para su ingreso en Atlas Lighting en 1953. Para 1959 se había convertido en el Primer Ingeniero de Iluminación de la LED (Lighting Engineering Department) de Londres y posteriormente fue ascendido a Ingeniero Jefe de la Región Oriental en 1962. Más tarde fue nombrado Ingeniero Jefe de Iluminación en 1967, y actualmente ocupa el mismo cargo en Thorn Lighting.
Además de haber prestado sus servicios en el Consejo de la IES así como en la Comisión de Educación de la IES, es secretario de la Comisión CIE TC 3–5, que se ocupa de Iluminación en el Medio Ambiente, sobre cuyas actividades informamos en nuestro último número. Forma parte del tribunal de exámenes de Ingeniería e Iluminación de "City and Guilds", ha dado conferencias ante muchos organismos profesionales y ha presentado ponencias ante la IES y ante el Primer Congreso Europeo de Iluminación celebrado en Estrasburgo.

7 HISTORIA DE UN PROYECTO DE ILUMINACION *por* **I. F. McLean, Jefe del Departamento de Ingeniería de Iluminación, Oficina Regional Oriental, Thorn Lighting.**

Aunque en muchos casos el diseño de los proyectos de iluminación es mecánico, el ingeniero de iluminación tiene una aportación vital que realizar en los edificios en que las consideraciones arquitectónicas y estéticas son de gran importancia. Es vital que se le consulte en cada fase temprana para evitar que se tomen decisiones que puedan dar a traste con un efecto considerado cuidadosamente.
En el caso histórico descrito a continuación el ingeniero de iluminación tomó parte activa desde el principio al final. Ilustra acerca de la mayoría de problemas con que se tropieza en tales proyectos así como el procedimiento más probable a seguir.
La sucursal de Bishopsgate que el National Westminster Bank tiene en la City londinense es un elevado edificio de estilo victoriano declarado de notable interés arquitectónico. En el interior tienen lugar destacado tres cúpulas planas de cristal que permiten el paso de luz natural y un techo de escayola muy elaborado que no podían ser perturbados. La iluminación existente consistía de lámparas colgantes del techo con varias luces con filamento de tungsteno y difusores de ópalo suspendidas de las cúpulas y era completamente inadecuada.
En una reunión celebrada a pie de obra con el arquitecto y los ingenieros del Banco se decidió hacer uso de cornisas profundas para la iluminación indirecta, pero continuaba existiendo el problema de disponer de suficiente luz para trabajar.
Se presentaron tres proyectos alternativos, uno de ellos formado por una serie contínua de accesorios fluorescentes montados longitudinalmente sobre el techo, otro utilizando grandes lámparas colgantes con lámparas Kolorlux, y el tercero conforme con el cual un anillo de lámparas Kolorlux se dispondría alrededor del "ojo" de cada cúpula. Este proyecto tenía dos ventajas principales, era sumamente discreto y como sería posible realizar el entretenimiento del equipo de iluminación podría realizarse desde arriba, resultaría económico.
Se aceptó el tercer proyecto y se decidió el tamaño y potencia de las lámparas. Los accesorios especiales diseñados para alojar las lámparas Kolorlux de 125W en reflectores VF 200 debían ser montadas para brillar a través de portillas de luz alrededor de cada una de las cúpulas. Se construyó un prototipo y se realizaron pruebas fortométricas para comprobar los cálculos de los ingenieros de iluminación, se instáló y aprobó una maqueta temporal. El Ingeniero de Iluminación mantuvo un estrecho control sobre la instalación, corrigiendo las dificultades a pie de obra conforme se presentaban, y finalmente hizo entrega al arquitecto de una instalación satisfactoria.

12 PRUEBAS ESTADISTICAS DE LAS LAMPARAS ELECTRICAS *por* **J. R. Scarr, Gerente, Departamento de Normas de Ingeniería, Thorn Lighting, en Enfield.**

El mantenimiento de la calidad de productos tales como las lámparas eléctricas presenta muchos problemas técnicos y económicos a causa de la complejidad de los materiales y de los procesos de fabricación utilizados. El producto terminado se hace conforme a las Normas Nacionales e Internacionales, mientras que las características internas controlarán la calidad de los componentes.
Aunque el método más económico de realizar la prueba es el realizado en las máquinas durante la fabricación, tales pruebas no son siempre posibles y en algunos casos pueden producirse fallos después de haberse enfriado la lámpara; por consiguiente se recurre a las pruebas estadísticas, eligiéndose las muestras al azar. Debido al peligro que supone la elección de la muestras inadecuadas, deben observarse las siguientes precauciones:

1) Para evitar cualquier tendencia a la parcialidad por parte del inspector las muestras son elegidas al azar.
2) El riesgo deberá ser evaluado cuantitativamente y aceptado como razonable por todas las partes interesadas.

Cuando se toman muestras de lámparas para pruebas a partir de varios miles de lámparas deberá decidirse un número mínimo adecuado de muestras y llegarse a un acuerdo en torno al nivel de calidad aceptable (AQL). En tales casos es costumbre dividir las faltas en dos categorías, "faltas vitales" que impiden el funcionamiento de la lámpara y "faltas secundarias" que aunque no son deseables no impiden el empleo de la lámpara. Si se supera el número de faltas permitible por muestra, toda la serie es rechazada y es necesario inspeccionar cada lámpara.

18 REVISTA DE LIBROS: Lamps and Lighting (Lámparas e Iluminación), S. T. Henderson & A. M. Marsden (Edward Arnold £5,75 neto); *por* **W. R. Stevens, B.Sc., M.I.E.E., F.Illum.ES. Mr. Stevens es Presidente de la Comision Internacional de Iluminación.**

Este nuevo volúmen cubre todo el campo de la iluminación en 34 capítulos, comenzando con los fundamentos y pasando por las lámparas, el diseño y fabricación de luminarias, para llegar al diseño de la iluminación y comentar y describir una variedad de téchnicas de iluminación e instalaciones. Excepto en el caso de un excelente capítulo dedicado a la luz del día, esta prácticamente dedicado a la iluminación e ingeniería eléctrica y tiene 602 páginas, entre las que se incluye el índice.
En cada uno de los 34 capítulos se cuenta con la aportación de un especialista en ese campo y el montaje y publicación de un libro de estas características requiere mucho cuidado y pericia. Los editores han triunfado en esta tarea y por lo menos uno de los colaboradores cuyo capítulo fue reducido a la mitad del original ha confesado desde entonces que la condensación del mismo ha constituído una mejora. Muchos de los autores, todos ellos miembros de la organización Thorn, colaboraron en la edición original publicada hace poco más de diez años, pero a ninguno de ellos se le ha pedido que escribiera sobre el mismo tema. Esto refleja con toda claridad la fuerza de la organización y al mismo tiempo el sentido común de los autores.
La impresión general es que se trata de un manual de considerable erudición que ha de ser de valor para muchos lectores; el único peligro consiste en que, espués de haberlo leído, resultará fácil imaginarse que uno sabe ya todo cuanto hay que saber acerca de la iluminación.

25 MEJOR VISION CON ILUMINACION POLARIZADA *por* **R. H. Simons, B.Sc., A.R.C.S., F.Illum.E.S.** *y* **L. Bedocs, M.Illum.E.S. Mr. Simons y Mr. Bedocs trabajan en el Grupo de Desarrolle de Iluminación en Enfield, del cual Mr. Simons es gerente.**

Puede resultar difícil la lectura de textos en papeles satinados porque la luz reflejada de la superficie puede crear un velo deslumbrador. Un método de controlar esto es mediante el uso de las propiedades de la luz polarizada.
La luz viaja en ondas que se orientan en planos que forman ángulos rectos con la dirección del viaje, pero de forma casual entre sí. Si se consigue que vibren en planos paralelos entonces se dice que la luz está polarizada. Cuando la luz se refleja desde una superficie horizontal brillante y no metálica, parte de la misma queda polarizada horizontalmente, mientras que la luz que pasa a través de la superficie queda parcialmente polarizada en un plano vertical. El ángulo en que se produce la mayor polarización se conoce como ángulo Brewster. La proporción de luz verticalmente polarizada que pasa a través de la superficie puede aumentar añadiendo varias capas de material traslúcido a la misma.
Las pantallas de polarización lineal permiten que pase a través de ellas solamente la luz polarizada en un ángulo. Por consiguiente, resultan útiles como gafas de sol, pero tienen inconvenientes para otros fines, puesto que reducen la cantidad total de luz que llega al ojo. Si se utilizara un polarizador de multiples capas en lugar de un difusor en una guarnición de iluminación, gran parte de la luz quedaría polarizada verticalmente antes de llegar a las superficies horizontales de los libros y papeles situadas debajo de la luz. Por consiguiente, se reduciría la componente de luz reflejada (horizontalmente polarizada). El porcentaje de polarización varía con el ángulo de elevación, se dispone de luz polarizada verticalmente en todas las direcciones de azimutal, mejorando así el contraste de la tarea visual.
Blackwell ha demostrado que un aumento del 1% en contraste puede representar el 15% de beneficio en el rendimiento visual y que una mejora que oscile entre el 3 y el 4% puede equivaler a un aumento de luminosidad que oscile entre el 50 y el 60%. La baja brillantez polarizador dispuesto a elevados ángulos de vista permite mejor control del deslumbramiento directo que la mayoría de los controles directos. El diseño de sistemas de iluminación que emplean accesorios de este tipo no presenta dificultades.

nel questa edizione

2 **PROFILO DI, W. K. LUMSDEN, M. Illum. ES.**
Ken Lumsden cominciò ad occuparsi di illuminazione relativamente tardi nell'arco della sua carriera, ma la sua scelta per questo settore fu più che giustificata. Infatti egli è divenuto una figura di rilievo non solo in seno alla Thorn Lighting, ma anche nell'ambito della IES ed a livello internazionale.
Nato nel 1928 a Newcastle-on-Tyno, Ken Lumsden frequentò i corsi alla Royal Grammar School, quindi a Penrith nel Westmoreland e nel 1943 cominciò a lavorare per la Dunlop Rubber Company a Newcastle. Nel 1946 fu chiamato alle armi ed entrò nella RAF.
Dopo il congedo, lavorò per alcune ditte, ma l'interesse per l'elettrotecnica, suscitato dalla sua esperienza di servizio—aveva lavorato presso la Meteors come elettricista—lo indusse ad inserirsi nella Atlas Lighting nel 1953. Nel 1959 divenne Senior Lighting Engineer per l'area di Londra e nel 1962 fu promosso Ingegnere Capo del settore illuminazione dela Eastern Region. Divenne Ingegnere Capo della Atlas Lighting Ltd. nel 1967 e conserva le stesse mansioni nella Thorn Lighting Ltd.
Oltre ad avere fatto parte dell'IES Council e del Comitato di diffusione dell'IES, è segretario del Comitato CIE TC 3-5, Illuminazione degli ambienti. Ispettore della City e della Associazione Ingegneri Illuminotecnici, ha tenuto conferenze in numerosi settori professionali ed ha presentato studi alla IES ed al Primo Congresso Europeo di Illuminazione di Strasburgo. In collaborazione con Lou Bedöcs, ha prodotto i primi apparecchi flourescenti assimmetrici, associandosi ai metodi di illuminazione per interni "Flow of Light", "Designed Appearance" e "Luminous Design". Attualmente si occupa dell'applicazione dei materiali polarizzati agli apparecchi di illuminazione e dello sviluppo di altri metodi per ridurre l'abbagliamento diretto e riflesso.

7 **STORIA DI UN PROGETTO DI ILLUMINAZIONE, I. F. Mclean, Capo del Dipartimento Elettrotecnica—Ufficio Regionale, Orientale Thorn Lighting Limited.**
Sebbene in molti casi un progetto di illuminazione sia una operazione meccanica, l'ingegnere illuminotecnico svolge un ruolo fondamentale nelle construzioni in cui sono predominanti delle considerazioni di ordine architettonico ed estetico.
E' quindi essenziale che sia consultato fin dai primi stadi, per evitare decisioni che possano compromettere la realizzazione dell'effetto voluto. Nell'esempio descritto oltre, l'ingegnere illuminotecnico è stato inserito nel lavoro dall'inizio alla fine. Esso spiega la specie dei problemi incontrati in questo progetto e la procedura migliore da seguire.
La succursale di Bishopsgate della National Westminster Bank nella City di Londra è un vecchio ed alto edificio Vittoriano, indicato come di preminente interesse architettonico. Il suo interno è dominato da 3 basse cupole di vetro attravarso le quali entra la luce naturale ed ha un soffitto a stucco molto elaborato che non può essere toccato. L'illuminazione preesistente consisteva in lampadari con lampade ad incandescenza in diffusori opalizzati sospesi alle cupole, ed era del tutto inadeguata.
In una riunione con l'architetto della banca e gli ingegneri, fu deciso di avvalersi delle profonde cornici per una illuminazione di tipo indiretto, ma il problema di fornire una luce adatta per lavorare rimaneva insoluto.
Tre soluzioni alternative furono formulate al proposito, una constituita da una linea continua di apparecchi montati longitudinalmente sul soffitto, una che usava pendenti cilindrici sui quali erano montate lampade Kolorlux ed una terza nella quale un anello di lampade Kolorlux avrebbe dovuto essere installato intorno all'-"occhio" di ciascuna cupola.
Questo ultimo schema presentava i maggiori vantaggi, in quanto non danneggiava le caratteristiche dell'-ambiente ed inoltre la manutenzione degli apparecchi d'illuminazione poteva essere effettuata dal basso.
Fu approvato il terzo schema e stabilite quindi la grandezza e la potenza delle lampade. Furono realizzati speciali apparecchi, disegnati per contenere lampade Kolorlux da 125W in riflettori VF 200 e per essere montati in modo da emettere luce attraverso le feritoie che si trovano attorno alla base di ciascuna cupola. Fu costruito un prototipo e realizzati dei test fotometrici per controllare i calcoli degli ingegneri illuminotechnici, ed il modello provvisorio fu installato ed approvato. L'ingegnere illuminotecnico seguì accuratamente l'installazione, corresse difficoltà sorte sul posto e finalmente consegnò all'architetto un'installazione soddisfacente.

