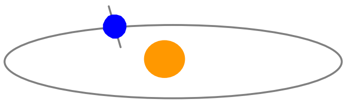
Fluid Optics™’ letter

La lettre des

Syzygies



September, 2000

EDITORIAL

We are pleased to present to you “La lettre des Syzygies” of the autumn equinox.

You will find in this letter two articles. The first one talks about the forms and sections of the reflected beams and the second about a diffuser considerably able to close the beam of light coming from an optical fibre.

The inventors of the Fluid Optics

CONCEPT

Forms and sections of the reflected beams

This first presentation, far from being exhaustive, will be followed by other presentations, allowing so to realize possibilities offered by the use of the concept of the Fluid Optics in the conception of reflectors. We led a big number of theoretical studies, and some prototypes were punctually manufactured.

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SUMMARY

PRODUCTS

A case of diffuser " Fluid Optics® " of the type Concol

The plastic optical fibre is more and more used in the lighting profession. Indeed, this one presents the advantage to transfer light from the generator to the object to be shown. So the problems of heat and maintenance are deported. This technique, more and more used, is often used in the shop windows of museums or to enlighten details of monuments.

The generator of light and its optical fibre

Besides the problem of the efficiency of the generator which is not the object of this article, another problem arises at the exit of the optical fibre. The exit of the optical fibre reacts as a new source constituted with multiple sources of light, and each of these emits light into an important angle, mostly of the order of 60°. Produced light is diffuse, muddled and controllable difficulty on a big distance.

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We present you, at first, our classification of reflectors according to the shape of the reflected beam of light. After, you will find the statement of some of our methods (we do not present knowledge to end in the result because it remains the property of his inventors) to modulate the section of flux of the reflected beam of light.

Classification of reflectors

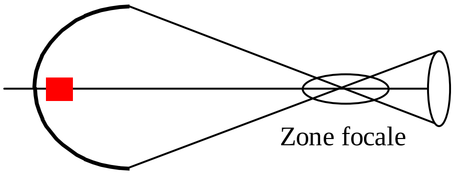
The reflector is an optical system intended to collect the light coming from one or several sources. This optical system sends the collected light to one or several places with the use of the simple or multiple reflection, of the simple refraction or the mixture, of the two at the same moment. Furthermore, the light must be sent in accordance to homogeneous, diverse, modulated flux and in accordance with the need.

One distinguishes, according to our concept, three main classes of reflectors.

The positive reflectors, the negative reflectors and the third class, occupied with reflectors to vocation, that are reflectors endowed with some of these functions at the same moment.

You will also find the following definitions on our Web site.

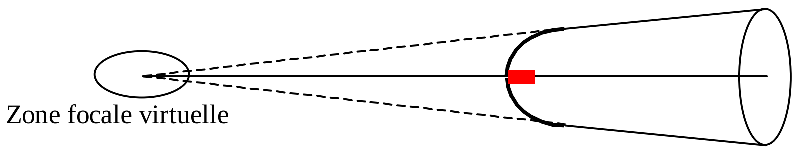
Positive reflector



- By internal convention, a reflector is called positive (convergent, almost convergent or pseudo-convergent) if the reflected flux created from its emissive zone is focused, concentrated or condensed in front of the reflector at a finished distance.

Example of application: One should appeal to a positive reflector to enter a flux of light into a bundle of optical fibres.

Réflecteur négatif



- By internal convention, a reflector is called negative (divergent, almost divergent or pseudo-divergent) if the virtual continuation of the reflected flux is focused, concentrated or condensed behind the reflector at a finished distance.

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That means also like if the whole flux virtually is coming from a reduced zone or not, behind the reflector.

Example of application: One should appeal to a negative reflector to enlighten a vast zone.

By misuse of language, one could speak about a "NULL" reflector, that would mean imagining a reflector able to create a parallel light beam. This is a sight of the spirit. One can assure that it is impossible to create a flux perfectly parallel from a vast emissive zone even with the help of the fluid optics. With some emissive zones, one can only try to approach this situation and create reflectors producing very narrow beams in certain situations. At present we manage to create (in theory and in practical application) a beam really opened to 12° using a vast arc lamp and without any peripheral flux. It is necessary to use the dioptric optics to be able to lower considerably this value. In the article "Products", you will notice that the use of one single Concol (dioptrics) allows, at present, to reach opening's angles of beams of about 3 at 5° with net edges.

