ELECTRIC STREET LIGHTING PROSPECTS

By J. G. CHRISTOPHER, Exterior Lighting Dept., The General Electric Co., Ltd.

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G.E.C.

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Not only in street lighting, but also in almost every other field there is a general air of expectancy that once the manufacturer has redirected his efforts towards peacetime production the consumer will be startled by revolutionary technical and mechanical developments.

Detail improvements there are in plenty, but major changes are conspicuous by their absence. The truth is that the major part of the war effort was of necessity destructive, and with a few notable exceptions, such as Radar, the technical triumphs of the war are not readily adaptable to the everyday needs of peace. The real benefits are likely to be secondary ones in the form of improvements to existing materials and techniques rather than revolutionary changes. This is certainly true of street lighting, and this article has been written particularly for those who are concerned with the planning of street lighting installations and who are wondering whether to go ahead with new schemes as soon as the present fuel economy restrictions are relaxed, or whether to adopt a cautious policy in the hope of new developments.

It is intended, therefore, to survey all the major aspects of street lighting in this article, and it is convenient to consider first the technique and secondly the equipment.

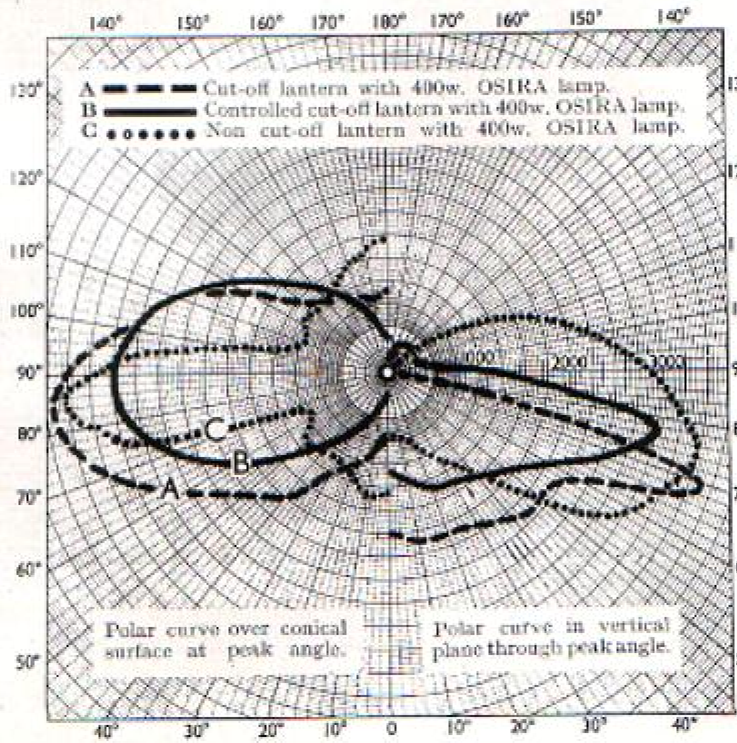
THE TECHNICAL ASPECT

Ignoring for the time being the actual light sources, it is fair to say that there were available in 1939 street lighting lanterns which provided every practicable form of light distribution for main road lighting. The operative word in this sentence is "practicable."

It is not practicable to light roads by night as they are lighted by day, that is to say, by means of a very large source at a very great height. It is equally impracticable to light them from the kerbs or to floodlight them or to contrive ingenious devices whereby the laws of optics are conveniently waived in order to light them from sources invisible to the road user.

It will be remembered that the Ministry of Transport Departmental Committee on Street Lighting produced a Final Report in August, 1937, making certain recommendations for the lighting of traffic routes (Group A) and other roads (Group B). In this report the theory of visibility by the contrast of dark objects against bright road surfaces was accepted, and for traffic routes recommendations as to spacing and mounting height were made which agree very closely with existing practice.

Since the publication of this report a British Standards Specification implementing the recommendations has been eagerly awaited. The portion dealing with traffic route lighting is now in draft form, and it is clear that



Comparison of light distribution from Cutoff, Controlled Cutoff and Non-Cutoff G.E.C. Lanterns.

whilst this goes into considerable detail concerning spacing, mounting height, light distribution and lantern performance, it does so only to the extent of giving *ex post facto* blessing to the good installations of 1939.