12 **PROVE STATISTICHE SU LAMPADE ELETTRICHE, J. R. Scarr, Manager Standards Engineering Dept., Thorn Lighting Ltd., Enfield.**
Mantenere il livello qualitativo dei prodotti come le lampade elettriche implica svariati problemi di ordine tecnico ed economico per la complessità dei materiali ed i processi di lavorazioni che vengono impiegati. Il prodotto finito viene costruito secondo norme standard nazionali ed internazionali, mentre specificazioni interne regolano la qualità dei componenti.
Sebbene il metodo di collaudo più economico sia quello effettuato sulle macchine durante la lavorazione, tuttavia tali prove non sono sempre totalmente realizzabili ed in alcuni casi possono riscontrarsi dei difetti dopo che la lampada si è raffreddata; di conseguenza si fa ricorso a tests statistici su campioni scelti a caso. Per la validità di tale metodo, si devono osservare le seguenti precauzioni:
1) Ad evitare ogni prevenzione da parte dell'ispettore i campioni sono scelti a caso.
2) Il rischio dovrebbe essere quantitativamente valutato e concordato come ragionevole da tutte le parti interessate.
Quando i campioni di lampade vengono estratti da partite di parecchie migliaia di pezzi, deve essere decisa l'entità del campione, il formato minimo e concordato il livello qualitativo desiderato. In tali casi è d'uso dividere i difetti in due categorie: "Difetti vitali" che danneggiano l'uso della lampada e "Difetti minori" che, sebbene indesiderabili, non interferiscono con il suo uso. Se il numero di difetti riscontrato è in eccesso, la intera partita viene respinta ed ogni lampada della stessa deve essere controllata.
Quando si sottopongono a prove le materie prime, campioni di lampade non complete o finite vengono usati per verificare un certo numero di caratteristiche.
Questi tests comprendono prove di elevata temperatura sulla virola e prove di vibrazione per il controllo della resistenza del filamento. Prove fotometriche e di durata vengono inoltre effettuate col metodo del campione ed uno dei principali aspetti di questi tests è costituito da uno stretto controllo della variabilità della durata di vita.
Verificare che un nuovo tipo di lampada corrisponda alle caratteristiche dichiarate, non esaurisce il problema. Infatti occorrono ripetute prove durante la lavorazione ed i metodi statistici di controllo rappresentano il sistema più efficace al riguardo.

18 **RASSEGNA LIBRARIA, Lampade ad illuminazione, S. T. Henderson & A. M. Marsden Edward Arnold. Di W. R. Stevens B.Sc., MIEE, F. Illum. ES. Mr. Stevens è presidente della Commissione Internazionale di Illuminazione.**
Questo nuovo volume, che in 34 capitoli tratta dell'-intero settore dell'illuminazione, inizia con nozioni fondamentali e descrive la gamma delle lampade, il disegno e la costruzione di apparecchi ed impianti di illuminazione, con dissertazioni sulla varietà delle techniche di illuminazione e di installazione. Ad eccezione di un eccellente capitolo sulla luce naturale, l'opera è pressochè completamente dedicata alla illuminazione elettrica ed alla progettazione.
Ognuno dei 34 capitoli è stato redatto da uno specialista del settore e la pubblicazione si contraddistingue per la considerevole competenza con cui la materia viene trattata. Gli editori hanno avuto successo in questo compito, per la collaborazione che i numerosi autori, tutti membri della Thorn, hanno fornito alla edizione originale, pubblicata poco più di dieci anni fa. Lo stile è stringato e si fa apprezzare per la rigorosa assenza di verbosità. Il libro, nonostante non sia diretto a coloro che si accostano per la prima volta alla materia, è scritto in forma piana e concisa. Il sistema di unità di misura usato, è di regola quello standard internazionale e le sole concessioni ai vecchi sistemi britannici sono specificate nelle note.
In un'opera di questa ampiezza il recensore è costretto a trovare alcuni punti di critica o di disaccordo e ci sono uno o due punti che richiedono una chiarificazione. Per esempio il termine "Relative Eye Sensitivity" è usato al posto di quello, usato internazionalmente, "Spectral Luminous Efficiency" e c'è un'occasionale confusione tra diffusore "perfeet" ed "uniform". Una critica può essere rivolta alla bibliografia che è piuttosto breve ed alla mancanza di citazioni. Un ampliamento di entrambe potrebbe essere più utile in un testo destinato a diventare opera basilare e di consultazione. La impressione complessiva è quella di un manuale di considerevole livello che si propone di essere di aiuto a numerosi lettori; il solo pericolo è che, dopo averlo letto, sia facile supporre di sapere tutto quanto c'è da conoscere sull-illuminazione.

25 **VEDERE MEGLIO CON LA LUCE POLARIZZATA, R. H. Simons and L. Bedöcs. Mr. Simons e Mr. Bedöcs lavorano ad Enfield nel Lighting Development Group di cui Mr. Simons è Dirigente.**
Può essere difficile leggere su carta lucida perchè la luce superficie riflessa può creare abbagliamento. Un metodo per diminuirlo è fare uso delle proprietà della luce polarizzata.
La luce si trasmette per mezzo di onde orientate su piani perpendicolari alla sua direzione, a distanze irregolari una dall'altra. Se le onde vengono trasmesse su piani paralleli, la luce si dice polarizzata. Quando la luce è riflessa da una superficie orizzontale lucida non metallica, una parte di essa diventa polarizzata orizzontalmente, mentre la luce che passa attraverso la superficie, è parzialmente polarizzata in un piano verticale. L'angolo in cui si ha la massima polarizzazione si chiama "Angolo di Brewster". La parte di luce polarizzata verticalmente che attraversa la superficie può essere aumentata aggiungendo parecchi strati di materiale trasparente.
Schermi lineari polarizzanti permettono solamente alla luce polarizzata in un certo angolo di passare attraverso di essi. Di conseguenza sono utili come occhiali da sole ma non sono adatti per altri scopi perchè riducono la quantità di luce che raggiunge l'occhio. Se fosse usato un polarizzatore multistratificato anzichè un diffusore in un apparecchio di illuminazione, molta della luce sarebbe polarizzata verticalmente prima di colpire le superfici orizzontali di libri, fogli sottostanti. Di conseguenza, la componente della luce riflessa polarizzata orizzontalmente sarebbe ridotta. La percentuale di polarizzazione varia con l'angolo di inclinazione, ma la luce polarizzata verticalmente è fornita di azimut in tutte le direzioni, aumentando in questo modo il contrasto del compito visivo.
Blackwell ha mostrato che un incremento dell'1% nel contrasto può far guadagnare un 15% nella percezione visiva e che un incremento del 3-4% può essere equivalente dal punto di vista visivo ad un 50-60% di incremento di illuminamento. La bassa luminosità di un polarizzatore visto secondo angoli a forte inclinazione permette un miglior controllo sull' abbagliamento diretto che non molti schermi prismatici. Soluzioni illuminotechniche che usano apparecchi di questo tipo non presentano difficoltà

a lighting case history

by I F Maclean

Many people suppose that the role of the lighting engineer is merely one of planning simple lighting schemes and then passing them on to others to install, he having moved on to the next job. It must be agreed that a percentage of schemes are of such a basic nature that they do not really exercise the engineer's capabilities to the full, but when an enquiry does come along where his powers are fully extended he must often be ready to act in a capacity far beyond the limits of simple lighting calculations.

Lighting is one of the really basic services in any interior and it is vital that its design be considered at a very early stage. The architect and the interior designer will have spent many hours considering the surface finishes, colours, shape and form of the interior, but if they have worked in isolation the lighting designer may completely and unwittingly destroy their carefully planned effects and ruin the aesthetic appeal of the interior through unsuitably chosen or sited lighting units.

The case history described below is one where the lighting engineer was involved at every stage of a major project right to its successful conclusion, and illustrates the engineer's role in the development of the design and, especially, how he was able to meet and overcome obstacles that arose during the period of the project.

The banking hall of the National Westminster Bank in Bishopsgate in the City of London was built in the days when lavish and complicated ceilings were in fashion. It is a superb example of Victorian craftsmanship in both marble and elaborate plasterwork and is now on the preservation list as a building of particular architectural interest.

I F Maclean is a chief Lighting Engineer of Thorn Lighting

The building as it was in 1863. Two more bays have since been added.

Relighting was necessary because of the low level of illumination produced by the tungsten lighting. Special multilamp pendant fittings, with high wattage lamps in acorn shaped opal glass bowls, had been suspended from the centre of each of the three domes that dominate the interior, the average illumination produced being only 200 lux on the counter top.

Minimum standard of 600 lux

An outline brief was issued by the bank's architects and engineers department requiring the lighting to be improved so as to meet their minimum standard of 600 lux, this to be achieved without any alteration to the plaster ceiling or to the walls. In addition, it was laid down that the new installation should not only improve the working illumination but should also serve to reveal the architectural detail of the interior. Any light sources used would have to possess good colour rendering properties and mix satisfactorily with the considerable volume of daylight entering from the domes and side windows.

The first stage in the design procedure was a meeting with the bank's architect and engineers to make a thorough investigation of the site. As with many large institutions, drawings of the building had been carefully preserved over the years and even included the original drawings used by the clerk of works at the time of erection in 1863.

Due to the nature of the elaborate plasterwork, the complicated ceiling shape and the three large glazed domes, it was obvious from the earliest discussions that a conventional installation of surface-mounted fittings could not be used.

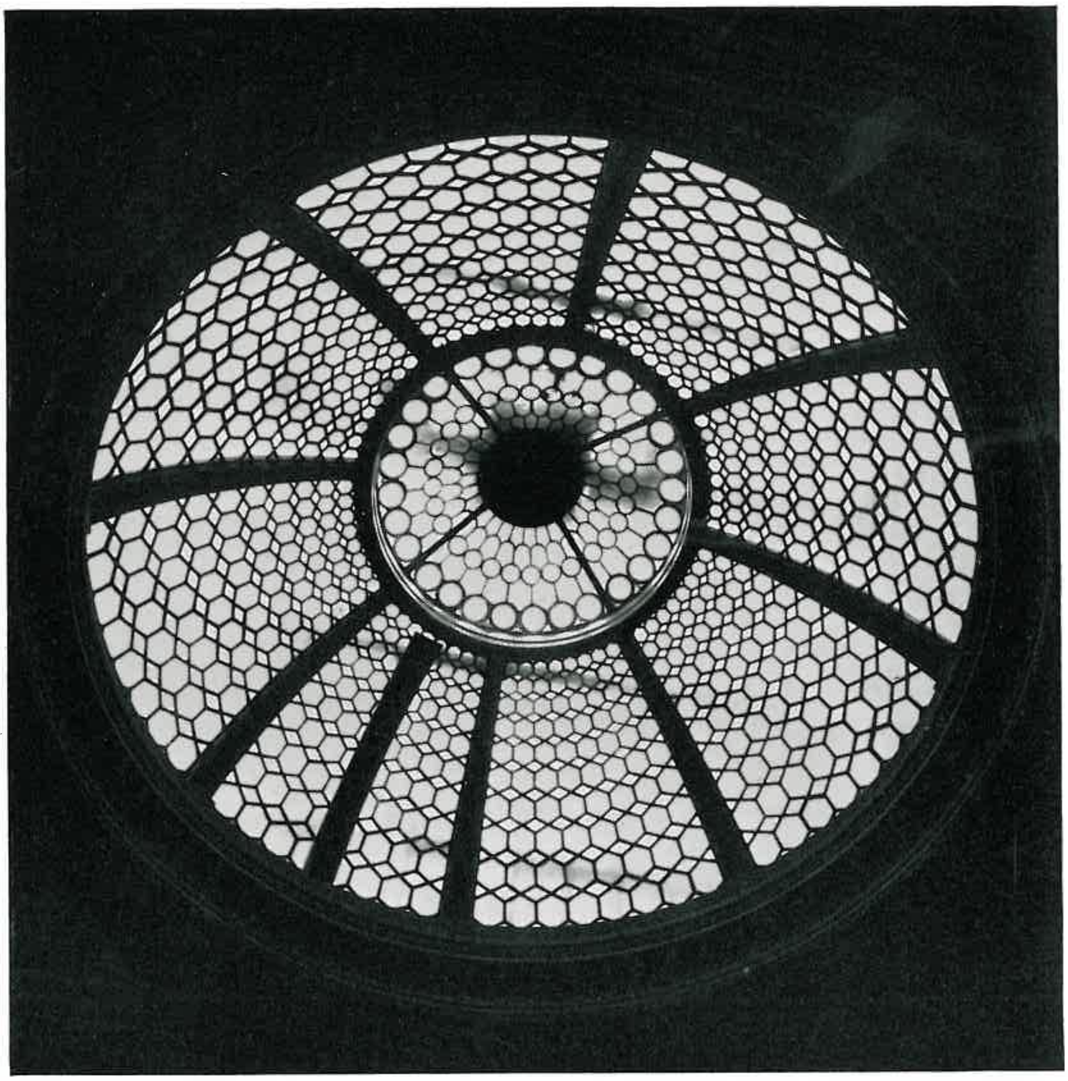
A marked feature of the interior is a flat topped cornice running down both sides of the hall. Small separate cornices cap the pairs of columns at the ends of the room. The addition of a small upstand would be all that was necessary to provide the cut-off for the fluorescent tubes at the normal viewing angles from the banking hall.