Reflectors to vocation

- By internal convention, one distinguishes a third class of reflectors called "to vocation". In this column, One will classify all the reflectors which are neither totally positive nor totally negative. It means that the pseudo-focal virtual zone can pass from the back of the reflector to the front of the reflector.

One will notice, in the following articles, that this classification of these three classes of reflectors corresponds well to families of very specific geometrical properties.

Examples of application:
The toric reflector of which the virtual emissive zone is simultaneously partially in front of and behind of the reflector.

Modulation of the sections of flux

To modulate a section of flux : It is to give to the envelope of the beam a specific section intended to define an outline of the section of the beam, foreseen in advance, on the target, by taking into account the orientation of the target with regard to the optical axis of the beam.

First method:

- This first method is the most simple. It consists in using the circular section of the beam created by the circular reflector and in occulting a part of the flux by interposing on the optical path a mask or another opaque object.

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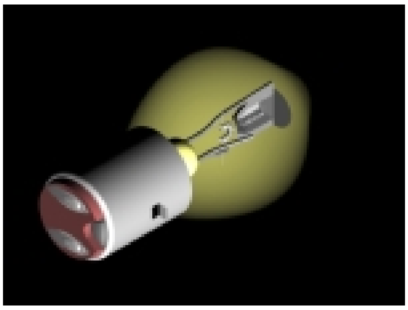
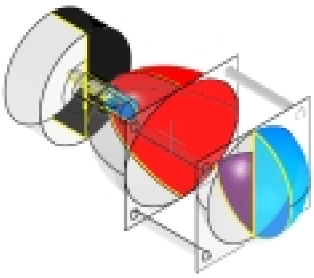


Example of application: In the automotive industry, sources with a small dish are used to create headlight projectors. In the show-business industry, the shape of the section of the beams is given by using masks intercepting all or any of the flux.

Second method :

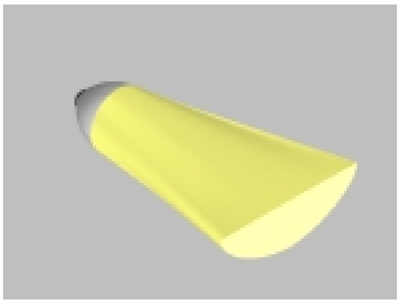
- A more little elaborated method consists in using appropriate rules for the imagery and its property of aplanetism.

In that case, everything means creating a small optical system capable of creating an image from an object. If, for example, the object is a half mask, this object will be transformed on the target by an enlightened zone adjacent to a dark zone. All the profiles presented with the object will be reproduced on the target.



Example of application: In the automotive industry, the limit of the light (horizontal line or with a slope of 15 °) of the low beams is regularly created with an adequate mask positioned between the source with its reflector and the lens of imagery (generally an aspheric convex plan lens).

Third method :



There are several methods of the setting geometry to modulate a flux resulting from lightsources from a reflecting surface generated by an evolution of profiles for creating spots in predefined forms. All these reflectors do not use a small dish or mask to create their horizontal limit of light. The mask absence naturally avoids the losses of light.

At the beginning, it consists in drawing fluid veils by correcting the shape or extrusion. These reflectors not of revolution, with smooth veils, are intended to create a straight limit of two adjacent zones, one enlightened, the other one dark. A quite particular study is necessary to make the gradient of light, limiting these two zones, the

