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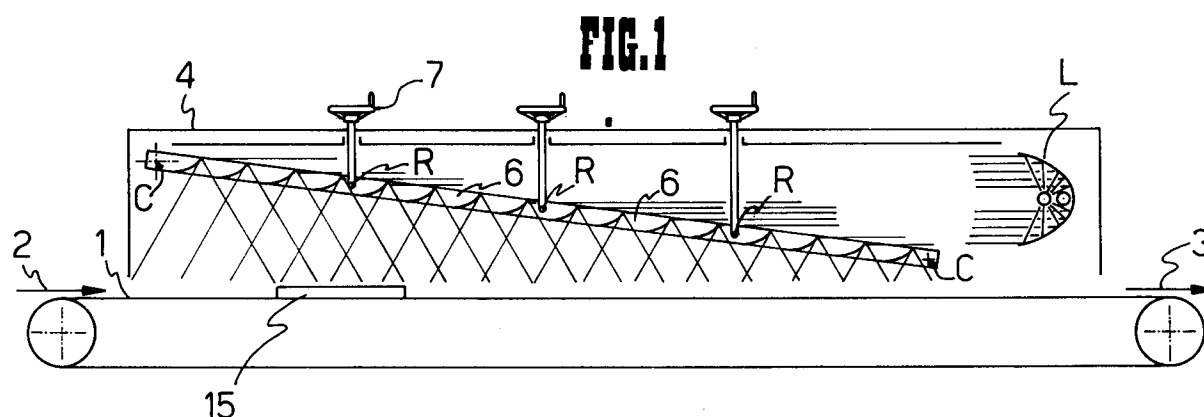
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**W-8000 München 40(DE)**(54) **Ultraviolet light irradiation device in painting plants using photopolymerizable paints.**

(57) Painted objects (15) are moved forward on conveying means (1) across an irradiation zone. The device comprises at least one light source (L), apt to send a beam of uviol rays (11) in a direction substantially parallel to the conveying means (1), and a

plurality of convex mirrors (5), positioned transversally above said means along a plane which is inclined in respect thereof, apt to fully intercept said beam of uviol rays and reflect it onto the painted objects.



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The present invention concerns an ultraviolet light irradiation device, employed in painting plants wherein use is made of photopolymerizable paints. In particular, the device of the present invention is meant for continuous painting plants, wherein the objects painted with the photopolymerizable paint undergo a series of drying treatments while they are moved forward on conveyors.

As known, the photopolymerizable paints drying cycle comprises, straight after the paint has been applied on the objects, the following succession of steps:

- Deaeration. During this step, the evaporation of most of the solvents contained in the paint is carried out, until the viscosity of the paint is suited for the subsequent treatments;
- Gelling. During this step, the painted objects are exposed to the radiation of low-power uvio light sources (approx. 1 W/cm of tubular lamp), thereby starting the reaction of photopolymerization and thus the reticulation of the layer of paint;
- Drying. During this last step the painted objects are exposed to the radiation of high-power light sources (from 80 to 120 W/cm of tubular lamp), thereby completing the hardening of the paint.

It is essential for the aforespecified different steps - and particularly the gelling step - to be carried out very gradually, so as to avoid reticulations and hardenings from being preferentially formed on the surface of the layer of paint, which can prevent and hinder the perfect hardening of said paint also throughout its thickness.

According to known technique, this is obtained with a series of low-power tubular lamps, positioned side-by-side, above and transversely to the conveyor along which the objects being treated are moved forward. The luminous emittance of these low-power lamps can in no way be regulated, whereby - in a specific plant - the intensity of the light radiation on the objects being treated and particularly its variableness, in the forward moving direction of the conveyor, is at present controlled, for what concerns the different working steps, merely by changing the number and/or the position of the lighted lamps.

Said arrangement is not however fully satisfactory. To start with, the plant is rather complicated and delicate as it includes a large number of lamps (more than 10 - 20 lamps per meter of conveyor) with the respective electric system. Furthermore - as said above - in a specific plant, the luminous intensity in the forward moving direction of the conveyor can only be regulated by switching off single lamps or groups of lamps, and cannot thus be continuously and homogeneously varied according to the particular requirements of the different

paints and/or objects being painted.

The object of the present invention is therefore to supply an ultraviolet light irradiation device in the aforespecified plants, wherein the irradiance (intensity of irradiation per surface unit being treated) can be easily and promptly regulated and - in particular - be varied at will along the forward moving direction of the conveyor.