Following preliminary calculations it became obvious that the cornices alone could not be used to provide sufficient illumination, due to the restricted number of tubes that could be employed together with the inherently poor utilization of this form of indirect lighting. However, as the lighting of the ceiling was necessary to reveal the detail in the plasterwork, together with the pleasing shape of the ceiling, it was decided to install some cornice lighting for this purpose.

Three alternative schemes considered

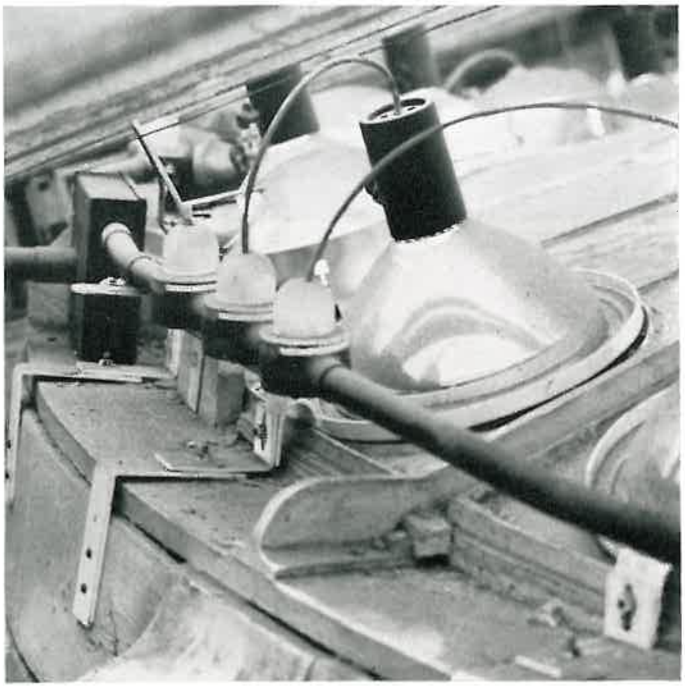
The problem now was to provide the required high level of working light. Again reference was made to the drawings and another long hard look taken at the interior. One possible solution seemed to be to equip the existing fittings with high light-output discharge lamps, although the installation of the associated control gear could lead to considerable problems. The higher light output of the MBF/U lamps and their long life performance had much to commend them, especially as the Kolorlux lamps met the colour requirements. One big problem that the lighting engineer had to take into account before recommending this particular solution, however, was that the higher light output would lead directly to a very considerable increase in fitting luminance. This would, in turn, produce a very glaring installation, especially at the comparatively low mounting height available. It was obvious therefore that this would not be a satisfactory solution.

Three alternative schemes were finally put forward for the consideration of the architect. In the first, the main working light came from two continuous runs of fluorescent lamps in diffusing fittings mounted on the flat part of the ceiling between the coved area above the



A close-up of one of the domes showing the lighting fittings grouped around the central 'eye'.

Fluorescent lamps are mounted on the existing cornices, a metal upstand screening them from view.



The lamps and reflectors mounted above the domes: control gear is housed separately.

The new lighting scheme is inconspicuous and emphasises the architectural features of the banking hall. Compare it with the old pendants which were both obtrusive and inefficient.

cornices and domes. The second involved the use of large cylindrical pendants housing Kolorlux lamps; while the third, which was accepted, consisted of a ring of Kolorlux lamps in reflectors around the 'eye' of each of the domes. This scheme had two major advantages: it was extremely unobtrusive and, since the light must enter from above, had the added advantage that with the removal of the pendants the ceiling would be revealed in its original uncluttered state. Moreover, since lamps could be replaced and reflectors cleaned from above the domes, fittings maintenance was extremely easy.

Reference was made to the architect for details of the structure above the domes and site investigations were instigated. It was immediately apparent that, due to the limited clearance available, the use of high powered lamps would be unsatisfactory and that a larger number of low wattage lamps would have to be installed. A careful examination of the dome revealed that suitable fitting mounting positions were possible. Additionally, space was available for housing the control gear on purpose-made frames, ensuring good heat dissipation and providing ready access for servicing. The next stage was to call for the services of a fittings designer and brief him on the special requirements of the project.

Having worked out the number and wattage of lamps needed to produce the required illumination, the lighting engineer produced a rough sketch from which the designer could work. The suggestion was to mount the 125W MBF lamps in VF 200 reflectors resting on portholes around the 'eye' of each of the domes. There was comfortable headroom for most of these fittings between the top of the domes and the glass coach-house roof above them, but in each dome two lamps occurred at points where structural members necessitated the use of VR 200 fittings in which the lamps are mounted horizontally. Control gear was to be mounted separately. The designer could now produce his drawings and arrange for the production of a prototype fitting. This was passed to Thorn Lighting's photometric laboratory for a technical report. The results of the photometric tests provided the data for the lighting engineer to check that both his scheme and the fittings performance were up to standard.

Visual assessment of sample fittings

The sample fitting was next installed on a temporary basis to enable a visual assessment to be carried out. The client's approval was obtained at this trial and the go-ahead was given for the full installation. Then, after detailed discussions had taken place with the electrical contractor to settle on a suitable installation programme, it was at last possible to submit to the client for the first time a detailed quotation for both the supply of the lighting equipment and for its installation.

Up to that point the lighting engineer had acted as 'ideas man', technical investigator, lighting designer and installation co-ordinator, and it might be thought that his task culminated in the submission of the quotation for the supply of the necessary equipment. However, so far from his task being finished with the acceptance of the quotation, it was his further responsibility to see that his design was installed as he wished and that any snags which arose during installation were satisfactorily sorted out. As is usual, he made a final check of the installation before handing over to his customer.

As can be seen from this typical case study, the lighting engineer must establish a close liaison with the architect initially and all other interested parties subsequently to ensure that the architect's original thoughts are fully understood and correctly interpreted. It is only by such deep involvement by the engineer that the full integration of the lighting services in any interior can be achieved.

statistical testing of lamps

by J R Scarr

It has been said that the basis of success in industry is to produce at the right time, at the right price and to the right quality. Maintaining the right quality of products such as electric lamps poses many problems of a technical and economic nature. Lamps are mass produced in vast quantities and their manufacture involves the use of a great variety of materials and components assembled and processed on highly complex machinery.

The acceptable objective quality of finished lamps is generally laid down in national (such as BSI) or international (IEC) specifications, or in customer specifications. The acceptable quality of materials and components is often dictated by the nature of the production equipment and is formulated in internal specifications.

Since the cost must be passed on to the customer, the economic aspect of lamp testing cannot be too strongly stressed. The most economic form of lamp testing is that carried out automatically on the production units and, where possible, this is applied to every lamp produced. It is particularly important that tests for faults of a potentially dangerous nature should be carried out in this way. For example, probes are used to make a number of electrical tests on all general lighting service incandescent lamps while they are still on the ageing capping machine. These tests detect lamps with crossed lead wires or short circuits between lead wires and cap shell which are potentially dangerous. In addition, they measure the achieved electrical characteristics of each lamp within determined limits to ascertain that the filaments are of the correct rating. Lamps failing any of these tests are automatically rejected from the production unit by an electronic 'brain'.

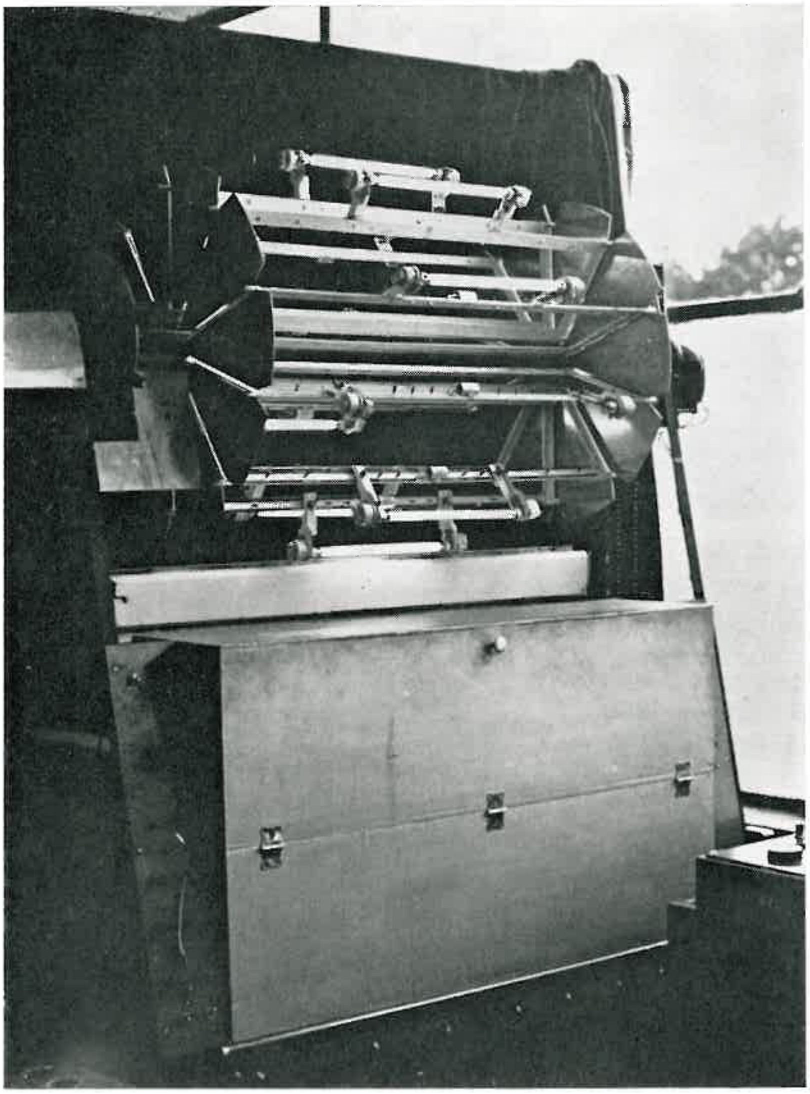
When automatic testing is not practicable

However, in many cases automatic testing is not practicable. Certain lamp faults may occur only after the lamp has cooled and testing of some materials and components may not lend itself to automatic methods without a prohibitive capital outlay on equipment. In these cases it is customary to resort to systems of statistical inspection and quality control. Even in cases where automatic testing is possible, it is often found advisable to back this by small monitoring statistical tests.

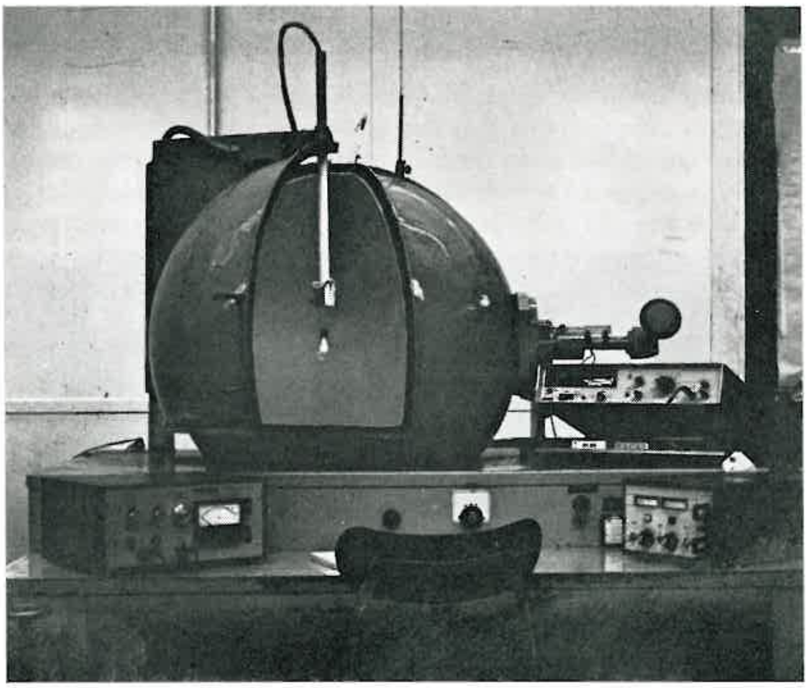
Practical and economic necessity dictate the use of statistical tests in industrial inspection and quality control. Because of the prohibitive costs involved in carrying out inspection or measurement on the whole product or on every individual component used in manufacture, comparatively small samples are selected and, on the basis of tests carried out on these samples, decisions are taken on whether to accept or reject the whole.

It is, of course, a matter of common experience that samples, particularly small samples, do not always reflect the characteristics of the whole and in all statistical testing there is some risk involved. There is a danger that batches of products or components of an acceptable quality may be rejected and that batches which are below standard may be accepted.

J R Scarr is manager of the Standards Engineering Department of Thorn Lighting.



On the left is a prototype of a computerised integrating photometer for fluorescent lamps. Each lamp is run up to a steady value on the rotating drum and is lowered into the photometric integrating chamber below it. Below is an integrating sphere photometer with digitalised devices for testing tungsten filament lamps.



The two main requisites of any sampling scheme are:

1 The samples should be selected in a way that precludes any tendency to bias on the part of the inspector. Generally, this involves ensuring that the samples are picked at random so that all items in the test batch have an equal chance of being selected. The method adopted to achieve this will depend on the size and nature of the batch or products or components being tested.

2 The risk should be quantitatively assessed and agreed as reasonable by all parties concerned.

As an example we may take a single sampling scheme of a simple nature. This method is used for making decisions on the acceptability of batches of certain types of miniature incandescent lamps. In such cases it is customary to divide the faults found in the sample into two categories: (a) Vital faults, i.e. those which impair the performance of the lamp; and (b) Minor faults, i.e. small faults which, while considered undesirable, do not interfere with the proper functioning of the lamp.