No new type of light distribution is called for; indeed, this was scarcely to be expected, since existing equipment varies almost between the extremes of practicability.

TYPES OF LIGHT DISTRIBUTION

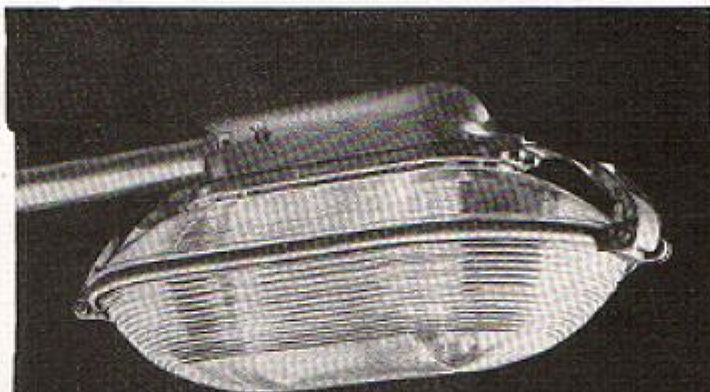
There are only three normal types of light distribution, and it is convenient to refer to these as Non-Cutoff, Controlled Cutoff and Cutoff.

There is, of course, no hard and fast division between these distributions, and some lanterns may have characteristics which lie between two types of distribution and are consequently difficult to classify. In general, however, Non-Cutoff lanterns produce their peak intensity at about 82 degs. from vertical, and at 85 degs. there is still a considerable amount of light, and high values are maintained up to and even above the horizontal. With Controlled Cutoff lanterns, the peak is also at about 82 degs., and at 85 degs, intensities are not less than 50 per cent. of the peak, whilst above this angle intensities fall off as quickly as possible, so that there is very little light at and above the horizontal. In the case of Cutoff lanterns, arrangements can usually be made for peak intensities to be at 65 degs., 70 degs. or 75 degs. to suit different spacings. Above the peak as little light as possible is emitted.

G.E.C. Difractor Lantern giving Non-Cutoff light distribution.

What are the relative merits of the three distributions? Lanterns with Non-Cutoff distribution may be regarded as the " maids of all work " of street lighting. They provide cheap, economical installations in which spacing is not critical, maintenance costs are low, and results good enough for any normal requirement.

The characteristics of this form of installation are, of course, the long T-shaped " patches " of brightness which combine to form a mosaic, covering the whole road surface. Controlled Cutoff is a refinement of the Non-Cutoff distribution, and the effect of the rapid decrease in illumination above the peak is to make the lanterns appear less bright. In so far as can be measured, there is little decrease in actual glare, as defined by a decrease in vision, but psychologically at least the installation can be more attractive and a little more comfortable. Controlled Cutoff normally calls for a more expensive form of lantern, and one of the penalties is that spacing is not nearly so flexible and should not normally exceed 150 ft. between lanterns at a mounting height of 25 ft. The tails of the T-shaped patches of brightness produced by individual lanterns are curtailed—which accounts for the need for more careful control of spacing.

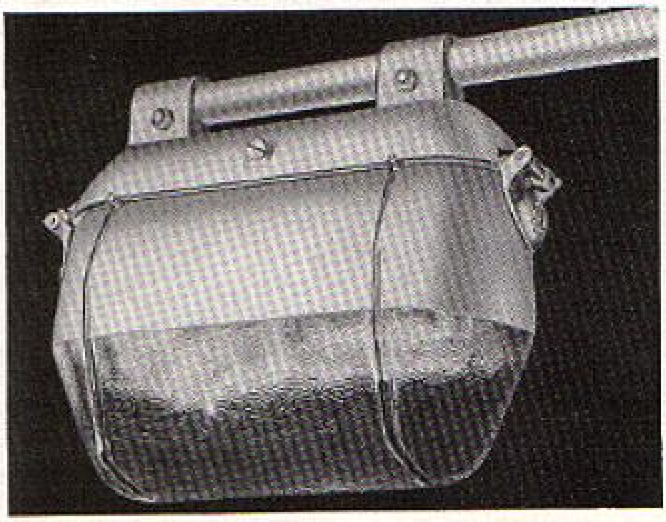


G.E.C. Dioptrion Lantern giving Controlled Cutoff light distribution.