Another object of the present invention is to supply an irradiation device apt to work with a very reduced number of lamps, preferably with a single lamp, so as to drastically simplify the electric system.

According to the present invention, said objects are reached with an ultraviolet light irradiation device - in painting plants using photopolymerizable paints, of the type in which the painted objects are moved forward on conveying means across the irradiation zone - characterized in that it comprises at least one light source, apt to send a beam of uvio rays in a direction substantially parallel to the conveying means, and a plurality of convex mirrors, positioned transversally above said means along a plane which is inclined in respect thereof, apt to fully intercept said beam of uvio rays and reflect it onto the painted objects.

Further characteristics and advantages of the irradiation device according to the present invention will anyhow be more evident from the following detailed description of a preferred embodiment thereof, illustrated by way of example on the accompanying drawings, in which:

Fig. 1 is a side elevation assembly view of the irradiation device according to the present invention;

Fig. 2 is a side elevation view, on an enlarged scale, of the light source;

Fig. 3 is a side elevation view, on an enlarged scale, of a reflecting mirror;

Fig. 4 is a plan view of the light source of the irradiation device of the present invention, showing the lamp selection device; and

Fig. 5 is a cross-section view along the line V-V of fig. 4.

As shown in fig. 1, the irradiation device of the present invention is mounted above suitable means for conveying painted objects, normally consisting of a slat or roller conveyor 1. The painted objects are positioned on the conveyor 1 in 2 and collected therefrom in 3, after having undergone the gelling treatment by means of the irradiation device of the present invention. The uvio radiation emitted is suitably screened by a framework 4 which covers the whole device.

Said device comprises a light source L, apt to send a beam of uvio rays in a direction substantially parallel to the conveyor 1, and a plurality of reflecting mirrors 5, which reflect the radiation from

the source L towards the painted objects moving along the conveyor 1. Each mirror 5 consists of a bar having an arc-shaped section, with convexity facing the conveyor 1, and is positioned substantially parallel to the surface of the conveyor and perpendicular to the longitudinal axis thereof. To favour an improved irradiation of the lateral edges of the painted objects, especially in the presence of undercuts, the mirrors 5 are preferably inclined - though keeping parallel to the surface of the conveyor 1 - in respect of the longitudinal axis of said conveyor, alternately on one side and on the other, by a suitable angle, for example between  $90^\circ \pm 20^\circ$ . The mirrors 5 are mounted by their ends, preferably in sets, onto a plurality of frames 6, positioned adjacent in front of the light source L and inclined in respect of the underlying surface of the conveyor 1, so as to allow the mirrors 5 to fully intercept the beam of rays emitted by the light source L.

The frames 6 are hinged one to the other in correspondence of hingeing points R, and the first and last frame are moreover hinged in C onto the framework 4 of the device. Furthermore, the position of the intermediate hinges R can be adjusted in a vertical direction by means of control handwheels 7. By suitably acting on said handwheels 7, the series of frames 6 can thus be generally positioned according to a straight or broken line, but in any case the mirrors 5 fixed thereto will be fully intercepting the beam of light emitted by the source L.

This allows to easily and promptly regulate the irradiance on the different zones of the conveyor 1. In fact, if the series of frames 6 is positioned on a straight line, the irradiance is perfectly constant along the whole conveyor 1; if, on the contrary, the frames 6 are positioned according to a broken line, the irradiance will be increasing along the forward direction of the conveyor when the convexity of said broken line is facing upward, whereas it will be decreasing in the contrary event.

Fig. 2 shows more in detail the light source L. It consists of a high-power tubular lamp 8, positioned in correspondence of the focal line of a cylindrical reflector 10 with parabolic cross section, said focal line being substantially parallel to the surface of the conveyor 1. In this way, the radiations sent by the lamp 8 are deviated into a beam 11 of parallel rays, i.e. the beam of uviol rays substantially parallel to the conveyor 1.

Successive portions 12 of said beam 11 hit the mirrors 5 - as shown in fig. 3 - and such portions will obviously be smaller, the narrower the angle formed between the frame 6, onto which said mirror 5 is mounted, and the direction of the beam 11. Thanks to this arrangement, it is actually possible to regulate the irradiance as previously described.