It is necessary to establish an agreed acceptable quality level (AQL) for both kinds of fault. We also have to decide what is an adequate minimum number of lamps in a sample to be taken from batches of several thousand lamps and the allowable number of faults which would be acceptable in these samples. If this allowable number is exceeded, the whole batch is rejected and would require 100% inspection—an expensive penalty!

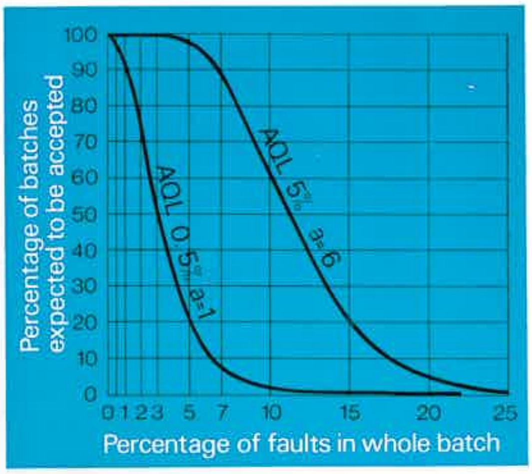


Figure 1

Operating characteristic curves

The risks involved are illustrated in Figure 1 which shows two curves, called Operating Characteristic Curves, corresponding to an AQL of 0.5% for vital faults and of 5.0% for minor faults. The sample size in each case is 60 and the acceptable number of faults for each sample is one and six for vital and minor faults respectively. The curves show the percentage of batches expected to pass the tests for various levels of faulty lamps. It will be noted that, for the appropriate AQL of each curve, the percentage of batches expected to pass is approximately 97.5, i.e. there is a 1 in 40 chance that the batch will be rejected even at the acceptable level.

As the percentage of faults in the batches rises above the acceptable level, the probability of passing the test decreases rapidly. If the incidence of vital faults rises to 2%, one-third of the batches tested would be rejected by this scheme and would require 100% inspection, a state of affairs which could not be allowed to continue for economic reasons. A similar condition would arise if minor faults rose above 9%. It will be seen therefore that this scheme is reasonably simple and economical in operation, and is effective in keeping the general quality at an agreed acceptable level.

Further economic gains in testing can be achieved by the use of

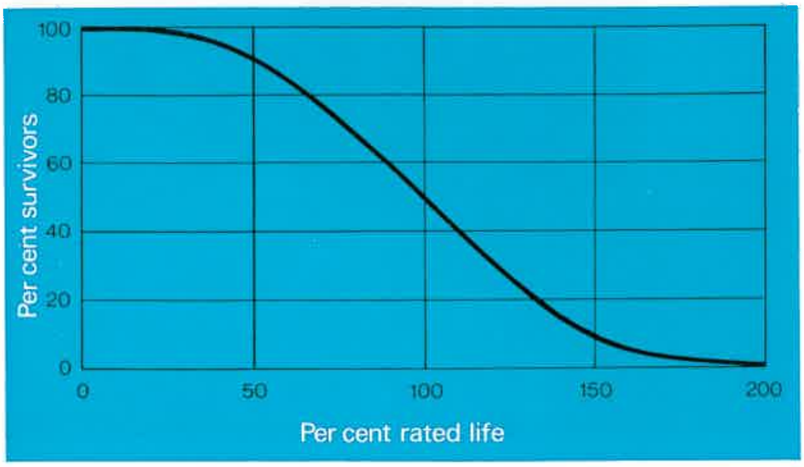
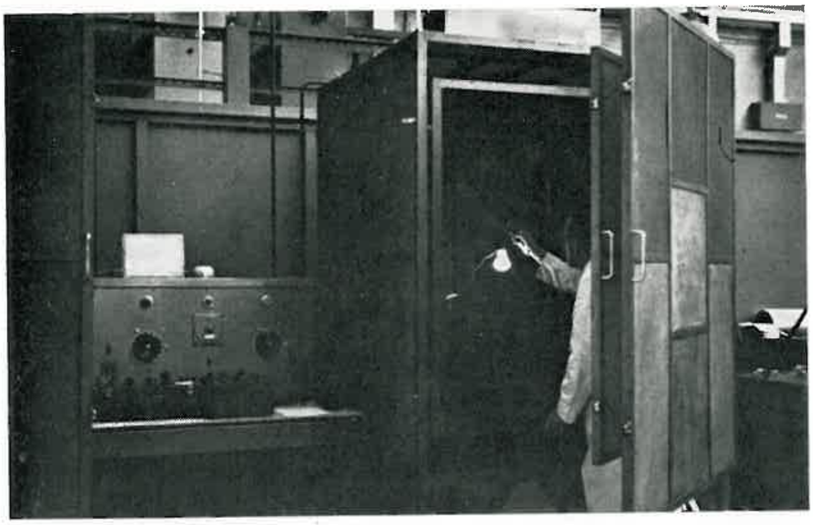


Figure 2



Temperature testing of incandescent lamp caps is carried out in this heat-insulated chamber. On the left may be seen the automatic recording apparatus

double, multiple and sequential sampling schemes which are developments of the single sampling scheme. These methods are widely used throughout lamp manufacturing for testing raw materials, sub-assemblies and finished lamps. A number of lamp characteristics are checked mainly by type tests which, in effect, establish that the lamp design is adequate and a small amount of monitoring is all that is required after design has been completed and accepted.

One example is that of temperature rise of the lamp cap during operation of the lamp. This has assumed increasing importance with the trend to smaller lamp sizes and limitations on this temperature rise are now required in national and international standards. Another example is testing for filament strength; this is particularly applicable to types of lamps which are likely to be subjected to conditions of appreciable vibration or shock in service. Methods of vibration, shock and impact testing have been developed not only for finished lamps but also as tools for establishing design material criteria for lamps under development.

Photometry and life tests are two very important aspects of lamp testing which are carried out on a sampling basis. The integrating sphere with its associated corrected photocell is still fundamental to the measurement of luminous flux but this is now used in conjunction with increasingly sophisticated methods of instrumentation. Controlled digitalized power supplies are used and the required electrical and photometric parameters are read directly on digital voltmeters. Statistical analyses of photometry results are important in control of lamp performance, particularly in respect of consistency and to give early indications of trends. Computers with their ability to deal with complex analyses of a mass of data play an important part in this work.

Lamp life is obviously important from the user's point of view but what may not be quite so obvious is the importance of control of life variability. If the incidence of early life failures is high, lamps which achieve an adequate average life will not generally be found acceptable even though there is a corresponding incidence of lamps with exceptionally long lives. Analysis of life test results is normally summarized in the form of survivor curves, an example of which is given in Figure 2 for some types of discharge lamps. For the purpose of generalization the curve is expressed in terms of rated lamp life and from it can be estimated the potential replacement requirements for any lighting scheme based on this type of lamp.

Checking that a new type of lamp meets the specification is not the end of the story. Constant tests are needed throughout manufacture and statistical methods of testing have proved the most effective method of carrying these out.

recent hospital and other installations

More than 11 000 fluorescent and tungsten lighting fittings and lamps have been supplied by Thorn Lighting for the new University Hospital of Wales and School of Medicine in Cardiff.
Atlas recessed Format modular fluorescent fittings, housing prismatic controllers, are used extensively throughout corridors, lobbies and reception areas.
Each patient has an adjustable bedhead tungsten lighting fitting, while in the out-patients' department the Isora Division of Thorn Lighting has provided a luminous ceiling.
In the medical school's concourse area (*pictured alongside*) Chelsea decorative fittings are combined with spotlights on Atlas Trakline to complement stained glass windows and to emphasize the texture of the stone wall.

Chosen for their excellent colour rendering and high efficacy, Atlas Kolorarc mercury discharge lamps light the gymnasium of the recently opened Bryntirion comprehensive school in Glamorgan. The 400W lamps are mounted in 24 high bay fittings. In the teaching areas 1 400 Popular Pack fluorescent fittings provide a minimum average lighting level of 300 lux; Invincible corrosion-resistant fittings light the swimming pool. The school will accommodate 1 000 pupils with a staff of 67.

The recently completed Stage 2 development of Addenbrooke's Hospital, Cambridge, is lit almost exclusively by fluorescent fittings from Thorn Lighting. Situated on a 40-acre site, the complex incorporates a nine-storey ward block, eight operating theatres, pathology and bio-chemistry laboratories, radiology and radiotherapy departments.

The ward block, providing 422 beds, is lit by Format surface-mounted fluorescents supplemented by custom-designed bedhead units housing 2ft fluorescent lamps.

Invincible fittings are installed in the kitchen and laundry areas while in the physiotherapy department the hydrotherapy pool (*pictured above*) is lit by twin-lamp Atlantic battens which have also been used throughout the main block.

The main reception areas contain an extensive array of shops, a bank, canteens and hairdressing salon, designed to make the hospital virtually self-sufficient. They are lit by Format surface-mounted fittings which are also installed throughout the staff dining room and cafeteria.

THORN LIGHTING'S SWEDISH COMPANY, Svenska Thorn, has contributed to a prestige lighting installation in a hair-dressing salon in Stockholm. The Salon Damfriseringen Har is lit by 13 Atlas fully recessed fluorescent fittings incorporating low-brightness specular louvers.

lamps and lighting

by W R Stevens BSc MIEE FIllumES

W R Stevens is President of the CIE.

The new edition of Lamps and Lighting must be one of the most complete compendiums of the subject now available. It contains 34 chapters, commencing with some of the fundamentals, ranging through lamps, their general description and construction, the design of luminaires and finally discussions and descriptions of a large variety of lighting installations. It contains one short, although excellent chapter on daylight, but, apart from this, is concerned almost entirely with electric lighting and its engineering. It devotes no significant space to that other highly important section of light and vision, namely, aesthetics and associated matters such as decor. In spite of these limitations the volume runs to 602 pages including the index. It is described as the second edition, the first having been published about six years ago, but of course the origins of the book lie in the Atlas Lighting Manual produced a little over ten years ago under the editorship of Harry Hewitt and the late Claude Weston. That relatively unpretentious loose-leaf publication, which was in many ways an extension of the Thorn catalogue of products, has now grown into this excellent book which will serve not only as a work of reference for most lighting engineers but will have valuable use as a text book for the more advanced lighting engineering student.

Orderly array of subjects

To assemble and edit such a volume would at first sight seem to be a relatively simple matter. First, rough out a general synopsis and some chapter headings, gather together 20 or 30 authors of repute, specialists each in his own part of the subject, brief them, gather together the chapters in due course, apply a moderate amount of blue pencilling to reduce the size as desired and this, one might think, was all. In fact, anyone who has attempted such an exercise will know that this apparent simplicity is far from the truth. The great art of producing and editing a book of such a kind is to achieve some uniformity of style, to retain a balance between the various parts, to make the whole run smoothly, and yet to retain something of the individuality of the authors and, most important, not to eliminate their very specialized knowledge. If this is done well the overall volume will have a value greater than the sum of the various parts: if not, it will be a loosely connected collection of chapters each of which may be interesting but will not lead to a smooth, attractive presentation.

In this instance the editors have done their work well. Their first task of laying out the ground to get an orderly array of subjects from fundamentals to application cannot have been easy. Of course, they had the first edition as a guide but many and considerable changes have now been made as a result of experience and of reaction to the first. There is, too, a great deal of new information to be included, particularly in lamps, after six years and one can imagine long and earnest discussion between the two editors and with their chapter writers to decide how best to cover this large ground.

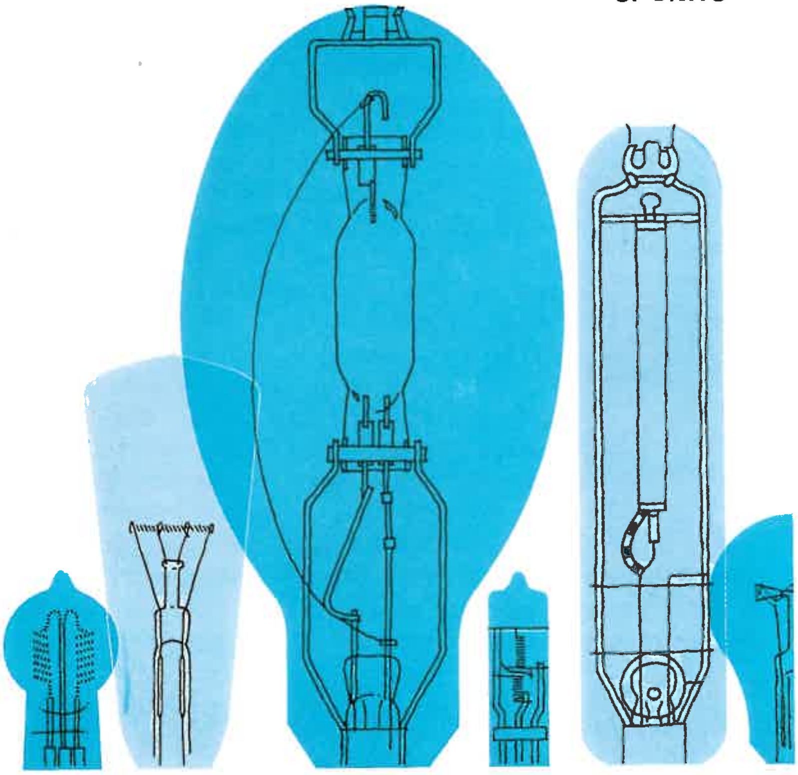
Lamps and Lighting is published by Edward Arnold (£5.75).