The chief characteristic of a Cutoff installation is that as light above a low angle is virtually " cut off," and for this reason the actual light sources cannot normally be seen, the only indication of their presence is a glow under each lantern. The effect of this cutoff on the patches of brightness on the road is that they become all head and no tail; in other words, bright bands across the road. For this reason very close spacing is necessary in order to avoid dark bands across the road, and it is not normally desirable to exceed a spacing of about 90 ft. between lanterns.

There is no doubt that if the necessary close spacing can be afforded, a Cutoff installation gives extremely pleasing results with an almost entire lack of glare. It is, however, an expensive system on account of the increased number of sets of equipment necessary for a given length of road.

Before leaving traffic route lighting, a further development for lighting double carriageway roads with considerable economy may be mentioned. This employs unidirectional lanterns facing the oncoming traffic, and no light is emitted in the direction of the traffic. This is completely practicable as traffic, of course, proceeds only in one direction on each carriageway. The system is very economical, for as light is only projected towards the oncoming traffic, all the light which would be emitted in other directions with normal lanterns can be redirected in the one direction. This, together with efficient lantern design, makes it possible to obtain good results with less than half the wattage normally required.



G.E.C. Lantern, giving Cutoff light distribution.

These, then, are the four types of light distribution available to the user, and it will be found that nearly every type of lantern now on the market falls in or between the different categories. Indeed whilst roads are lighted with lanterns at heights of 25/30 ft. at spacings of 90/180 ft., it is difficult to see what other form of light distribution could be evolved.

Mention may also be made of the lighting of round-abouts and main road intersections. Whilst these do present a considerable problem to the street lighting engineer, it is one which can normally be solved by the correct location of standard lanterns rather than by the provision of special equipment.

LIGHTING OF RESIDENTIAL ROADS

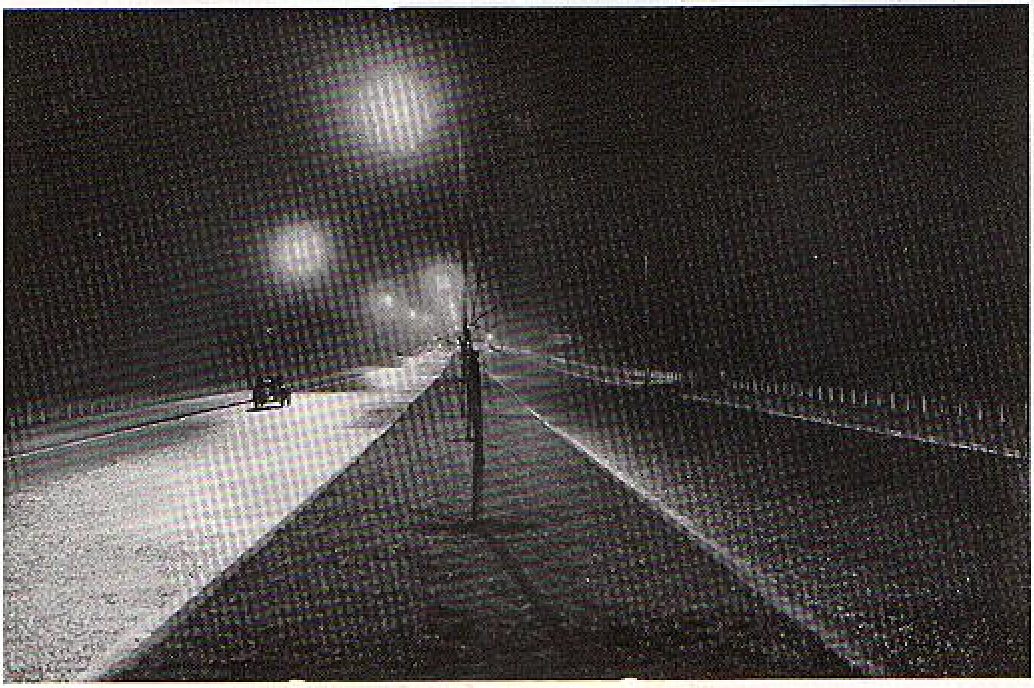
All the foregoing remarks on the technical aspect have been concerned with traffic route (Class A) lighting. The lighting of other roads does not present such a formidable problem, as roads in this category are mainly residential. It is at least as important to light the footways and kerbs as it is to light the road surface. On the other hand, normal Non-Cutoff light distribution does provide a good deal of light behind the lantern and is probably the most suitable type of distribution for this class of road. Small versions of the Non-Cutoff lanterns in use for lighting traffic routes are available, and these normally accommodate lamps up to 200 watts tungsten filament, 125 watts H.P.M.V., or 60 watts sodium.

