ELECTRONCS AND ELECTRICAL ENGINEERING
ISSN 1392 – 1215 *2006. Nr. 2(66)*
ELEKTRONIKA IR ELEKTROTECHNIKA

ELECTRICAL ENGINEERING
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ELEKTROS INŽINERIJA

Example of a New Design for Industrial Luminaires

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Introduction

For illuminating industrial production halls with high ceilings, industrial luminaires are employed among others. Many different embodiments of such spot luminaires are known and are used mostly also to illuminate public shopping centres, high open railway station halls, high industrial production halls and alike.

Owing to the differing installation heights of the luminaires, different reflector variants are required with a different focal point of the lamp.

In the case of commercially available industrial luminaires, the different radiating characteristics are implemented by replacing the reflector or by mounting the socket for the illuminant in an adjustable manner within the housing to which the reflector is firmly attached. By shifting the socket for the illuminant it is possible to change the relative position between the illuminant socket and the reflector.

The capability of being able to shift the illuminant socket involves some disadvantages. For example, the illuminant socket is not easily accessible from the outside of the housing so that shifting the illuminant socket within the housing is operation-wise complicated. There is technically possible variant where the position of the socket is adjustable from the outside whereby the seal represents an important design aspect. In extreme cases it may be necessary to disassemble such a luminaire for of being able to shift the illuminant socket.

Moreover, a permanent electrical contact must be ensured for the movable illuminant socket. This can be implemented in an involved manner by means of sliding contacts or by means of flexible wires. In the latter case, the wires are subject to deformation when moving the illuminant socket. This can result in increased wear and in extreme cases interrupt the electrical supply to the illuminant socket.

The new development relates to a spot luminaire implementation for high spot luminaire heights and chiefly for the socket variant with an E 40 thread.

Compared to extrusion profiles, this engineering solution is considerably more stable and permits a most pleasing visual design.

Protection rights have been applied for the end-product.

Planning of design based on a Project Management System

The entire list of questions and development plan is presented in consideration of a project management system.

Design of all components was based on new CAD methods (SolidWorks®, [1]) and the pre-production units were implemented by relying on rapid prototyping [2] – rapid product development [3].

Strategic objectives

Project management system should be based on a clear and unambiguous strategy.

Project planning within the scope of the project management system shall be utilized to determine the necessary complexity for implementing the project [4]. Since the scope and also the complexity of projects tend to increase, the aspect of project planning is also becoming more important.

Spot Luminaire Project Plan

For the successful implementation of the project, the project management system [4] was used. The system encourages the workers to increase the efficiency of performance [5] and the affinity to clients. The efficiency of the created light engineering, long life of a product in service and a simple recirculation according to requirements WEEE [6] were taken into account.

State-of-the-Art

In order to avoid the possibility of subsequent protection rights and registered design rights infringements, the state-of-the-art needs to be researched.

There exist visually and optically quite different solutions from well-known manufacturers, whereby the luminaire housings are made of surface-treated sheet steel, of cast aluminium alloys and recently also of synthetic materials.

Aluminium as the material for the reflectors and also a polycarbonate refractor [7] preferably is being used.

What shall be achieved?

It is the objective of the new design to develop a visually pleasing housing with design components that clearly set it apart with respect to existing products. In this sense of the product responsibility in accordance with §22 of the Closed Substance Cycle Waste Management Act, as few as possible different and easily recyclable materials must be used. An important aspect in this case is the longevity of the product in view of the difficult maintenance conditions encountered in practice.

A further objective is to find a design solution with a clear engineering differentiation with respect to the current state-of-the-art offers to the subsequent users' optimum problem solutions in consideration of economic and ecological aspects.

In the case of the new industrial luminaire it shall be possible to set up different radiation characteristics with minimum complexity, especially in the case of already mounted luminaires. At the same time a maximum service life of the luminaire shall be attained through the avoidance of wearing parts, like for example, sliding contacts or wires which are exposed to bending forces. Moreover, it must be possible to rationally manufacture the industrial luminaire while at the same time maintaining a visually pleasant appearance, good heat dissipation properties and high stability.

Upon starting the considerations, answers to important basic questions had to be found. The answers are decisive for the quality of the problem solutions for the subsequent end product.

For the best understanding of problems, during early stages, the following should be taken into account: what is the target group for the products, are the applications only within the industrial area or also within architecturally designed buildings, how important are the visual design components, what effects do high ambient temperatures at high levels have on the housing, under which ambient conditions will the luminaires be mostly mounted, how important is the aesthetic shape of the end product and which accessory and design variants need also to be taken into account?