LAMPS
AND LIGHTING

GENERAL EDITORS
S.T. HENDERSON & A.M. MARSDEN

SECOND EDITION

SI UNITS



Authors are notoriously difficult to keep in check, particularly when, as is obvious from the names on this list, there are so many who are well recognized as authorities on their subject and who do not naturally take kindly to emendations and corrections by editors however distinguished these may be. One of the authors, indeed, whose name is well known to everybody in the lighting world, confided to me that his chapter had been roughly halved by the editors, a process of which he disapproved greatly until he saw the result and the way in which it fitted into the rest of the volume. Now, being both a modest and an honest man, he is prepared to concede that the changes were for the better.

A commonsense approach

It is interesting to see that many of the authors were authors also for the first edition and, indeed, some of them contributed to that first lighting manual; but none of them has been asked to write on the part of the subject with which he dealt on earlier occasions. This must, of course, reflect something of the strength of the organisation from which the authors have been drawn but even more a commonsense approach on the part of the editors. Lighting is a subject which tends to over-specialization; and it is all too easy to dig in a narrower and narrower area until an expert finally disappears down a chasm of his own making so deep that no one else is interested in reaching its bottom. By being asked to contribute to other parts of the subject, authors are brought back to ground level and persuaded to write in a manner of general interest.
The style adopted throughout is essentially factual. It is evident that

each chapter writer is well familiar with his subject and is not attempting to pad with large areas of essay type contribution. This, however, does not prevent the whole from being essentially readable; the writing is in good straightforward English, clearly and briefly set down. The manual is not aimed at the beginner and a fair standard of basic knowledge is required in order to read it most usefully. Nevertheless the fundamentals are frequently covered in synopsis in such a way as to refresh the memories of those of us who 'did it once' and make us feel less difficulty in following up the more advanced arguments. The SI system of units is used throughout with few exceptions and almost the only concession made to the older British system is the occasional definition in Appendix 2, for example: 'FOOT-CANDLE: Obsolete unit of illuminance, equal to 10.76 lux'. This may not be entirely pleasing to the reader in the USA.

In a work of this magnitude there must be a number of things which any reviewer will find it difficult to agree with or will even find incorrect. For example, one wonders why the $V\lambda$ curve is described as Relative Eye Sensitivity without reference to the internationally agreed name Spectral Luminous Efficiency. The authors' description is perhaps a good one but it is bound to be confusing to the student if he is not at the same time introduced to the term which he will meet frequently in other writings. Again, there seems some confusion (a very common one) between a perfect diffuser which has a 100% reflectivity and a uniform diffuser whose radiance is the same in all directions. Not a vital matter but if the book is to be used as a bible by the student such small faults of clarity can waste his time unnecessarily.

Manual of considerable scholarship

No doubt a good many other detailed quibbles will turn up from time to time as anxious readers write to the authors to demonstrate the thoroughness with which they have read the book. My own major adverse criticism is, I think, that the bibliography is rather short and that there are no references. An expansion in both of these would be valuable if this is to become a standard work of reference and a standard textbook, as it well could. But the overall impression is of a manual of considerable scholarship which will be of value to many readers. It will serve as a work of reference to verify half-remembered facts and to clear doubts and difficulties; it is a book to dip into, to read a chapter or even part of a chapter; it will be a standard textbook for many engineering students. Not its least value will be as a general work of reference to those who specialize in one part of the subject.

Perhaps the greatest difficulty which it may raise arises from the fact that most of its sections are so well prepared and appear to be so complete that it will be easy to believe that, having read and digested it part by part, one will be in complete command of the subject. One must only hope that only the very stupid will imagine that they can learn the whole of lighting economics in eight-and-a-half easy pages, however well written, or that one chapter could possibly deal in all its detail with the interior environment, its perception, its design and the relation between lighting and the many other services. But it is a compliment to the book that this sort of danger may arise: and the danger will be at its greatest for those who believe that engineering is the whole of lighting, a trap that many of us engineers have been prone to fall into.

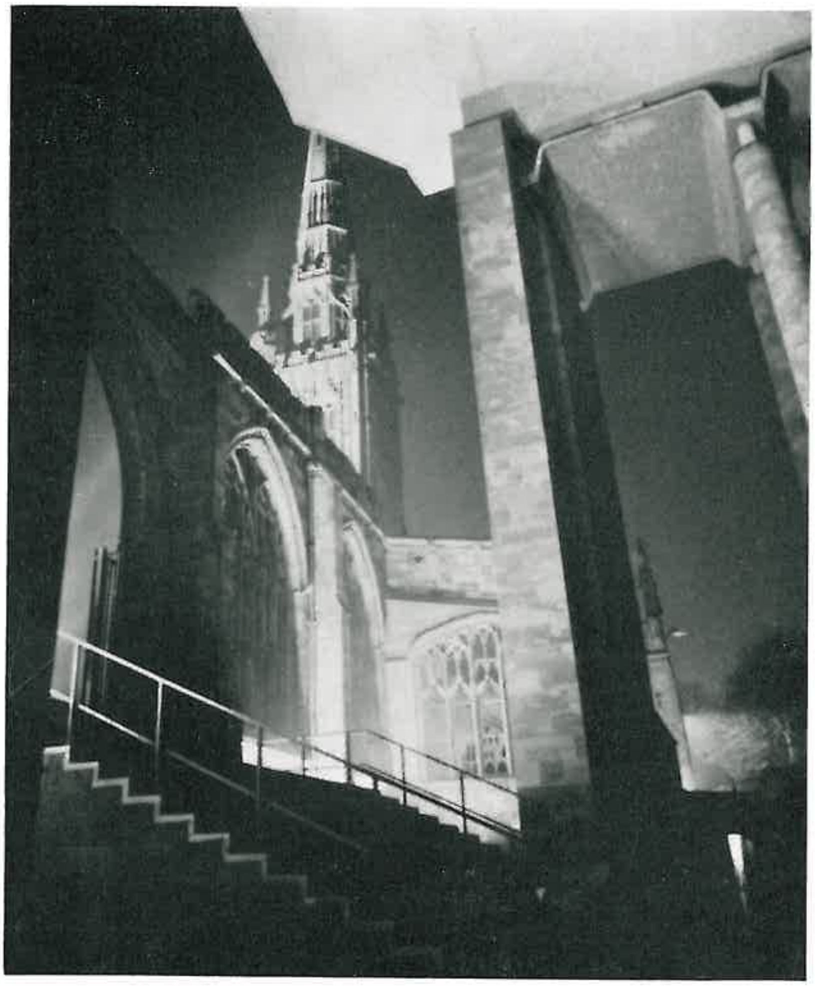
This is an excellent volume, well prepared and well produced, which deserves to stand on our bookshelves not only because it looks impressive but because it will be consulted frequently.

floodlighting at Coventry

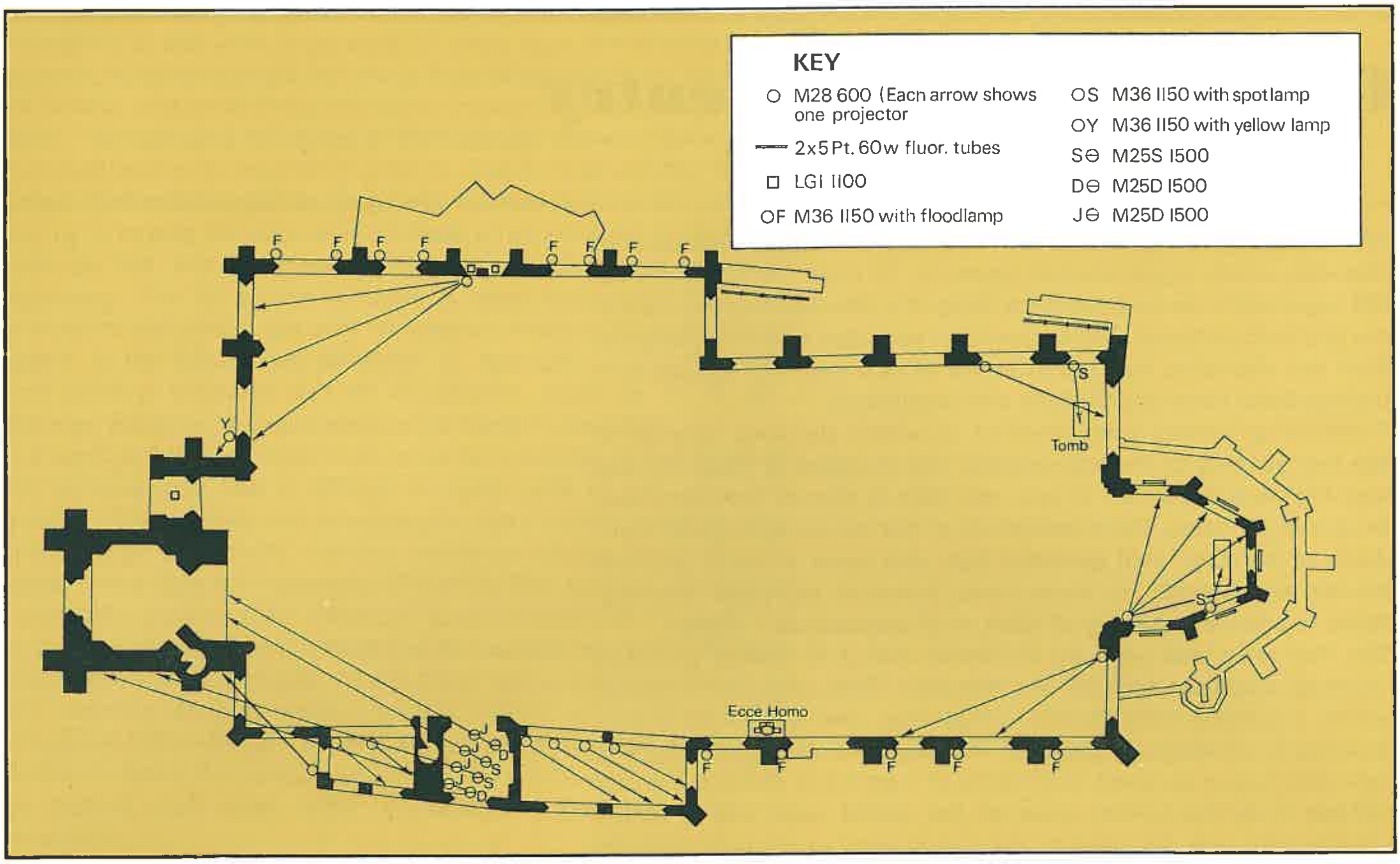
The IES National Conference for 1972 was held in the University of Warwick which is just outside Coventry. To mark the occasion, the IES organized a competition for a design for floodlighting the ruins of the city's old cathedral. The competition was open to young designers from any discipline working in teams of two and was judged by a distinguished panel of architects and consultants.

Twenty-four entries were received of which six were selected at the first meeting of the adjudicators. The standard of these six was very high and there was, in fact, very little to choose between them. In almost all cases, the presentation of the entries was good, standards of drawing were generally high and many entrants provided models and 'visuals'. In some cases, however, elaborate 'dressing' failed to conceal a paucity of ideas or an impracticable design.

The first prize was won by R Forster and J D Walker of Thorn Lighting, and their scheme was installed. They produced a design which combined considerable imagination and sensitivity with a thoroughly professional grasp of the problems of engineering and light distribution involved. Difficulties of installation precluded floodlighting from the central areas of the ruined nave and a further complication was that most of the area is open to the public so that equipment had to be sited to give the minimum of glare and be out of danger from prying fingers. A further difficulty was that the flood-



The porch of the new cathedral is visually linked to the ruins of the old by discreet low-level fluorescent floodlighting.



lighting had to be designed to be seen from inside the circuit of the walls; the height of the window sills made it impossible to see it from outside.

It was decided to use the floodlighting to define the perimeter walls of the ruins, but in order to avoid competion with the adjacent new cathedral the levels of illumination were kept low and no direct light was put on the eastern end of the north wall which gives access to it. Tungsten filament lamps were selected on the grounds that they had the best colour-rendering properties for the warm sandstone of the ancient walls and that their compact size and the lack of the necessity for control gear would facilitate installation. Lamps and equipment were mounted at high level to avoid glare and discourage vandalism, and to render the wiring and equipment inconspicuous.

A particularly attractive feature of the winning design was the use of quite simple standard floodlighting equipment and especially of PAR lamps. Using a large number of small and compact light-sources allowed great flexibility in the play of light upon the walls and the size of the lighting equipment made it inconspicuous in daylight. 'Flow of light' techniques were relied upon rather than the dramatic use of spotlighting and by this means over-emphatic highlights and shadows were avoided. This was especially noticeable on such features as Epstein's 'Ecce Homo', which would not have lent itself to a more dramatic treatment.

Linking the ruins to the entrance porch of the new cathedral was simply effected by floodlighting the façade of the latter by means of fluorescent tubes concealed behind the partially ruined walls. This emphasised the new work by partially silhouetting the old against it, but lighting levels were kept low so that the eye travelled naturally from the old to the new.

Floodlighting the tower and spire were not included in the original brief. In the event, they were floodlighted independently and since

Floodlighting equipment located on the plan above is illustrated on page 24.

Above: Looking back from the South East corner of the ruins emphasises how the warm tones in the stone were brought out by the use of conventional tungsten filament lamps.

Left: Attention is focused on the ruined apse with its altar cross made from partly burned beams retrieved from the ruins.

M28,500 light-duty floodlight taking a 500W GLS lamp.

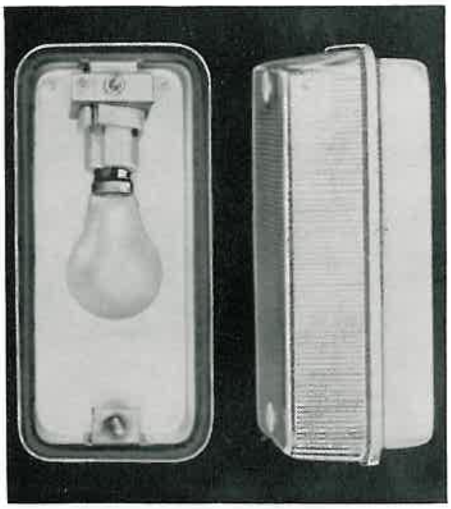
A 150W PAR spot or floodlamp mounted in a M35.1150 miniflood.