It may be stated that at present the lighting of residential roads is done on exactly the same lines as traffic routes, but on a reduced scale and normally without the complication of Controlled Cutoff or Cutoff distribution. Mounting heights of 13/15 ft. and spacing up to 120 ft., as recommended in the M.O.T. Departmental Committee Final Report, will produce a completely satisfactory installation.

Research work has, however, been directed chiefly towards the provision of efficient traffic route lighting, and there is still considerable scope for investigation in the field of residential road lighting. It may well be that the ultimate solution will be a system other than scaled-down traffic route lighting.

FOG LIGHTING

At this point it is convenient to consider " fog " lighting. There are several points of interest to consider.



Both Carriageways are lighted with G.E.C. Uniway Lanterns and 125-Watt OSIRA Lamps. On each carriageway light is directed only towards on-coming traffic, making the other carriageway appear unlighted.

First, there is absolutely no evidence to indicate that any particular colour of light has any advantage over another colour in so far as fog penetration is concerned ; in fact, such work as has been done in this connection, particularly by Stiles, indicates no difference between individual colours. Secondly, it appears that no one form of street lighting is any better than another in fog other than by virtue of its intrinsic merit as a street lighting installation. In other words, the better the installation, the better it will be in fog.

It must be admitted, however, that there comes a time when fog is so dense that normal street lighting becomes useless. There is considerable scope for research into the provision of an entirely separate system for lighting roundabouts and traffic route intersections in thick fog. Such a system, which might employ electric discharge lamps because of their distinctive colour, would be switched on only when the density of fog was such that normal street lighting became useless.

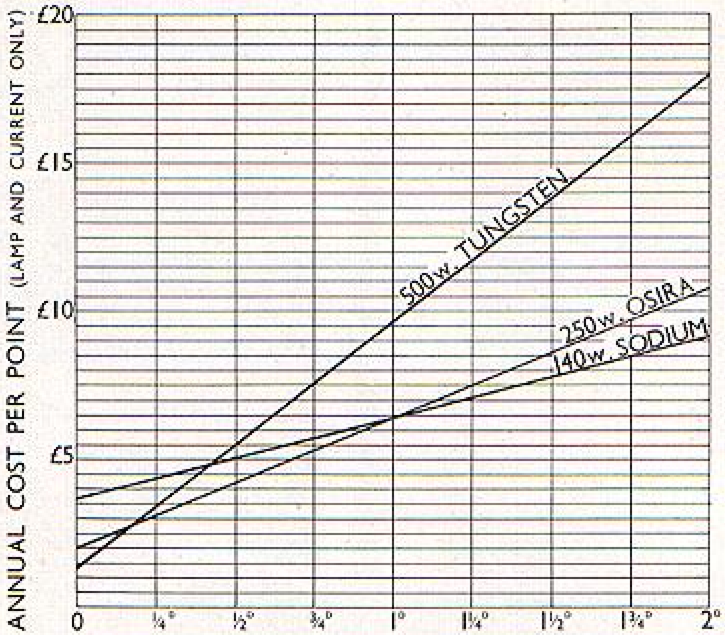
Experiments on these lines have already been made in several places, but it is felt that no completely satisfactory solution has yet been evolved.

THE LAMP AND ECONOMICS

First, let it be stated emphatically that the long tubular fluorescent lamp is not the panacea for all street lighting problems. The need for this comment is apparent from the number of enquiries received for this form of lighting.

In general, the long tubular fluorescent lamps now available are too small in power and too large in size for street lighting, and there is no prospect at present of larger wattages being produced. The present range is only 40 and 80 watts, and even the 80-watt lamp is too small for main road lighting with present spacings, unless several lamps per lantern are employed.