Constructional Solution

The development is related to an industrial luminaire with a two-shell housing, an illuminant socket held in the housing, and a reflector attached to the housing. The industrial luminaire is equipped with a mounting point at the side of the ceiling. Simple mounting is possible through the Pracht clip system. Through an additional clip arrangement on the side, the industrial luminaire can be swiveled (Fig.1).

Fig. 1 depicts two housing half-shells (10) extending in the longitudinal direction. Provided on their outside are in each case cooling fins (12) which run in parallel to the longitudinal axis of the housing (10) for the purpose of optimally dissipating the heat. In the mounted state there is located between the two housing half-shells a cylindrical housing volume for accommodating a ballast unit (14), an adjustment element (16) on the side of the housing, an illuminant socket (18) and a section of an adjustment element (20) on the side of the reflector.

Illuminant socket (18) and reflector (34) can be locked by an adjustment mechanism at different relative positions with respect to each other. Here the illuminant socket (18) is mounted within the housing (10) at a fixed position.

Thus not the illuminant socket (18) is designed to be movable within the housing (10), but only the reflector (34) has been designed to be movable with respect to the housing. In this manner all current carrying components including the illuminant socket can be mounted at a fixed and unchangeable position within the housing. When adjusting the radiation characteristic, these parts are not moved and thus are not subject to any wear. An adjustment of the radiating characteristic can be simply attained in that one operator takes hold of the housing with one hand and the reflector with his other hand so that the components are moved in a suitable manner relatively with respect to each other. Access to the inside of the housing or making adjustment elements within the housing accessible from the outside has been dispensed with. Moreover, no adjustment elements will adversely affect the visually pleasing design of the luminaire surface.

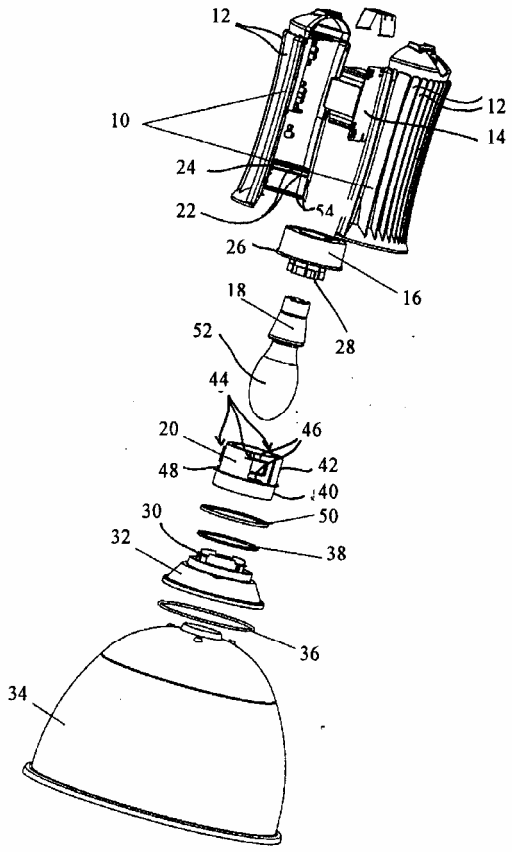

Fig. 1. Exploded view of the industrial luminaire: 10 – Housing half-shells, 12 – Cooling fins, 14 – Ballast unit, 16 – Adjustment element-housing side, 18 – Illuminant socket, 20 – Adjustment element-reflector side, 22 – Ridges, 24 – Groove, 26 – Flange, 28 – Adapter, 30 – Bayonet lock, 32 – Reflector holder, 34 – Reflector, 36 – Sealing ring, 38 – Sealing ring, 40 – Section, 42 – Section, 44 – Guiding pieces, 46 – Legs, 48 – Flange, 50 – Sealing ring, 52 – Illuminant, 54 – Stop, 56 – Groove

The adjustment mechanism consists of two telescopic adjustment elements (16) (20), of which one is firmly connected to the reflector (34) and the other to the housing (10). Telescope adjustment elements represent a solution which can be implemented with a low degree of complexity. Moreover, at each of the two possible reflector positions a visually pleasing overall appearance of the luminaire is facilitated.