As stated above, the mirrors 5 have an arc-shaped section with convexity facing the conveyor 1, so as to reflect the radiation over a surface 13 which is far wider than that of the mirror; said radiation thereby intersects the radiation of the neighbouring mirrors, finally resulting into a more uniform irradiance on the layer of paint 14 of the objects 15. Preferably, said arc-shaped section is a parabolic-arc section, designed and oriented so as to improve the homogeneity of the irradiance. It is moreover possible to regulate the irradiance on the conveyor 1 by varying the reciprocal distance between the mirrors 5.

According to the present invention, it is also possible to select the emission spectrum of the light source L - so as to adapt it to different types of paint - by replacing the lamp 8 with a lamp 9, already prearranged for the purpose into a suitable housing. Said arrangement is shown more in detail in figs. 4 and 5. The lamps 8 and 9 are mounted on a pair of supports 16, which are in turn fixedly connected to a pair of gears 17, caused to rotate by a pneumatic actuator 18 through a pair of driving gears 19 which are reciprocally connected by a shaft 20. The pneumatic actuator 18 is meant to allow a rotation by exactly  $180^\circ$  in one sense and in the opposite sense. In this way, the position of the lamps 8 and 9 - thanks to the fact that the supports 16 rotate about an axis 21 barycentric in respect of said lamps - alternates between a working position, in correspondence of the focal line of the reflector 10, and a rest position close to the bottom of said reflector, where the switched off lamp by no means disturbs the distribution of the reflected radiation. The radiations of the switched on lamp, which hit the switched off lamp, would in fact anyhow not be utilized, as they would in any case be reflected on and intercepted by the switched on lamp.

The electric system feeding the irradiation device according to the present invention is obviously far more simplified than that feeding the devices of known technique, seen that a single lamp has to be fed for each conveyor of four to six meters length, instead of the 40 to 120 lamps required in the devices of prior art. According to a preferred embodiment of the present invention, a single electric system is provided to feed the lamps 8 and 9, automatically connected to either one of the two circuits of the lamps 8 and 9, only when one of these lamps has to be switched on.

The device according to the present invention allows to obtain evident and important advantages. It in fact notably reduces capital and running costs, thanks to the fact that it uses, as light source, a single more powerful lamp to obtain on the painted objects the same irradiance ( $100\text{--}400 \text{ mJ/cm}^2$ ) normally obtained with a plurality of low-power lamps.

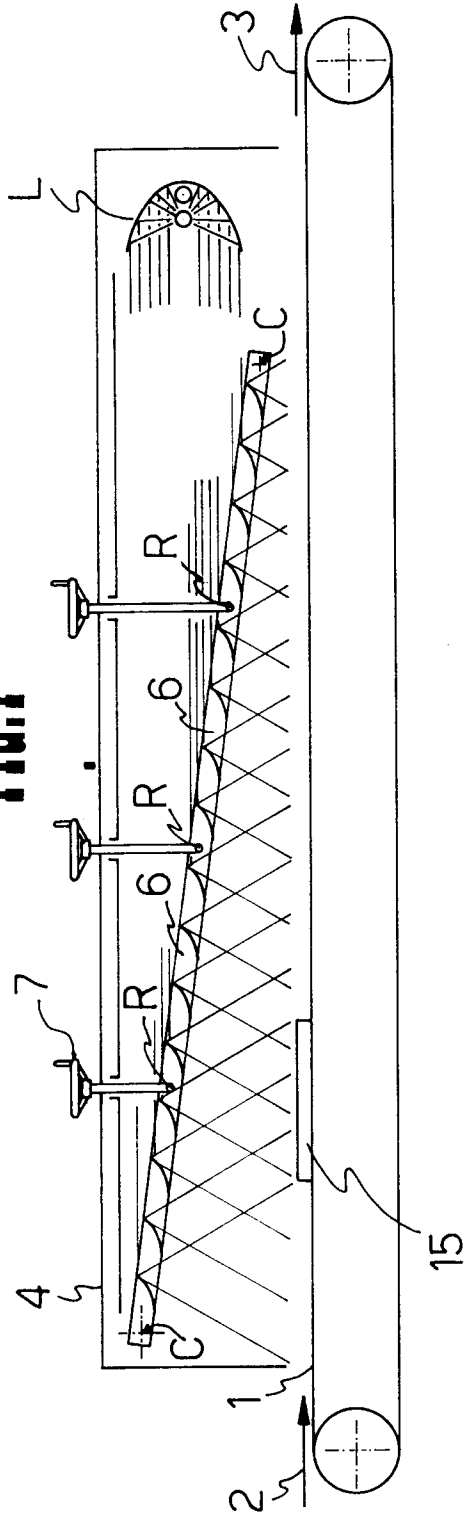
It provides for many possibilities to regulate the irradiance along the travelling path of the objects being treated, avoiding any dispersion of light radiation and thus keeping constant the overall amount of power fed to the irradiation device. It finally allows to work with two light sources having a different spectrum, by simply rotating the device for selection of the lamps 8 and 9.

