PATENT SPECIFICATION (11) 1 585 779

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(21) Application No. 35257/77 (22) Filed 23 Aug. 1977

(31) Convention Application No. 4846 (32) Filed 24 Aug. 1976 in

(33) Italy (IT)

(44) Complete Specification Published 11 Mar. 1981

(51) INT. CL.[3] G03B 27/54

(52) Index at Acceptance
G2A 315 317 C3 C5 C6 EF
F4R 203 233 337 FN

(19)

(54) ILLUMINATION SYSTEM FOR A PHOTOGRAPHIC ENLARGING OR PRINTING APPARATUS

(71) We, DURST AG., a body corporate organised according to the laws of Italy, of 39100 Bozen, Gerbergasse 58, Italy, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The invention relates to an illumination system for a photographic enlarging or printing apparatus employing a light-mixing shaft.

Colour heads, for example, of enlargers frequently produce colour filtering of the light source by introducing a colour filter or filters to different depths into the light beam from the source, and a light-mixing shaft serves to so mix the partially filtered beam that the light incident on the negative or other original is uniformly coloured.

The invention provides an illuminating system for a photographic enlarging or printing apparatus, which comprises a light-mixing shaft defined by a number of contiguous sections having reflecting internal surfaces extending from the light inlet end to the light outlet end, the sections being arcuate in a direction from the inlet end to the outlet end and straight in cross-section taken parallel to the inlet and outlet planes.

The invention enables a light shaft to be constructed in which a satisfactory intensity distribution over the surface to be illuminated, for example a negative, can be achieved without the necessity of using a diffuser screen in the light outlet plane having a diffusing action which is different over different areas of the screen: a diffuser screen of uniform strength over its whole area can be used. Further, the light shaft can be such that the intensity distribution in the light outlet plane is such that a thinner diffuser screen can be used than hitherto there. Thus better luminous efficiency can be achieved since a thinner diffuser screen will result in less light loss, without substantially affecting the quality of light colour mixing, as compared with a conventional light-mixing shaft of the same length.

A satifactory intensity distribution over the surface to be illuminated (for example, the surface of a negative) may or may not be uniform. Thus, while it is almost always desired to produce a uniform intensity on the projection plane (supposing, for the sake of simplicity, the negative to represent an object of uniform birhgness) the light shaft may provide a non-uniform intensity to compensate for vignetting by the enlarger objective, possibly also taking into account the opposite effect resulting from vignetting caused by a camera lens used to produce the negative.

Preferably, the arcuate sections are each part right circular cylindrical: this enables sheet metal to be used for the sections thereby making the light shaft inexpensive to construct.

Advantageously, the sections are so inclined to the light outlet plane that the angle between the light outlet plane and the tangent, at the light outlet plane, to each arcuate section, lies between 75° and 105°, and so that the shaft flares from the inlet end to the outlet end. Advantageously, the concave sides of the arcuate sections are at the interior of the light-mixing shaft.

The inner wall of the shaft may have a mirror reflecting surface or a diffusely reflecting surface, for example, a matt surface.

An illuminating system having a light-mixing shaft will now be described in detail, by way of example, with reference to the accompanying drawing, which is an axial cross-section of the system.

For the sake of clarity, various parts of the illuminating system are not shown in detail. The illuminating system shown is designed for a photographic enlarging apparatus. The system incorporates, above its negative plane

in which the originals to be enlarged are positioned, a light-mixing shaft 1, which is composed of four arcuate sections 2 extending from the top to the bottom of the shaft and connected with one another. On the light inlet side, a diffuser screen 3 may be provided and on the light outlet side a further diffuser screen 4 may be provided. The four side sections 2 are part-cylindrical, that is, they each coincide with the surface of an imaginary cylinder (cylinder being used in this Specification to mean a right circular cylinder), and arranged with respect to one another in such a manner that the cross-sections of the light-mixing shaft that are parallel to the diffuser screens are substantially rectangular. The use of cylindrical lateral portions 2 makes it possible to produce a light-mixing shaft of this type particularly cheaply from sheet metal components of appropriate shape. The cylindrical faces are of such a width that the sections connect directly to each other at their edges. The individual components forming the light-mixing shaft may, for example, be joined together by means of rivet joints as shown in the drawing, which also makes for simple and cheap production. The inner wall of the light-mixing shaft is preferably provided with a mirror surface, for example, using a suitable sheet mirror. However, it is also possible for the inner faces to be diffusely reflecting surfaces, totally or partially, an effect which can be achieved by suitable treatment of the material forming the shaft.