The adjustment element (20) on the side of the reflector can be suspended within the adjustment element (16) on the side of the housing in a movable and turnable manner. An adjustment of the reflector (34) is in this case effected through a combined translational and rotational movement of the adjustment elements (16), (20) relatively with respect to each other.

An especially advantageous shape of the luminaire at the narrow beam position of the reflector is attained through the cylindrical shape of the adjustment elements. At the narrow beam position the reflector has, compared to the wide beam position of the reflector, an increased distance with respect to the housing. The visually advantageous cylindrical shape of the adjustment element on the side of the reflector may, at the narrow beam position of the reflector between housing and reflector, be visible at least in some parts from certain viewing angles.

An adjustment element (20) exhibits a guiding piece (44) which defines the two fixed positions and into which a suitable guiding element of the other adjustment element (16) engages. If the adjustment elements are manufactured by means of an injection moulding or casting process, in particular involving synthetic materials, it is easily possible to adapt the shape of the guiding piece and the guiding element already during the stated manufacturing process to the shape of the adjustment elements.

The legs (46) of the guiding piece (44) extend perpendicularly with respect to the longitudinal axis of the housing. When the guiding element of the first adjustment element is located in the upper leg of the guiding piece, then the narrow beam version has been implemented. In the case of the wide beam version, the guiding element is located in the bottom leg of the guiding piece. An adjustment between the wide beam and narrow beam position can in this case be easily attained by moving the guiding element through a relative movement between reflector and housing within the guiding piece from one leg to the other leg.

An improved degree of stability for the entire adjustment mechanism is attained through three arrangements of guiding piece (44) and guiding element spread equally along the circumference of the adjustment elements.

At the inside of the housing, a stop (54) restricts the movement of the adjustment element (20) on the side of the reflector in a direction away from the adjustment element (16) on the side of the housing. When the adjustment element (20) on the side of the reflector rests against this stop (54) then the narrow beam version has been implemented. The adjustment element (20) on the side of the reflector exhibits a flange (26) which projects towards the outside and which operates effectively together with the stop (54) at the inside of the housing.

The adjustment element (20) on the side of the reflector can be linked by means of a bayonet lock (30) to the reflector (34). In this manner a link between the adjustment element (20) and the reflector (34) can be provided cost effectively, quickly and with precisely adjusted relative positions with respect to each other. The bayonet lock (30) is in this case so designed that it cannot be easily released again by a simple twisting movement between adjusting component and reflector. In this way the reflector can not become detached from the adjustment element on the side of the reflector when changing the radiating characteristic. Loosening of the bayonet lock is only possible using a suitable tool. Alternatively the bayonet lock can be so designed that it can only be released while exerting a comparatively high force. This force must be selected to be significantly greater than the force which is necessary to adjust the radiating characteristic.

A seal is provided between the adjustment element on the side of the reflector and the inside of the housing. In the case of telescopic adjustment elements thus at each relative position between reflector and housing a proper seal can be ensured for the housing opening facing the reflector. Thus no dust and no humidity can enter into the inside of the housing. The seal is affixed at the radially extending circumferential flange which projects towards the outside in connection with the stop provided at the inside of the housing.

Moreover, an ageing and temperature resistant housing seal between the two half-shells (10) prevents the ingress of dust and humidity into the inside of the housing. This housing seal is not visible from the outside, respectively covered by parts of the housing. For this reason, the seal is not exposed to external attack and is protected against ambient influences.

This important design feature and the design and position of the special seal ensures on the one hand easy mounting and on the other hand, after having been mounted, a long-lasting compliance with the specified IP protection rating.

The reflectors which are open at the light emission side offer the possibility of being sealed off in addition only by a captive cover glass which is easy to fit and which is dust-tight and jet water protected. The glass must be able to sustain high temperatures. In connection with the seals between the two housing half-shells and between the adjustment element on the side of the reflector and the inside of the housing, the inside area of the housing as well as also the inside area of the reflector is sealed off firmly.

Material Solutions for Special Application Areas

The luminaire can be installed in both dry and moist areas.

The two-shell housing is made of an aluminium alloy. The two half-shells are manufactured by means of a casting process. Compared to the conventional housings made of extruded profiles there results through the two cast half-shells an increased stability. At the same time an improved visual appearance becomes possible.

Experimental results

For an experimental research the high-pressure mercury lamp (250 W) was used.

Fig. 2 and 3 show the distribution curve of luminous intensity for the narrow beam and wide beam adjustment.