An M25S or M25D 1500W floodlight. The suffix S denotes a concentrating reflector, D a diffusing type.

the brightnesses achieved were considerably higher than those obtaining on the rest of the buildings, this to some extent upset the balance of the composition by moving the main emphasis away from the ruined apse and the altar enclosed within it. However, the effect was not noticeable on entering the ruins from under the tower, although it was very marked when one looked back from the entrance to the new cathedral.

The original intention was to allow the vertical illumination on the south east corner of the tower to range from 30–40 lux on the east side and not to exceed 20 lux on the south side. This would have allowed the tower to fade away into the darkness, although projections such as string-courses, gargoyles and window heads and sills would catch the light. The direct illuminance on the chancel walls was designed to be about 70 lux but the window tracery was high-lighted by fluorescent lamps mounted behind them. A peak intensity of over 500 lux was achieved on the altar table, by a 1500W lamp mounted in a concentrating M25S 1500 projector mounted in the entrance of the south east window of the apse. The walls of the side chapels were illuminated only to values of 125–150 lux. As stated above, no direct light was cast on the north wall, but the window tracery and the voussoirs of the arches were outlined by the lighting equipment mounted outside the walls below them.

All installation work was done by the Midland Electricity Board which worked in very close collaboration with the designers of the lighting scheme.



LGI 1100 'Escort' bulkhead fitting to take a 100W GLS lamp.

better seeing with polarized light

by L Bedöcs MIllumES *and* R H Simons BSc ARCS FIllumES

We are all familiar with the difficulty sometimes experienced in reading print on glossy paper. The light reflected off the surface produces a veil of light that reduces the contrast between the print and the paper, as in Figure 1. This effect is known as veiling glare; it is a form of disability glare and it is present to a greater or lesser extent in almost all visual tasks. The purpose of this article is to describe one method of controlling it, namely by making use of the properties of polarized light.

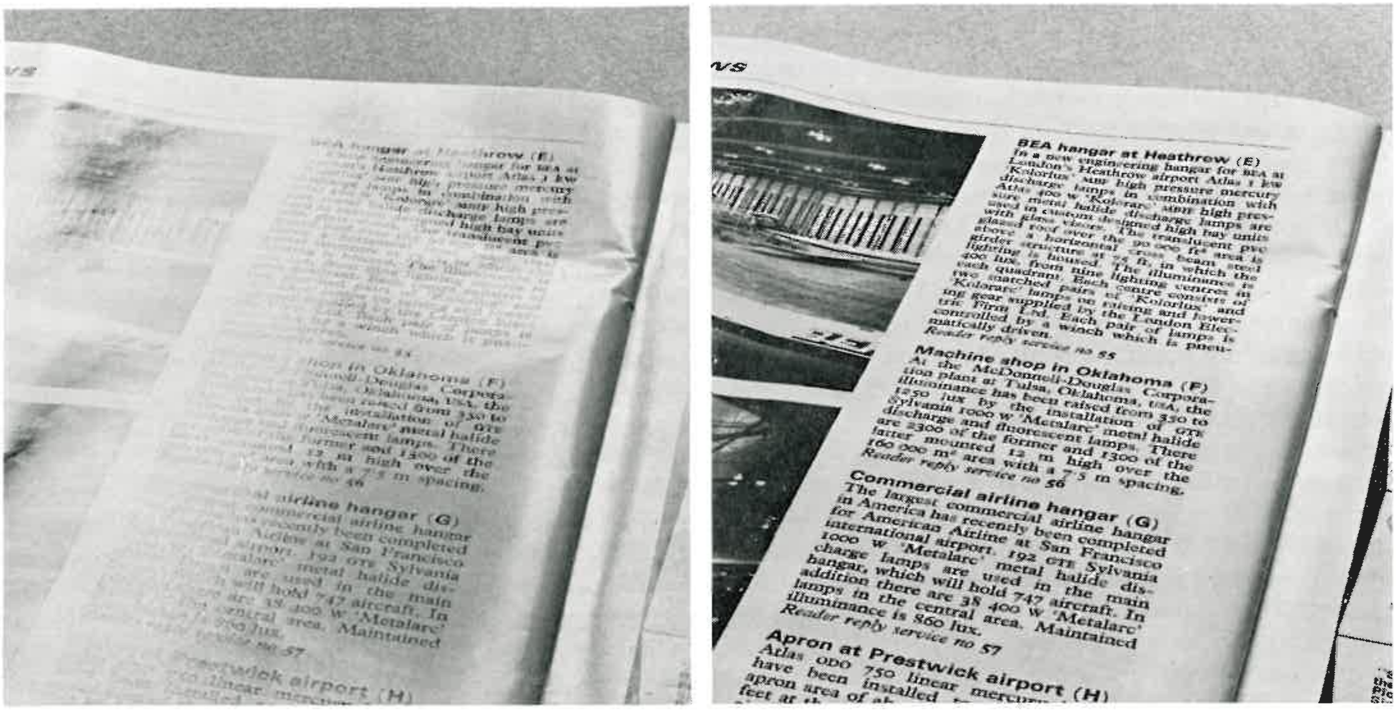
Veiling glare

To obtain a deeper insight into the nature of veiling glare we must consider the ways in which light is reflected. There are two principal modes of reflection: specular and diffuse. In specular reflection an image of the source of light is formed as in a mirror: it is well defined and bright. In diffuse reflection no image is formed and, as the name implies, the light is scattered in all directions so that the surface is less bright. Blotting paper is a good example of a diffuse reflector.

In practice, we tend to find modes of reflection which are a mixture of the two principal kinds, especially with glossy surfaces. Here a small percentage of the light is reflected off the glossy surface, while most of the light penetrates the surface and is then diffusely reflected.

Let us now consider how the specular component reduces the contrast in a visual task. Contrast is measured by the difference in luminance between the background, in this case the paper, and the object of

The authors are members of the staff of the research development of Thorn Lighting. L. Bedöcs is senior engineer responsible for interior lighting development. R H Simons is manager of the lighting development group.



An extreme example of veiling glare is shown on the left *(Fig 1a)*. Removal of the horizontally polarized light completely eliminates it and makes the print clearly visible *(Fig 1b)*.

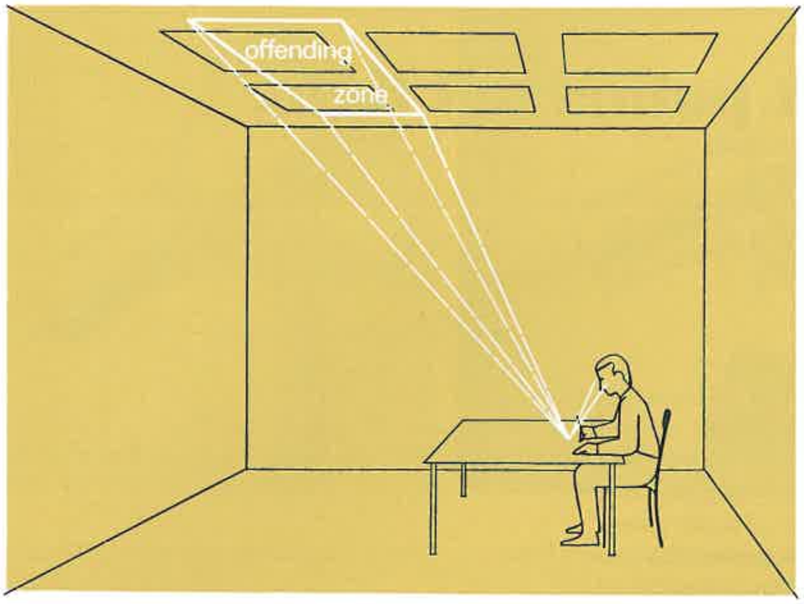


Figure 2 Luminaires in the offending zone producing veiling glare.

regard, the print, divided by the luminance of the background. Veiling reflections are caused by luminaires positioned in the offending zone from which light is reflected into the eye (Figure 2).
These reflections increase the luminance of both the print and the background by the same amount. The difference in luminance between the print and the background will, therefore, remain the same, but as the background luminance will have been increased the contrast will be correspondingly decreased. This reduction of contrast constitutes veiling glare. Veiling glare can also occur in a less obvious way if the paper is matt but the print is shiny, as it very often is when the writing is in pencil. Here the specular reflections make the writing brighter than normal but do not affect the paper itself, once again giving reduced contrast. We can reduce the brightness of these specular reflections by making use of polarized light.

Polarized light

Polarization of light can be explained by considering that light travels in waves. The vibrations that constitute the waves take place at right angles to the direction of travel, that is in planes that pass through the rays of light. If these planes are oriented at random to one another for different rays, the light is said to be unpolarized. However, if they are parallel to one another the light is said to be polarized and we can define the orientation of the polarization by that of the planes. Figure 3 shows light that is horizontally polarized, i.e. the light waves vibrate horizontally, and light that is vertically polarized. Now it is a fact that when light is reflected off a glossy, non-metallic horizontal surface it becomes horizontally polarized to an extent that depends on the angle of incidence. All the reflected light is polarized when its incidence to the normal is at an angle known as Brewster's angle, which is about 58° for most common surfaces, and is less completely polarized at other angles of incidence.
If the surface is transparent the light that passes through it is polarized in the vertical plane (Figure 4) to an extent which once again depends on the angle of incidence. Even at Brewster's angle the proportion of transmitted light that is vertically polarized is small, but there is a dodge by which the proportion can be increased. This is by stacking a number of parallel surfaces one behind the other (Figure 5) and passing the light through the stack.
To sum up, veiling glare is produced by light reflected from glossy surfaces. Some of this light is horizontally polarized, so the brightness of reflections can be reduced by eliminating this, either by filtering it

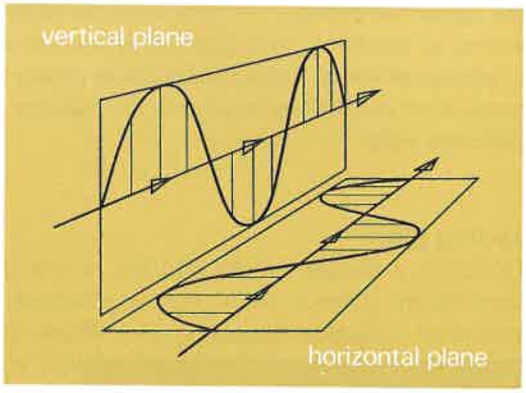


Figure 3 Planes of polarization.

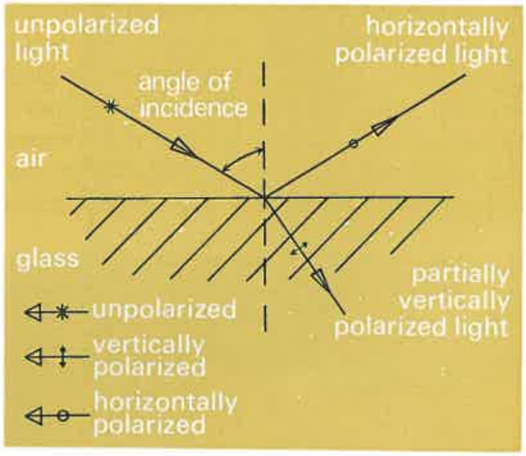


Figure 4 Polarization by reflection at a glass-air surface.

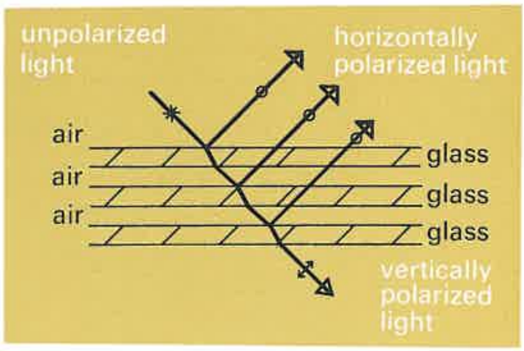


Figure 5 Stack of glass plates as multi-layer polarizer.