The present invention has been described with reference to a specific preferred embodiment thereof, but it is evident that its protection also extends to any other embodiments allowing to optimize the essential functions of the device according to the invention, for example by varying the shape and arrangement of the mirrors, the length and number of the mirror frames, the position and number of lamps of the light source, and so on.

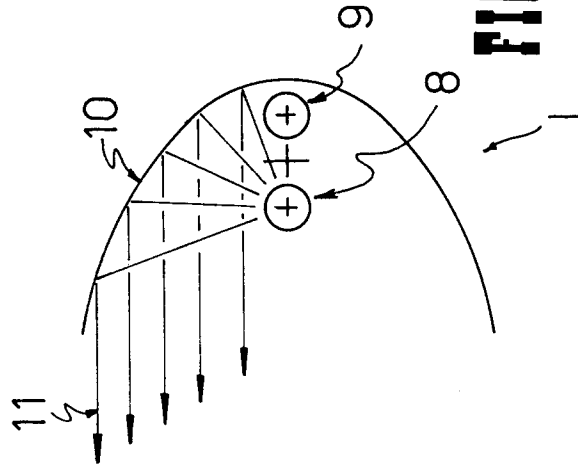
### Claims

1. Ultraviolet light irradiation device in painting plants making use of photopolymerizable paints, of the type in which the painted objects are moved forward on conveying means across an irradiation zone, characterized in that it comprises at least one light source, apt to send a beam of uviol rays in a direction substantially parallel to the conveying means, and a plurality of convex mirrors positioned transversally above said means along a plane which is inclined in respect thereof, apt to fully intercept said beam of uviol rays and reflect it onto the painted objects.
2. Irradiation device as in claim 1), wherein said light source consists of a cylindrical reflector with parabolic cross section, along the focal line of which there is positioned a tubular uviol lamp.
3. Irradiation device as in claim 1), wherein said mirrors consist of bars having a parabolic-arc section.
4. Irradiation device as in claim 3), wherein said mirrors are inclined on the horizontal plane, and in respect of the direction of said beam of uviol rays, by an angle between  $90^\circ \pm 20^\circ$ .
5. Irradiation device as in claim 1), wherein said mirrors are mounted in sets onto a series of swinging frames.
6. Irradiation device as in claim 5), wherein said frames are adjacent and hinged one to the other, the free ends of the first and last frame being hinged onto the framework of the device.
7. Irradiation device as in claim 6), wherein control means are also provided to adjust the position of the intermediate hinges in respect of a substantially vertical direction.
8. Irradiation device as in claim 2), wherein said light source also comprises a second lamp, parallel to the first and stiffly connected thereto by way of a common housing, said second lamp being positioned close to the bottom of the reflector.
9. Irradiation device as in claim 8), wherein said housing of the two lamps is hinged on an axis barycentric in respect of the lamps, motor means being provided to invert the position of said lamps by rotating the housing by  $180^\circ$ .
10. Irradiation device as in claim 8), providing for a single electric system feeding said two lamps, apt to automatically feed the lamp which is moved into the working position.