The use of several lamps per lantern will result in considerably increased maintenance costs and large, expensive lanterns. Apart from these major drawbacks there is, however, no particular difficulty in designing lanterns to produce suitable forms of light distribution, provided that the user is prepared to foot the bill.



Comparison between running costs of Tungsten, H.P.M.V. and Sodium Lamps in lanterns producing approximately equivalent light distributions with electricity at prices up to 2d. per unit. These curves are based on 4,000 burning hours per annum and include cost of lamps and current only.

The normal choice will, therefore, lie between tungsten filament, high pressure mercury vapour and sodium lamps. As stated earlier, colour plays no part in assisting visibility and can only be a matter for individual preference.

Relative lamp efficiencies are apt to be misleading, as the only true criterion is the cost of producing a given light distribution. If electricity is very cheap, this will favour tungsten filament lamps ; if it is dearer, the use of mercury vapour or sodium lamps may enable considerable economy to be effected. Other factors, such as the capacity of street lighting mains, may also have to be taken into account.

It is suggested, therefore, that the logical approach to a street lighting problem should be as follows :—

(1) A decision should be made as to the type of light distribution required (i.e., Non-Cutoff, Controlled Cutoff, or Cutoff), taking into account the type of result which is to be achieved.

(2) Lanterns should be selected giving approximately equivalent light distributions employing the different types of light source under consideration.

(3) Annual running costs using the types of lantern, lamp and equipment selected (including depreciation on capital, maintenance, electricity, lamp replacements, etc.) should be prepared.

(4) The results of these calculations can then be assessed, taking into account any personal preference for colour.

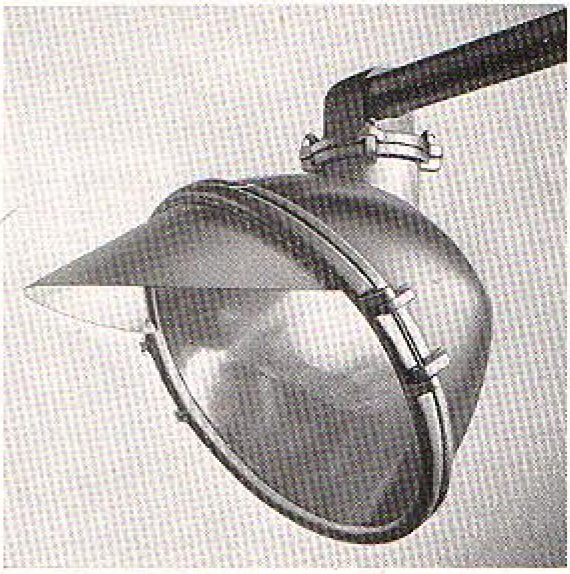
A decision can then be made on whatever point is considered most important. It may be that in some places colour will be the criterion, whilst in others price may be more important, and yet in others appearance may be a deciding factor.

From these remarks the conclusion may well be drawn that no one form of lighting can be considered to be " the best." Every installation produces its own problems, technical and economic, and only by resolving these problems can a satisfactory solution be arrived at.

All the above considerations are, of course, in addition to purely engineering aspects, such as lantern construction, design and performance of auxiliaries, etc., which should be considered before any economics are investigated.

THE LANTERN

The lantern is, of course, the heart of an installation, as no matter what degree of excellence is achieved by other components, it is the lantern which causes the light to be spread over the road surface. Having decided on the type of distribution required (Non Cutoff, Controlled Cutoff or Cutoff), it is fairly simple to consult data published by manufacturers to find which particular lantern most nearly approaches the performance which is required.



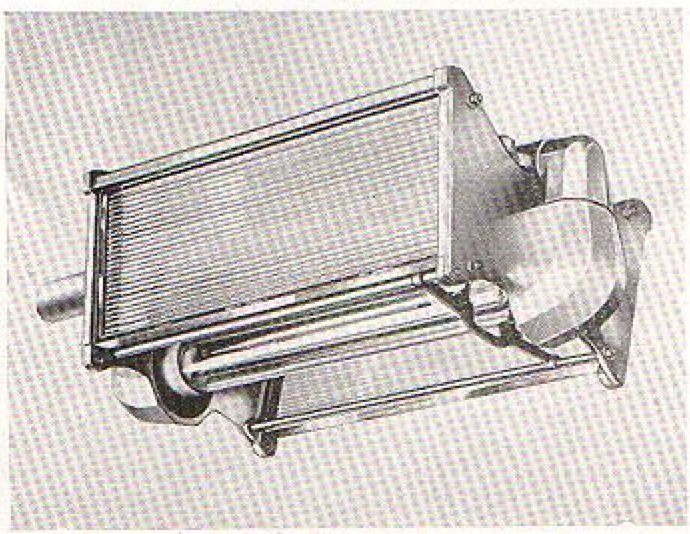
G.E.C. Uniway Lantern for uni-directional lighting on double carriageways, using 80- or 125-Watt OSIRA Lamps.