The transparent originals (not shown) to be illuminated are arranged in the vicinity of the light outlet plane, which, in the example shown, is covered by the diffuser screen 4, a projection lens (also not shown) being provided beneath the originals.

A printing light source (not shown) is arranged above the diffuser screen 3. Between this source and the diffuser screen 3, it is possible for colour filters to be introduced into the light path, and further light-conductive and/or light-mixing means may also be positioned there.

The curve which the arcuate sections 2 have depends on the light conditions at the light inlet plane, on the shape and extent of that plane, the length of the light-mixing path, on the shape and extent of the light outlet plane, and also on the brightness distribution required at this plane.

In this respect, the inclination α of the arcuate side sections with respect to the light outlet plane is particularly important: α is the angle between the light outlet plane and the tangent to a side section at the point of contact of that side section with the light outlet plane. The brightness of the peripheral areas of the illuminated format relative to the central zones is directly affected by this inclination.

If the angle α is increased relative to a given starting position, the peripheral zones become brighter relative to the light distribution there in the starting position, and the converse is the case if the angle α is decreased, the peripheral zones being illuminated less brightly relative to the light distribution in the starting position.

Thus, the selection of the appropriate angle α means that it is possible, within certain limits, to control the brightness of the peripheral zones in such a manner that the image cast onto the projection plane has no definite fall off in intensity at the peripheral zones.

The angle α may lie, for example, between 75° and 105°. Another consideration to be borne in mind is that the shaft should be as short as possible.

Various modifications are of course possible. Thus, for example, the side sections 2 need not be part cylindrical. They may for example be such that the art lies on a curve different from a cylinder, while still being straight in cross-sections parallel to the inlet and outlet planes, thus enabling them to be made for sheet metal appropriately bent.

As an example of the dimensions for the illuminating system, the following may be employed: outlet plane 60 mm by 90 mm; separation between inlet plane and outlet planes, about 58 mm; angle between the light outlet plane and the line extending from a point midway along the edge of the light outlet plane to a point midway along the edge of the light inlet plane, 77° at the longer side and 82.5° at the shorter side; and radius of curvature of the sections, 137 mm for the longer side and 235 mm for the shorter side. This gives values of α of 90° both for the longer and shorter sides, respectively.

WHAT WE CLAIM IS:-

1. Illuminating system for a photographic enlarging or printing apparatus, which comprises a light-mixing shaft, defined by a number of contiguous sections having reflecting internal surfaces extending from the light inlet end to the light outlet end, the sections being arcuate in a direction from the inlet end to the outlet end and straight in cross-section taken parallel to the inlet and outlet planes.

2. Illuminating system as claimed in claim 1, wherein the arcuate sections are each part right circular cylindrical.

3. Illuminating system as claimed in claim 1 or claim 2, wherein the light-mixing shaft is defined by four sections.

4. Illuminating system as claimed in claim 3, wherein the light-mixing shaft has a cross-section that is substantially rectangular.

5. Illuminating system as claimed in any one of claims 1 to 4, wherein the sections are so inclined to the light outlet plane that the

angle between the light outlet plane and the tangent, at the light outlet plane, to each arcuate section, lies between 75° and 105°, and so that the shaft flares from the inlet end to the outlet end.

6. Illuminating system as claimed in any one of claims 1 to 5, wherein the concave sides of the arcuate sections are at the interior of the light-mixing shaft.

7. Illuminating system as claimed in any one of claims 1 to 6, wherein a diffusing screen is arranged in the light outlet plane of the light-mixing shaft.

8. Illuminating system as claimed in claim 7, wherein the diffusing screen is planar.

9. Illuminating system as calimed in any one of claims 1 to 8, wherein a diffusing screen is arranged in the light inlet plane of the light-mixing shaft.

10. Illuminating system as claimed in any one of claims 1 to 9, wherein the sections are joined together by means of rivet joints.

11. Illuminating system as claimed in any one of claims 1 to 10, wherein the light-mixing shaft has mirror-reflecting surfaces on its inner wall.

12. Illuminating system as claimed in any one of claims 1 to 10, wherein the light-mixing shaft has diffusely-reflecting surfaces on its inner wall.

13. Illuminating system substantially as hereinbefore described with reference to, and as shown in, the accompanying drawing.

14. A photographic enlarging or printing apparatus having an illuminating system as claimed in any one of claims 1 to 13.

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Printed for Her Majesty's Stationery Office,
by Croydon Printing Company Limited, Croydon, Surrey, 1981.
Published by The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*