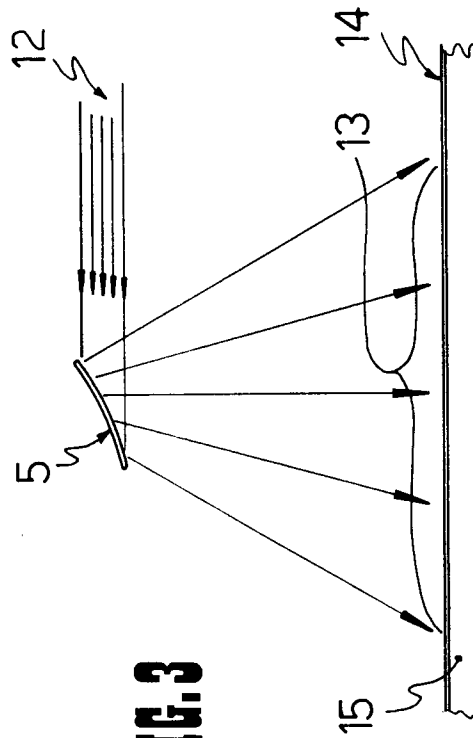
**FIG. 1**

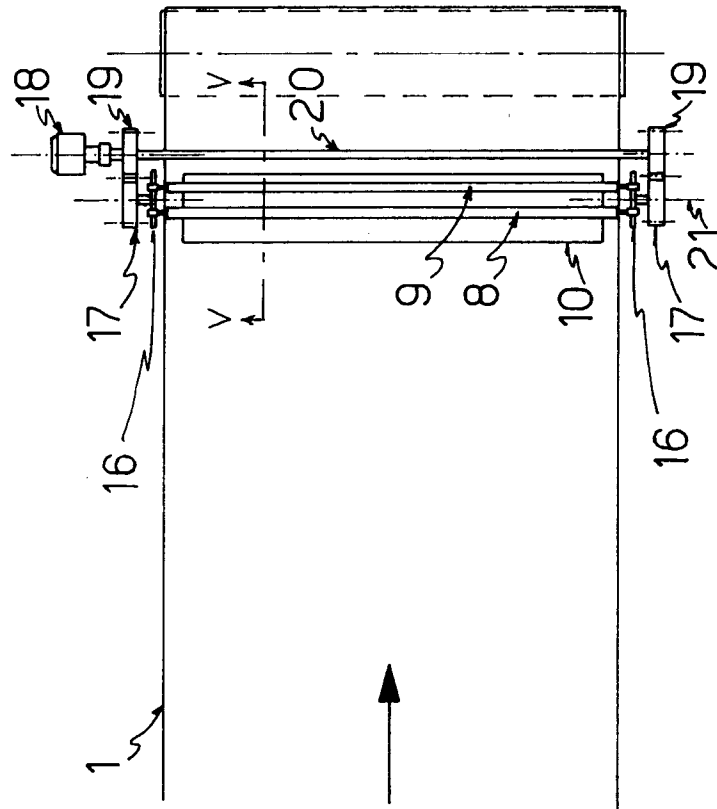
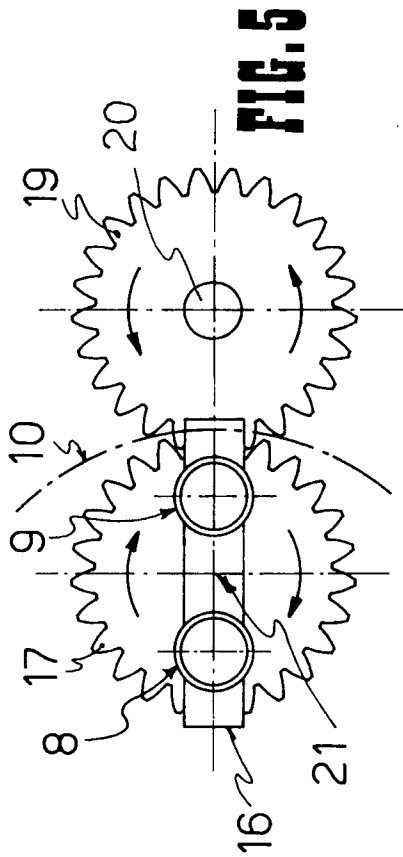


**FIG. 2**



**FIG. 3**







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## EUROPEAN SEARCH REPORT

Application Number

EP 91 12 0664

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                               |                                                   |                                               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------|-----------------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim                                 | CLASSIFICATION OF THE APPLICATION (Int. Cl.5) |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | DE-A-2 639 728 (RONGREN)<br>* the whole document *<br>---                     | 1,2,5                                             | F26B3/28                                      |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | DD-A-8 211 (BLASCHEK)<br>* the whole document *<br>---                        | 1,5                                               |                                               |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | DE-A-2 046 066 (GENVRAIN S.A.)<br>---                                         |                                                   |                                               |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | GB-A-1 209 335 (N.V. TOOLS LIMITED)<br>-----                                  |                                                   |                                               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                               |                                                   | TECHNICAL FIELDS<br>SEARCHED (Int. Cl.5)      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                               |                                                   | F26B                                          |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                               |                                                   |                                               |
| Place of search<br>THE HAGUE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                               | Date of completion of the search<br>03 MARCH 1992 | Examiner<br>SILVIS H.                         |
| <b>CATEGORY OF CITED DOCUMENTS</b><br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>.....<br>& : member of the same patent family, corresponding document |                                                                               |                                                   |                                               |