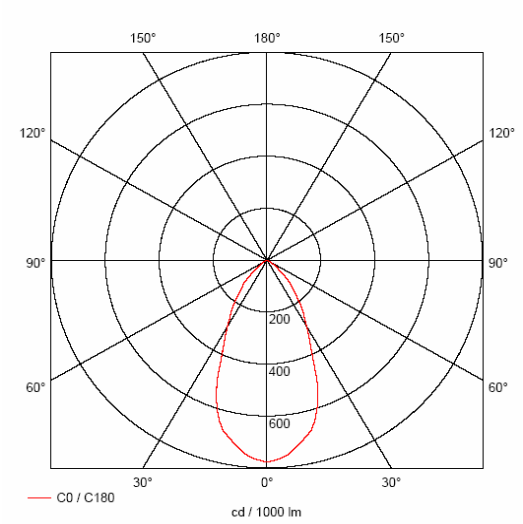

Fig. 2. Polar distribution curve of the narrow beam adjustment

The polar distribution curve indicates the directionality of the standardized luminous intensity to the luminaire in one plane. The luminaire axis runs through the 0°/180° polar coordinate. The light distribution has a rotational symmetry. From figures it is visible, that by means of moving a reflector the narrow beam adjustment has an emitting angle of 50.7° and the emitting angle of the wide beam adjustment is 94.6°.

The diagrams for the narrow beam and wide beam lighting applications are shown on the figures 4 and 5. The conic section runs through the cone axis. The cone diagram indicates the beam width and luminance depending on the distance to the luminaire.

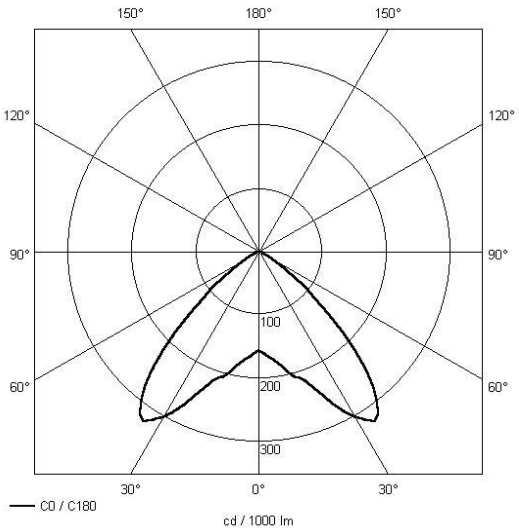

Fig. 3. Polar distribution curve of the wide beam adjustment symmetry

Conclusions

1. In the course of the development of a new line of luminaires for use at particularly high heights, new design engineering aspects of universality were taken into account.

2. The most important patent protection covers the use of a single reflector for both narrow and wide beam configurations. Through one, respectively two additional synthetic material parts, the socket with the lamp always remains at the same mounting point within the luminaire housing. With the aid of the additional adapter components it is possible to adjust, through a bayonet movement, the reflector unit and thus the focal point of the lamp. The advantage lies in the design of a narrow or wide light distribution curve with a single reflector. Thus warehousing of the large volume reflectors and service-friendliness is considerably increased.