This is not, however, the whole story. It is important that the lantern should be sufficiently strong mechanically to resist arduous conditions and that the optical system should be easy to clean and of a permanent nature, so that initial performance is maintained over a long period.

Immediately before the war there was a strong tendency to abandon the old hand-made sheet metal lantern technique, and lanterns were being introduced making full use of modern engineering practice, light alloys and mass assembly methods. Such methods enable prototype lanterns to be designed very carefully and subjected to the most rigorous tests before mass production is commenced.

This trend has been accelerated since the end of the war and lanterns are becoming very much more simple in appearance, and the emphasis on the optical system is much more pleasing than the pseudo-decorative lanterns of 10 years ago.

Most modern street lighting lanterns are constructed on basically similar lines, employing corrosion-resisting alloys and finishes, and a minimum of " bits " and adjustments. In nearly every case the lantern is supported on the pole from its side, which enables the bracket to be attached to the main body casting, which is the strongest component. Also, the tendency is for the lantern to be slipped over the bracket and clamped with special clamping screws, instead of the old method of threading the bracket and screwing the lantern on to it. The latter method inevitably resulted in some weakening of the bracket and a more laborious process of erection. A further advantage of side entry is that it avoids the old trouble of water condensing in the bracket and running down on to the lamp.



G.E.C. Lantern for use with 80- and 145-Watt Sodium Lamps.

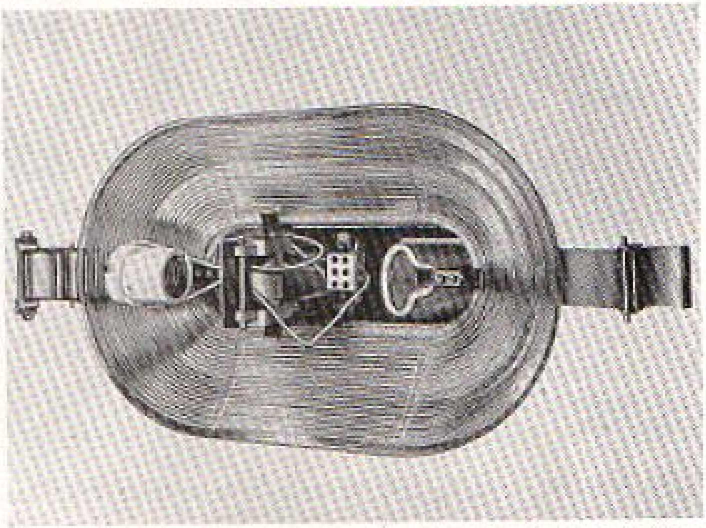
Mention has already been made of the special corrosion-resisting finishes being employed in conjunction with light alloys. The cost of such finishing is very considerable, and in some cases amounts to as much as 25 per cent. of the cost of the lantern.

The need for these special finishes has become apparent during the war, when street lighting installations have generally been neglected and lantern painting has not been carried out regularly. If really regular painting—say, once a year—could be relied upon, much less expensive finishes could be employed with consequent reduction in cost to the user. It should be borne in mind that a regular programme of painting with the type of paint recommended by the manufacturer is the finest possible insurance against subsequent corrosion troubles.

THE OPTICAL SYSTEM

All street lighting lanterns must employ some device for directing light flux into the required directions. There are normally only two alternatives—reflectors or refractive media. Some lanterns employ one, some the other, and some a combination of both. It may be stated in general terms that pressed prismatic glassware is probably the most efficient of all optical systems. Light transmission and control is good and, particularly if the external surface of the lantern glassware is smooth, initial performance can be maintained.