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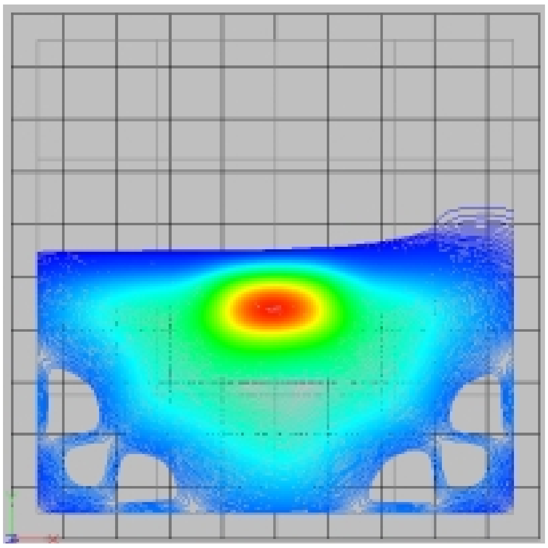
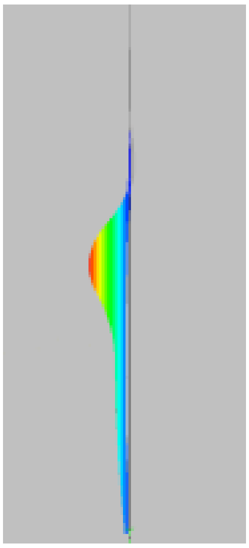
most raised possible.


Vue of the target at 25m of the projector
Graph of isolux


Profile vue
of the target

Above, One sees the presentation of a limit of the light zone obtained from a source (without mask or small dish) and with a fluid veil drawn to send the light according to a traditional target of low beams. Furthermore, on the simulation above, we well notices the beginning of the creation of the horizontal limit line of flux by simple deformation of the fluid veil. And we notices, on the right picture, an intensification of the flux located a little under the horizontal line.

One will note that this type of setting of geometry of reflector is in studying. So we try, to define necessary geometrical parameters to learn to control the characteristics of iso-rays and the gradient of flux on the target. Furthermore, one does not ignore light predictable inevitable degradation during the manufacture of such a prototype.

Example of application: Theoretical studies, with punctually, some applications allowed to develop several families of reflectors classified according to their function.

Fourth method :

One can even mix solutions and create a mixed reflector being able to assure two functions.

Example of application: In the automotive industry, the reflector can have a function of low beam with a lit source and high beam with a second lit source. One reminds that these two sources do not own a mask, that the reflecting veils are smooth, and that, obviously, the reflector can work without window or behind a smooth window.

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Fifth method :

A last method consists in using body of dioptric transparent material to modulate a beam and then to create a profile on the target.

We quoted this example to put in evidence that it is also possible to reach the result by using body of dioptric transparent material.

Example of application: The dioptric double projector conceived by us, on the magnificent concept-car KOLEOS imagined by the design management team of the company RENAULT. KOLEOS was presented on the occasion of the automotive exhibition of Geneva of March, 2000 and also to the automotive exhibition of Paris of September, 2000.

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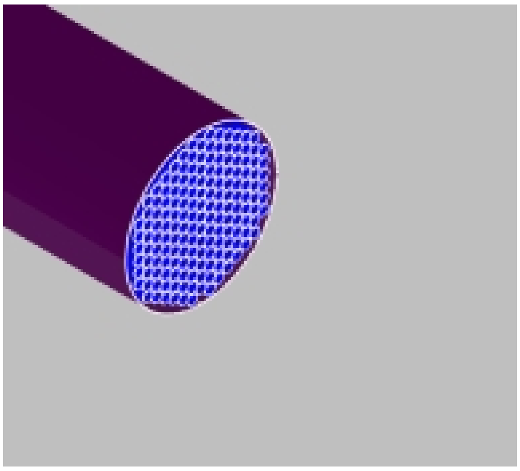
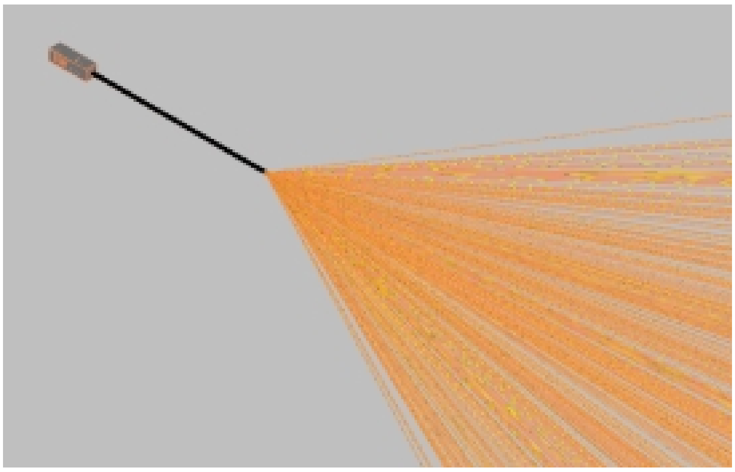