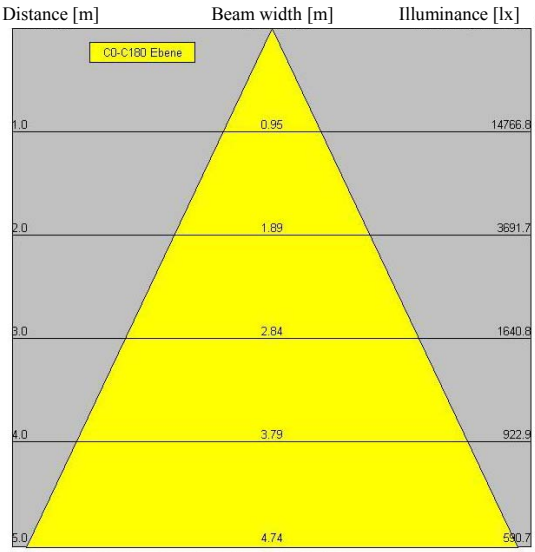

Fig. 4. Diagram of narrow beam adjustment

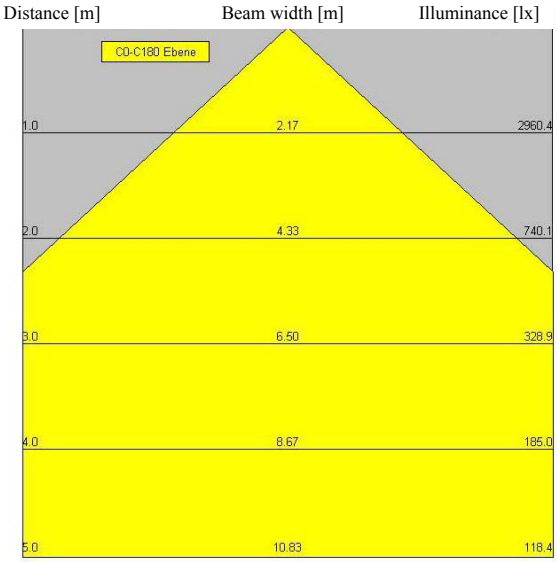

Fig. 5. Diagram of wide beam adjustment

3. Extremely warp resistant combined with a high protection class IP 65, single point mounting through the Pracht clip system, long service life for the materials used, very good recycling possibilities.

4. In particular the coordination of deadlines and the interdisciplinary area were monitored and successfully controlled by the project management system.

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Presented 2005 10 17

F. Pracht. Example of a New Design for Industrial Luminaires // Electronics and Electrical Engineering. - Kaunas: Technologija, 2006. – No. 2(66). – P. 45–49.

In industrial production halls with high ceilings, industrial luminaires are installed as an alternative to fluorescent lamps. Owing to difficult installation conditions because of, for example, crane bridges, industrial luminaires because of their single point mounting capability are preferred over fluorescent lamps. In the sense of product responsibility and subsequent recycling, specifically with the aim of working with as few as possible different materials, which are easily to dispose of in an environment-friendly manner also for thermal engineering reasons, chiefly aluminium is used. The novelty offered by the new development is the use of a single basic reflector for narrow beam or wide beam lighting applications. Ill. 5, bibl. 7 (in English; summaries in English, Russian, Lithuanian).

Ф. Прахt. Пример конструирования промышленных ламп новой конструкции // Электроника и электротехника.- Каунас: Технология, 2006. - №. 2(66).–С. 45–49.

В качестве альтернативы флуоресцентным лампам в промышленных помещениях с высокими потолками используются промышленные светильники, у которых есть преимущество перед флуоресцентными лампами, выраженное в единственном их закрепляющем узле, в то время как флуоресцентным лампам присущи сложные инсталляционные условия. Предлагается рассматривать преимущества алюминия по отношению к другим материалам, имея в виду последовательную переработку, а также стремление использовать как можно меньше разнородных материалов, которые подвергаются легкой обработке и переработке, не нанося ущерба окружающей среде. Дополнительное преимущество алюминия – хорошие его теплопроводные качества. Новизна данного инженерного решения основана на том, что для получения узкого или широкого потока света используется лишь один рефлектор. Эта идея воплощена путем применения рефлектора с изменяющейся высотой, изготовленного из адаптивных компонентов. Ил. 5, библ. 7 (на английском языке; рефераты на английском, русском и литовском яз.).

F. Pracht. Naujos konstrukcijos pramoninių šviestuvų projektavimo pavyzdys // Elektronika ir elektrotechnika.- Kaunas: Technologija, 2006. – Nr. 2(66).– P. 45–49.

Kaip alternatyva fluorescencinėms lempoms, aukštų lubų pramoninės gamybos salėse yra naudojami pramoniniai šviestuvai. Dėl sudėtingų įrengimo sąlygų, kurias lemia, pavyzdžiui, kranų tiltai, pramoniniai šviestuvai yra pranašesni už fluorescencines lempas, kadangi jie turi tik vieną tvirtinimo mazgą. Aptariami pramoniniai šviestuvai sukonstruoti iš kuo mažiau skirtingų medžiagų, kurias lengva perdirbti aplinkai nekenksmingu būdu. Kaip pagrindinė šiuos reikalavimus atitinkanti medžiaga pasirinktas aliuminis, kuris daugeliu atvejų yra pranašesnis ir dėl gerų šiluminio laidumo savybių. Sprendimo naujumas pagrįstas tuo, kad įvairiems tikslams, kur reikalingas siauras arba platus šviesos srautas, yra naudojamas tik vienas pagrindinis reflektorius. Ši puiki idėja įgyvendinta taikant keičiamo aukščio reflektorių, sudarytą iš adaptyviųjų komponentų. Il. 5, bibl. 7 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).

DOI: 10.5755/j02.eie.10594