In some lanterns it is not practicable to secure the required light distribution by means of prismatic glassware, and the main optical system consists of silvered glass mirror. There are many alternative forms of reflector available, but lead and copper-backed silvered mirror is probably the most attractive on account of its high resistance to abrasion and to the weather. Plated and anodically-treated metallic mirrors are attractive on account of light weight and strength, but in general do not maintain their peformance to the same extent as silvered glass.



This shows the interior of the top half of the G.E.C. Dioptrion Lantern. The magnetic deflector is immediately in front of the lampholder, and has been released from its normal position to show its construction.

When 250 or 400 watt H.P.M.V. lamps are employed the long length of the column of light materially influences the optical system. If the lamp is vertical it is difficult to exercise a high degree of light control in a vertical plane, and maximum control is exercised in azimuth. For this reason the vertical lamp is more suitable for producing Non-Cutoff light distribution, which has a broad peak in a vertical plane.

When Controlled Cutoff distributions are required, using these lamps, it is necessary to burn them horizontally so that precise optical control can be exercised in a vertical plane to secure a quick "runback" above the peak. Special lamps with hard glass outer bulbs can be supplied which will operate in a horizontal position. The arc tends to bow upwards, and in order to compensate for this the lamp must either be operated at a lower efficiency (41 L/W instead of 45 L/W in the case of the 400-watt lamp) or alternatively a high efficiency lamp can be employed with a small magnetic deflector above it which deflects the arc into a central position.

As the cost of a deflector is very small compared with the lantern cost, and as it consumes only a few watts, it is obviously a good bargain in that it enables the lamp to be operated at a higher efficiency. Magnetic deflectors can be operated either in series or parallel with the lamp and need careful design to withstand the high temperatures encountered at a distance of only a few inches from it.

It has already been implied that the lantern, or at least the optical system, should be totally enclosed and non-ventilated and should present smooth surfaces to the exterior. This is a very definite necessity in the lantern of 1946, but it may be mentioned that it produces some headaches for the designer in the form of high temperatures, which can adversely affect mirrors, glassware, lamps and lamp caps unless they are taken into account.

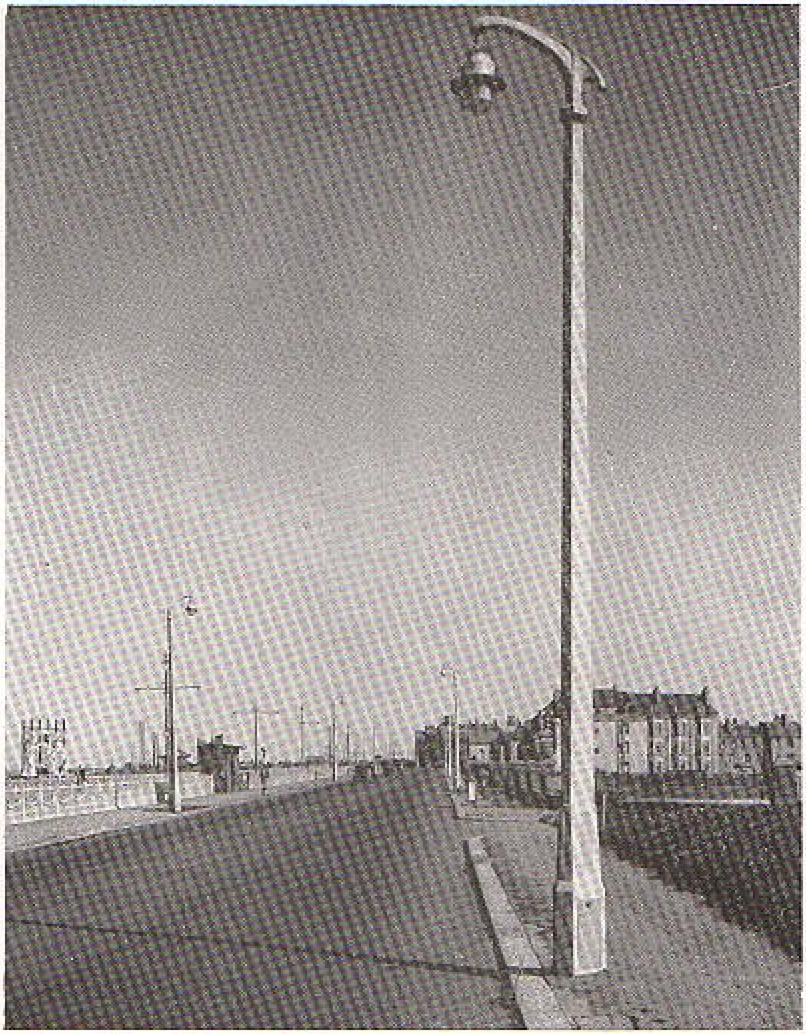
For the future, the use of transparent plastics for reflectors and refractors offers interesting possibilities. They are light, can be bent, moulded, machined and drilled and are mechanically strong. On the other hand, they have at present serious disadvantages, and until these can be overcome they are unsuitable for general use in street lighting lanterns. The most serious drawback is that such materials cannot be used at temperatures normally experienced in totally enclosed lanterns without the possibility of softening and distortion. Also resistance to abrasion is much lower than glass, and this appears to be an inherent disadvantage of this material for street lighting purposes.