Modelling of an extremity of optical fibre



Vue of the flux of the exit of the optical fibre

If it is necessary to highlight exactly a reduced part of a work of art, it will be useful to use the Concol. Indeed, the Concol has for function to transform the wide and muddled exit beam of the optical fibre into a beam with a

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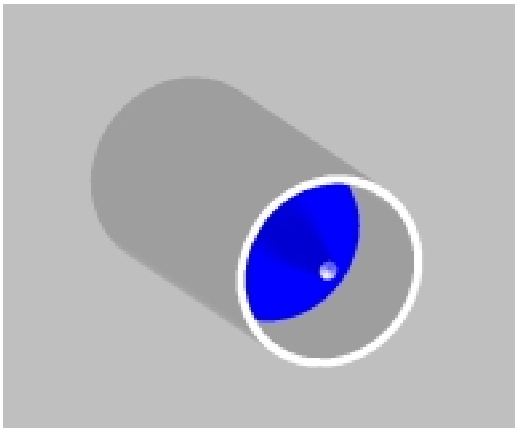
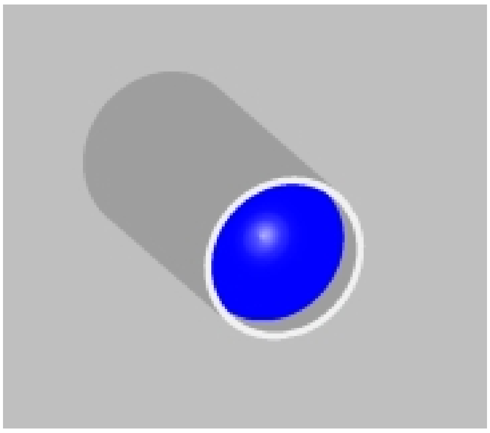
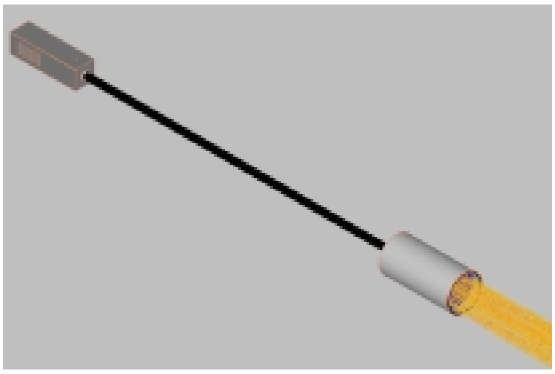
very little emissive zone and opened to some degrees only.

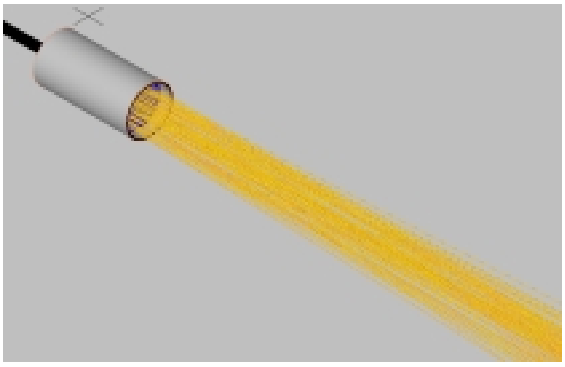
The optics of exit or Concol


Back vue of the Concol

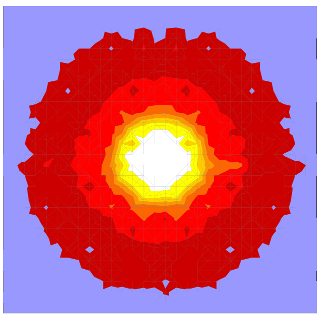

Front vue of the Concol

Optical system presented here, is maintained in a cylinder of aluminium, giving it a good protection. Calculated by using the concept of the Fluid Optics®, this optic allows the use of the output beam coming from the bundle of optical fibre. The optic reduce the opened angle of the beam from 60° to a half angle of less than 3°.