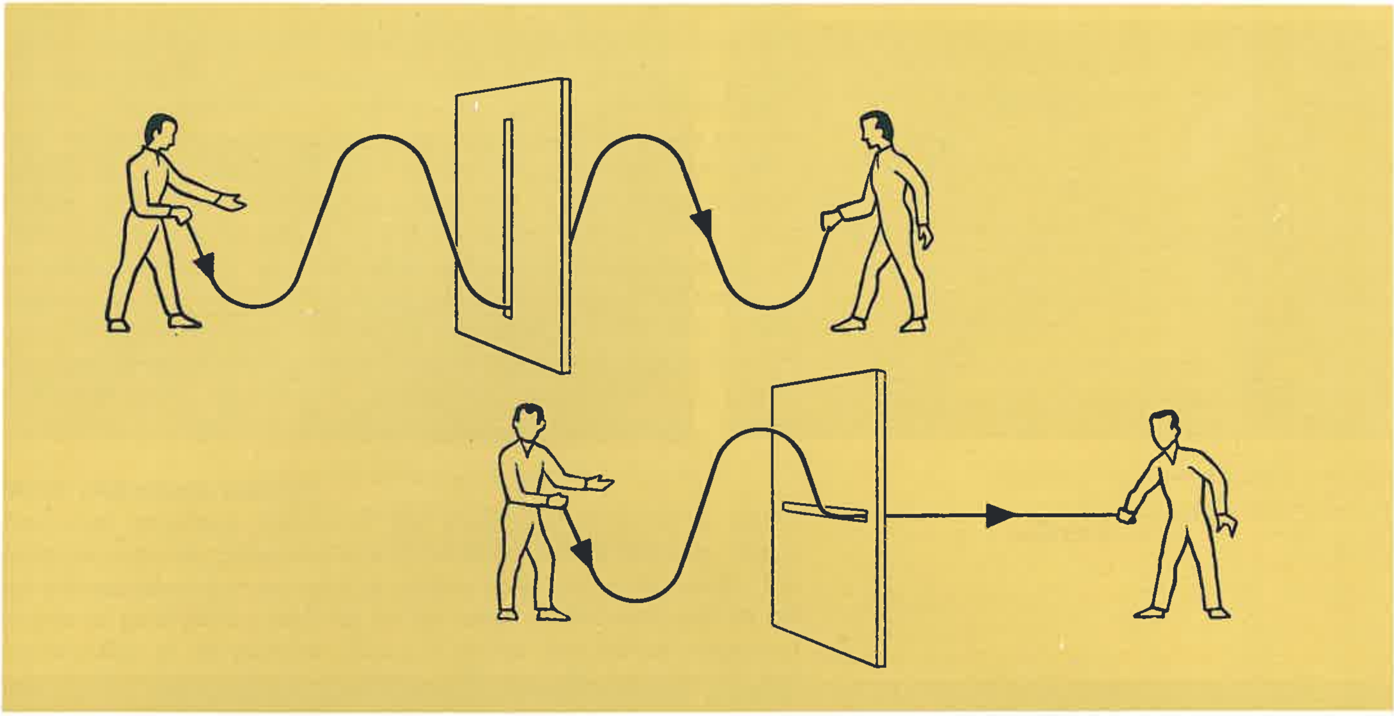


Figure 6 Principle of linear polarizer.

out before it reaches the surface or after it has been reflected from it. The practical methods of achieving this are by the use of linear or multi-layer polarizers.

Linear polarizers

It has been stated that a proportion of the light reflected off the horizontal surface is horizontally polarized. This can be removed by orienting a polarizing screen (sometimes known as a linear polarizer) so that it allows only vertically polarized light to pass through it. An analogy of the way this works is shown in Figure 6. The rope represents vertically polarized light. If the slit in the screen is vertical the waves are transmitted without hindrance, but if it were horizontal they would be stopped. A polarizing screen has an analogous action to the slit.

There are two ways in which a linear polarizer could be used. It could be made up into glasses and worn by the occupants of the room. Such a solution would be inconvenient. Alternatively, it could be made up into an attachment for use on the luminaire, so that the horizontally polarized light is eliminated before it reaches the task. The snag here is that it would work only for one direction of view relative to the orientation of the linear polarizer. A major disadvantage with both alternatives is that linear polarizers transmit less than 50% of the light, so that in most cases the advantage one hoped to gain by reducing veiling glare would be offset by the loss of light. This does not apply outdoors where there is an abundance of light and reducing the brightness of the scene may be an advantage in itself. For this application, linear polarizers are often made up into sunglasses.

Multi-layer polarizers

It was noted earlier that polarized light can be produced by passing unpolarized light through a stack of parallel glass plates. This principle is used in luminaires, but glass would be unwieldly. Instead, the multi-layer polarizer is used and this is made of flakes of a translucent material giving the panel a slightly opal appearance. It is normally less than 0.5 mm thick and forms one of the surfaces of a standard optical controller, which may be of PVC, styrene or acrylic materials in opal or clear prismatic form. When the controllers are

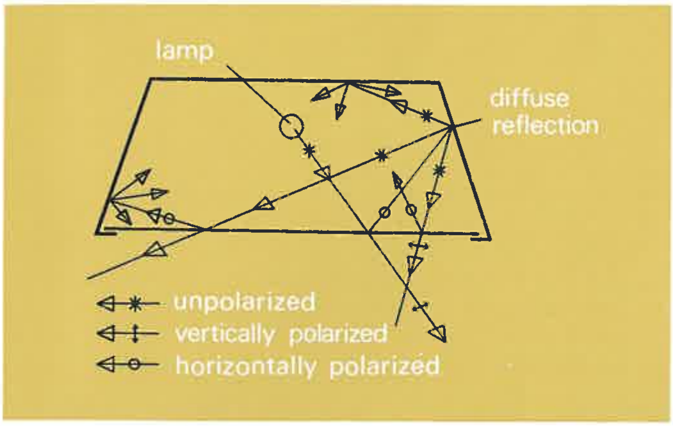


Figure 7 Section through luminaire showing reflux polarization.

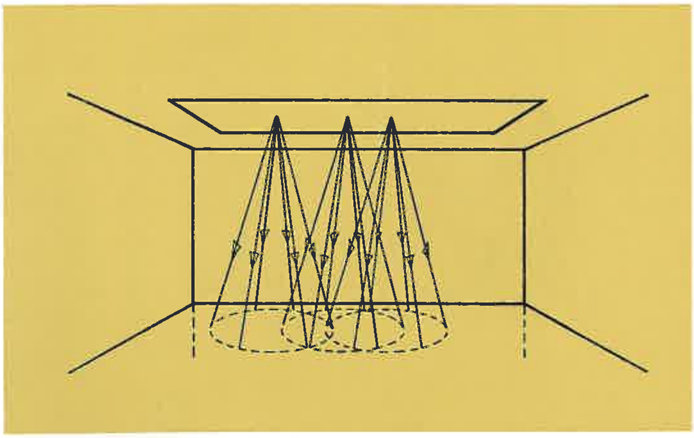


Figure 8 Radial polarization showing overlapping cones to ensure an even coverage of polarized light.

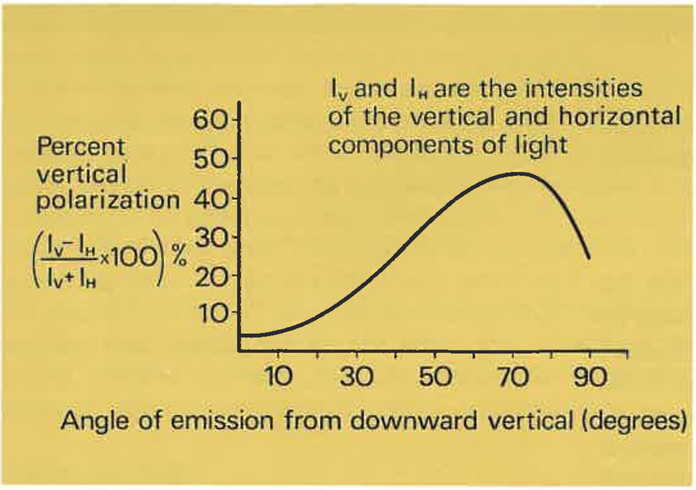


Figure 9 Variation of percentage polarization with angle of emission.

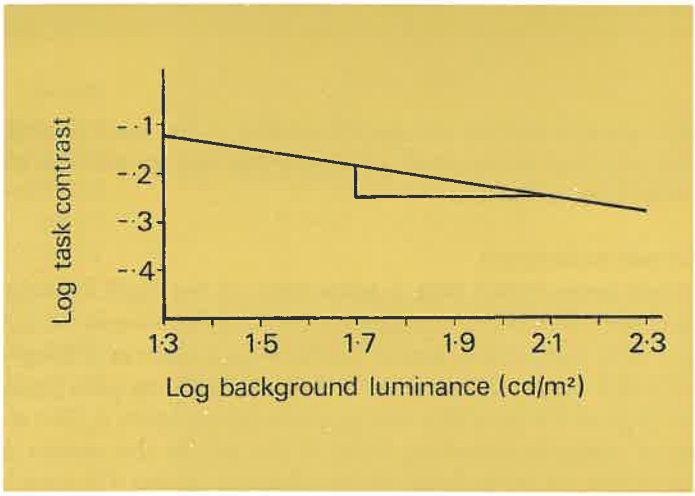


Figure 10 Standard performance curve.

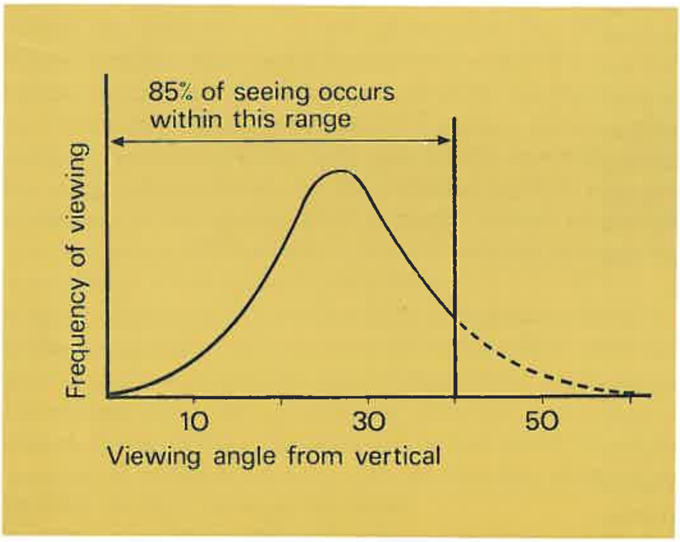


Figure 11 Frequency distribution of viewing angles.

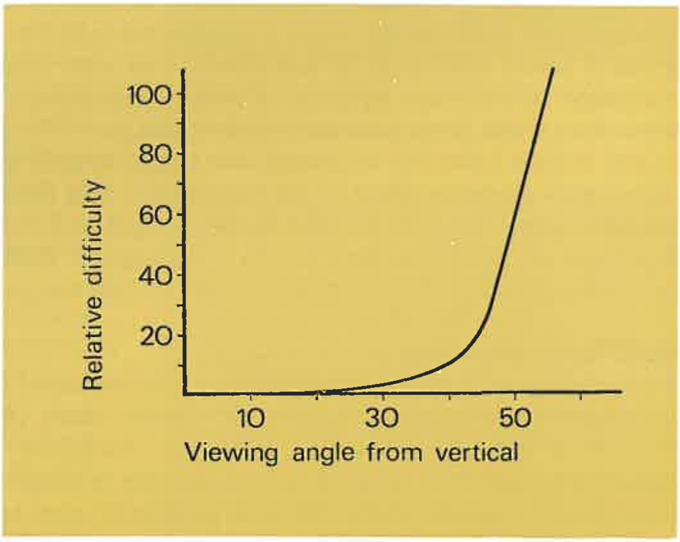


Figure 12 Variation of difficulty of seeing with viewing angle.

installed it is essential that the polarizing layer is always on the outside since to achieve polarization it must be the last material through which the light emerges. By this method of achieving polarization little light is lost as the horizontally polarized light which is reflected back into the luminaire housing will be depolarized by the white painted surface and reflected so that it can pass through the multi-layer sheet. Further reflections, depolarizations, and transmissions produce additional output of polarized light. This process is called reflux polarization (Figure 7) and enables the multi-layer polarizer to produce luminaire efficiencies or light output ratios (LORs) similar to those produced by opal diffusers. In a modular troffer (1.2 × 0.6 m) with two, three or four fluorescent tubes, LORs from 45% to 55% are achieved.

Most important feature

The most important feature of the multi-layer polarizer is that it provides vertically polarized light in all directions of azimuth. This is sometimes referred to as radial or conical polarization (Figure 8). The degree of polarization depends on the angle of emission and on the construction of the polarizer. Figure 9 shows how the percentage of polarization varies with this angle. It can be seen that between 55° and 60° more than 40% of the light is polarized.

As the light from the luminaire is radially polarized it improves the contrast of the task equally in all directions of azimuth, so there is no need to orient the task or luminaire in any particular direction. The improvement in contrast can be significant. Blackwell in the USA has shown in his studies on visual performance that at lighting levels currently used in interiors a 1% increase in contrast gives an improvement in visual performance equivalent to a 15% increase in illuminance (Figure 10). In an installation consisting of multi-layer polarizers the exact amount of improvement will depend on the angle of view. Almost 85% of the viewing angles in offices and schools (Figure 11) lie between 0° and 40° to the downward vertical. At these angles the multi-layer polarizer can produce 3% to 4% improvement in contrast. This gives an improvement in visual performance which would be greater than that obtained from a 45% increase in illuminance. An even greater improvement is obtained at large viewing angles where, owing to veiling glare, seeing is at its most difficult (Figure 12). An additional benefit of multi-layer polarizers is that they control discomfort glare since they have a low brightness at high angles of view compared with opal diffusers.