A modern steel Street Lighting Column, with G.E.C. Difractor Lantern at 25-ft. mounting height.

Another interesting point is that, owing to the formation of static charges on the surface of the plastic, dust is attracted and retained. Fortunately, the solution has already been found for this difficulty, and it is possible to rub the material with a special powder which appears to dissipate the static charges and prevent this dust collection in a most remarkable manner. Taking into account the newness of the materials, however, one cannot but be optimistic as to the future. Not perhaps this year, or next year, but eventually the present difficulties will be overcome and a most interesting range of new materials will become available and may radically influence lantern design.

AUXILIARY EQUIPMENT FOR ELECTRIC DISCHARGE LAMPS

As is well known, H.P.M.V. lamps require a choke in series and a condenser for power factor correction—sodium lamps similarly employ a leaky flux transformer and condenser. Designs of these components have changed little since before the war.



A main road concrete Street Lighting Column with G.E.C. top-entry Difractor Lantern.

Conditions in the base of street lighting columns where this auxiliary apparatus is normally housed are arduous. Temperature changes are considerable and a good deal of condensed moisture is formed inside the pole from which the auxiliaries must be protected. In the case of chokes and transformers, the best solution is to immerse the windings in a sealed metal canister filled with wax, which affords complete protection. Similarly, condensers are normally protected by being sealed with bitumen compound inside metal containers.

There is little room to spare in the base of steel lighting columns, and components must be reduced in size as far as is practicable. For this reason considerable use is being made of condensers with the paper dielectric soaked in petroleum jelly, which on account of its better dielectric properties enables the size to be reduced without a corresponding reduction in capacity.

STREET LIGHTING COLUMNS

The basic types of street lighting column remains much the same as before the war. The two main types available are metal (steel or cast iron) and concrete.

Of these two types, it may be said that whilst both have inherent virtues and disadvantages, either will give very satisfactory service as a means of supporting street lighting lanterns. Steel columns are lighter, easier to erect and cause slightly less obstruction on the footpath. On the other hand, concrete columns require no painting, and painting is a not inconsiderable item of the maintenance bill, and some very pleasing designs can be obtained.

A concrete column for Side Street Lighting with small G.E.C. Lantern.

In this connection a plea may be made for simple unobtrusive columns rather than the over decorated survivals of twenty years ago, which may have harmonised with the Victorian architecture but will be quite out of keeping, one hopes, with our reconstructed cities.

CONCLUSION

To those who expect a lighting revolution, 1946 may, perhaps, be a trifle disappointing, but with a science as highly developed as street lighting, revolutions are hardly likely to occur.

The gap due to the war has, however, enabled the well-tried principles of 1939 to be confirmed and has resulted in improved materials and finishes which, whilst perhaps not altering the basic appearance of the equipment, will certainly improve its serviceability.

There is, however, real scope for improvement in the standardisation of systems of lighting in adjacent towns and boroughs. On the London North Circular Road, for instance, there are no fewer than twenty-seven different systems of lighting, varying from very good to very bad. Even a change from one good system of lighting to another equally good but different form of lighting can be disconcerting to the motorist, and it is to be hoped that the Minister of Transport will take considerably more interest in the co-ordination of traffic route lighting in the future than he has done in the past.

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