Vue of the complete optical system


Vue enlarged of the exit of the concol

For the modelling, a plane sensor is placed at 3 m of the exit of the optics. This sensor analyzes the profile energy of the beam light as well as the distribution of rays according to the angle.


Energy profile of the beam of light at 3m

We know, for every light ray simulated and calculated, the angle formed with the ray coming from the Concol and the optical axis of this one.

According to these calculations we obtain the following angular distribution:

- 55% of rays form an angle less than 1°,
- 33% of rays form an angle between 1° and 2°,

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- 12% of rays form an angle between 2° and 3°.

No rays form an angle superior to 3°.

The angles of the rays of the beam coming from the optical fibre were all strongly reduced regarding to the optical axis. All these angles are lowered from more than 30° to less than 3°.

Measures on the manufactured optics

This picture presents the generator of light and its optical fibre enlightening the entrance of the Concol. The generator is a generator of the state of the art for optical classic fibre endowed with a light bulb of electric power of 50W. The Concol is manufactured in PMMA.

Two photos below put in evidence the effect of the Concol in the beam in the exit of optical fibre. The first left photo presents the hot spot on a wall located at 3 metres. Using the Concol, the second right photo presents the hot spot on the wall located at the same distance. In both cases the generator creating the flux of light is the same.

Without the Concol

With the Concol

The beam of light coming from the optics is in accordance with simulations.

The light entering by the entrance is collected, organized and is sent. It is important to note that in the geometrical functioning of the Concol no light is lost because none of the rays strike on the aluminium cylinder. Inside the Concol, There is no internal mask or no optical trap to eliminate the badly directed rays. A measure of the diameter of the spot is made with a rule and the result is 27 cm. The angle of the beam maybe deducted easily and his value is worth about 2,6°.

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The uncertainty of measure is about 2 cm (10%), without taking into account the uncertainty of the eye to distinguish the edges of the spot. The value of 3° announced by the simulation is well verified according to the uncertainties of the experiment.

Applications

This optics of the type "Concol" allows the use of the optical fibre to enlighten objects of art, reduced visible surfaces, located at big distances of the extremity of the bundle of optical fibre. These objects are not accessible and are situated in places where it is difficult to install projectors at the risk of destroying the beauty of places. Thanks to "Concol", it is possible to enlighten and highlight a work of art.

To verify the range of the beam, the optical system was used to enlighten the windows of a house at more than 50 meters. The window lit in the first floor, enlightened with a source of 100 W, seems more intense than the two windows enlightened in the third floor. This generator of light for optical fibre (of an electric power of 50 W) gives a good idea of the light beam spread over a stony large surface.

We notice that the beam screened, using the Concol, possesses net edges and does not present perceptible twilight to the eye. The gradient of light at the edge of the task is very big, that means that the gradient comes from the full light to the full darkness upon a very weak distance. It seems although we begin to have a new method to control the edges of the beam created with dioptric optics.

Other applications of the Concol can be declined. Indeed, it is possible for example to manufacture a Concol creating a beam whose section is not circular, without a mask or a diaphragm to enlighten logos, roads, scenes of theatres or quite other application with artistic calling.

NEWS

If there is a subject which you wish to see treating in this letter, you can directly contact us by email at the address:

syzygies@optique-fluide.org

You can also join **MEGALUX**, the company charged to exploit the Fluid Optics, at the Address:

info@megalux.com

NEXT LETTER

The next Letter “La lettre des Syzygies” will appear for the winter solstice, or for the end of December.