Design procedure

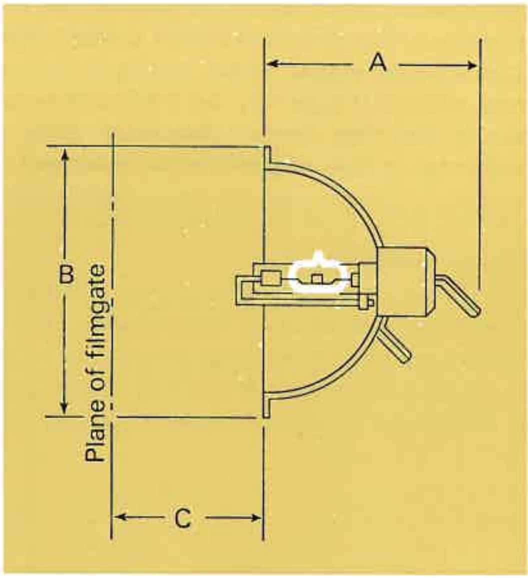
The design procedure for lighting schemes using luminaires with multi-layer polarizers is the same as that used for conventional lighting equipment. Because of the ease of application, their use for the control of veiling and discomfort glare will establish them as one of the standard weapons in the armoury of the lighting engineer.

tungsten halogen projector lamps

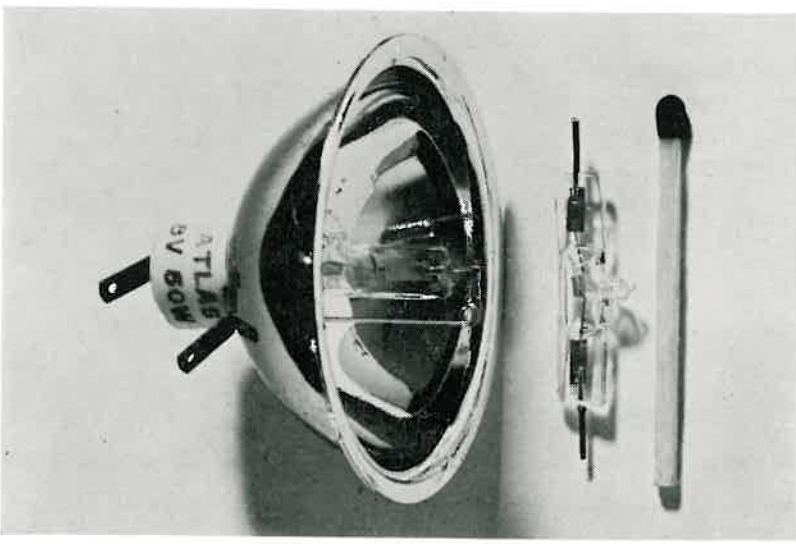
Although it is not the policy of the Journal to devote a regular section to new products, it is felt that recent developments in tungsten-halogen projector lamps merit a short description. Almost all types of cinema, slide and overhead projector now use one or other of the tungsten-halogen range and the advantages of long life and constant maintenance of light-output throughout life which these lamps provide are becoming increasingly apparent.

All the characteristics of the tungsten-halogen principle are combined with the use of krypton in the gas filling of the new Atlas Hi-Lux lamp which has been developed in collaboration with Eumig of Vienna, one of Europe's leading projector manufacturers. Krypton, one of the rare gases of the atmosphere, has a molecular weight of 83.8 as compared with the 39.9 of the argon commonly used in filament lamps, and, by increasing the gas pressure on the filament, still further improves light output without loss of lamp life. Since it must be separated from liquid air by fractional distillation, krypton is very expensive to produce and has been used in the past only in miners' cap lamps where the maximum efficacy is required from a small bulb. The minute size of the Hi-Lux bulb, however, justifies its use. The extra pressure which the gas exerts on the filament allows the latter to be operated at a temperature close to the melting point of tungsten, achieving a very high efficacy and a colour temperature in excess of 3500°K.

The very compact filament of the double-ended lamp is mounted at the focal point of an elipsoidal polished anodised aluminium reflector; thus its light is concentrated in the film gate which is at the second focus of the elipse obviating the need for a condenser lens and reducing the cost of the projector. Up to 30% increase in screen illumination can be achieved compared to that provided by a conventional projector lamp.



The A1/250, Atlas Hi-Lux lamp compared with a matchstick. Between the two can be seen the double-ended tungsten halogen bulb.



A1/250

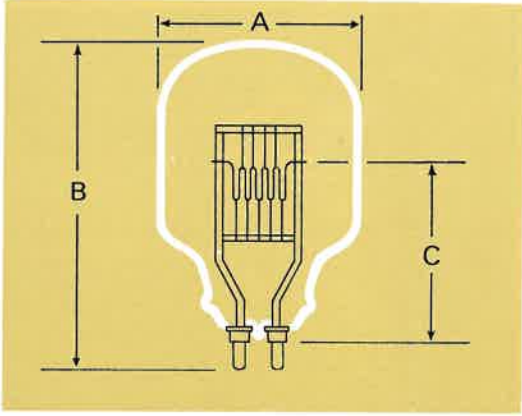
Watts	50	Max A=39mm
Volts	8	Max B=50mm
Cap	Two tab connectors	Nom C=32mm
Life	50 hours	

Tungsten-halogen projector lamps which can be used in apparatus designed for conventional lamps without modification are becoming increasingly familiar. The A1/278 and A1/249, both of which are designed for use in overhead projectors, are rated at 800W and 650W respectively and the latter is designed as a direct replacement for the conventional A1/244. Overhead projectors require extra powerful lamps as they are often required to project a picture on to an unusually large screen in lecture theatres, school halls, etc.
In this connection Thorn Lighting makes a special Halogen Plus range of lamps designed as direct replacements for the large high-wattage lamps used in stage and studio equipment. Since these lamps have much smaller bulbs than the conventional types they are mounted on special bases, with the same caps as the type they replace. The long base brings the filament into the correct focal position in the projector, which does not then require modification. An important advantage of using tungsten-halogen lamps for lighting film studios is that since there is no blackening of the bulb their colour temperature remains constant throughout life. Conventional lamps made for this purpose contain a little powdered tungsten in the bulb, which is used to scour off the tungsten deposited on its surface. This necessitates periodic removal of the lamps from the projectors with consequent labour costs and some risk of damage to the filament which will have been weakened by the changes in its crystaline structure caused by heating.

The CR 13, a conventional theatre spotlamp compared with its more compact tungsten halogen equivalent. Note the metal collar which brings the filament into the correct focal position.

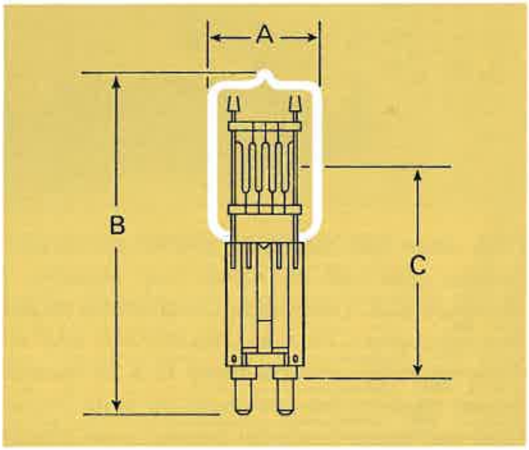
Glass elipsoidal mirrors coated with a dichroic material of the type described in the last issue of the *JOURNAL* are used to reduce the heat at the film gate and to eliminate the condenser lens in two other new projector lamps, the A1/246 and A1/25. The former, a 24V 260W tungsten-halogen lamp is designed for use in 16mm projectors and the latter, the 24V, 200W A1/25, can be used as a direct replacement for the American EJL.

Below can be seen the A1 252 and A1 246 with a Hi-Lux lamp between them. The two outer lamps have dichroic elipsoidal reflectors.



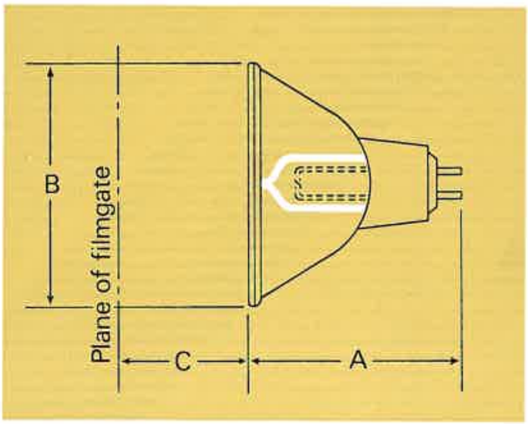
CP13

Watts	5000	Max A=205mm
Volts	115,230,240	Max B=341mm
Cap	Bi-post	Nom C=165±2mm
Life	150 hours	
Lumens	145000/135000	



CP29

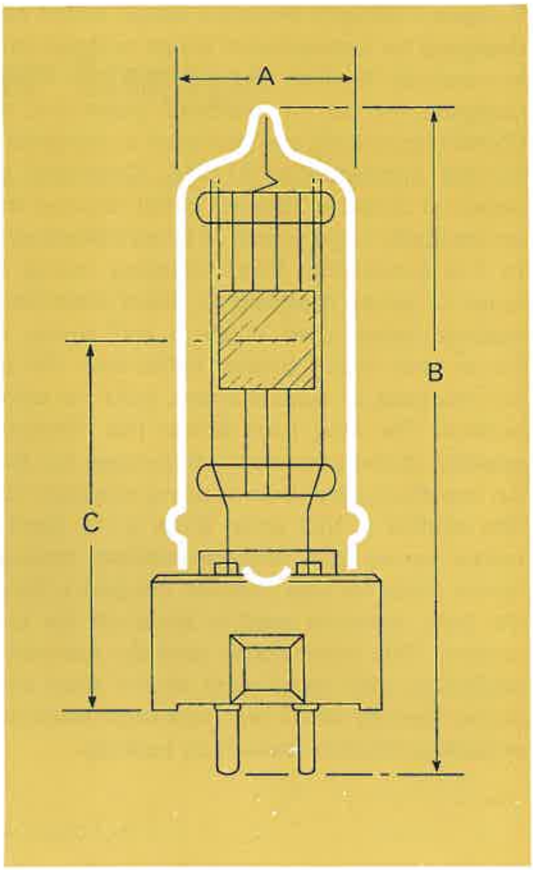
Watts	5000	Max A=75mm
Volts	115, 220, 240	Max B=280mm
Cap	Bi-post	Nom C=165±2mm
Life	300 hours	
Lumens	145000/135000	



A1/252

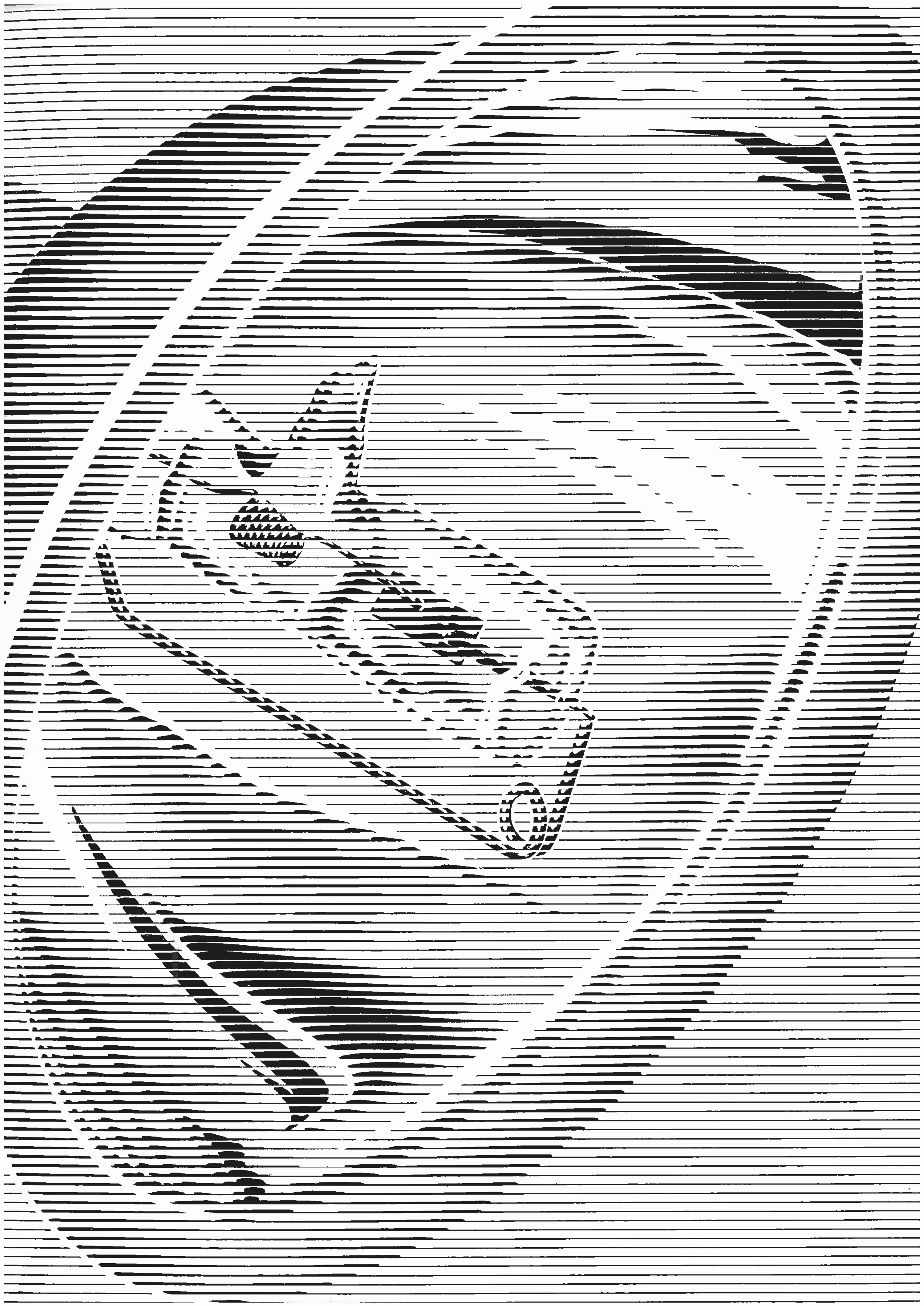
Watts	200	Max A=45mm
Volts	24	Max B=50mm
Cap	G5.6	Nom C=32mm
Life	25 hours	

The other two lamps illustrated are designed for use in slide projectors, the use of which has become widespread not only in Schools and Colleges but to illustrate technical lectures published by manufacturers. They are the A1/245 and A1/247 and both have the internationally standardised G-6.35 two-pin base. The variety of bases used in the past held up lamp improvements to some extent and the move towards international standardisation is both timely and economical.



A1/245

Watts	800	Max A=22.5mm
Volts	220/230, 240	Max B=84mm
Cap	GY 9.5.	Nom C=44.5mm
Life	75 hours	
Lumens	21500	



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