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Weisglass et al.

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[54] **LIGHT HEAD WITH INTERCHANGEABLE MIXING CHAMBERS FOR HIGH SPEED ENLARGER**

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[52] **U.S. Cl.** **355/71,** 355/35, 355/37

[51] **Int. Cl.**.....**G03b 27/76**

[58] **Field of Search**.....355/71, 35, 37

[56] **References Cited**

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[57] **ABSTRACT**

A light head for a high speed enlarger for the making of photographic prints utilizing interchangeable light mixing chambers for the efficient transmission of light through negatives of various sizes. Light mixing chambers of economical construction are provided including several types of light directing means for the light inlets to restrict light losses to a minimum with attendant increase in speed of print production.

6 Claims, 2 Drawing Figures

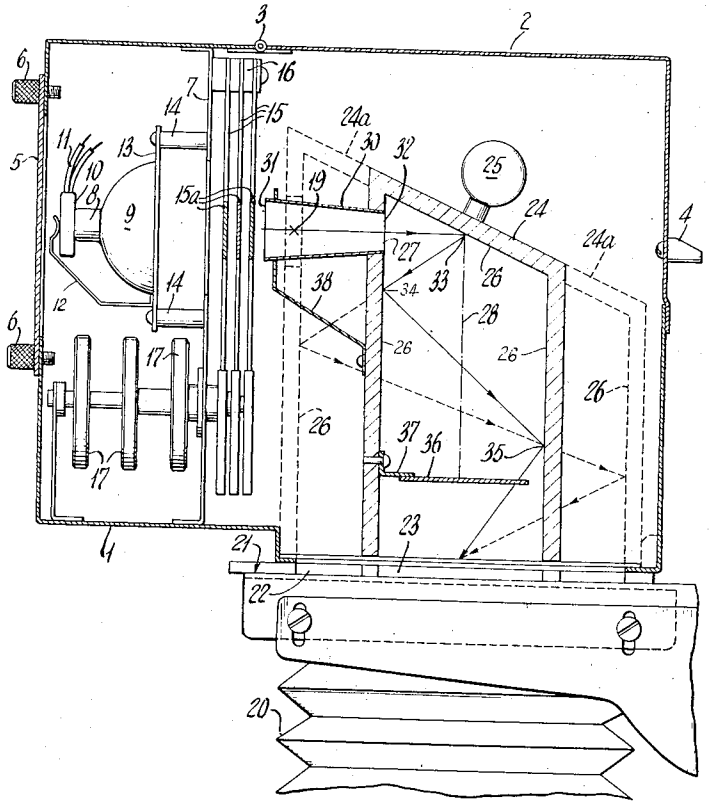

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Fig. 1.

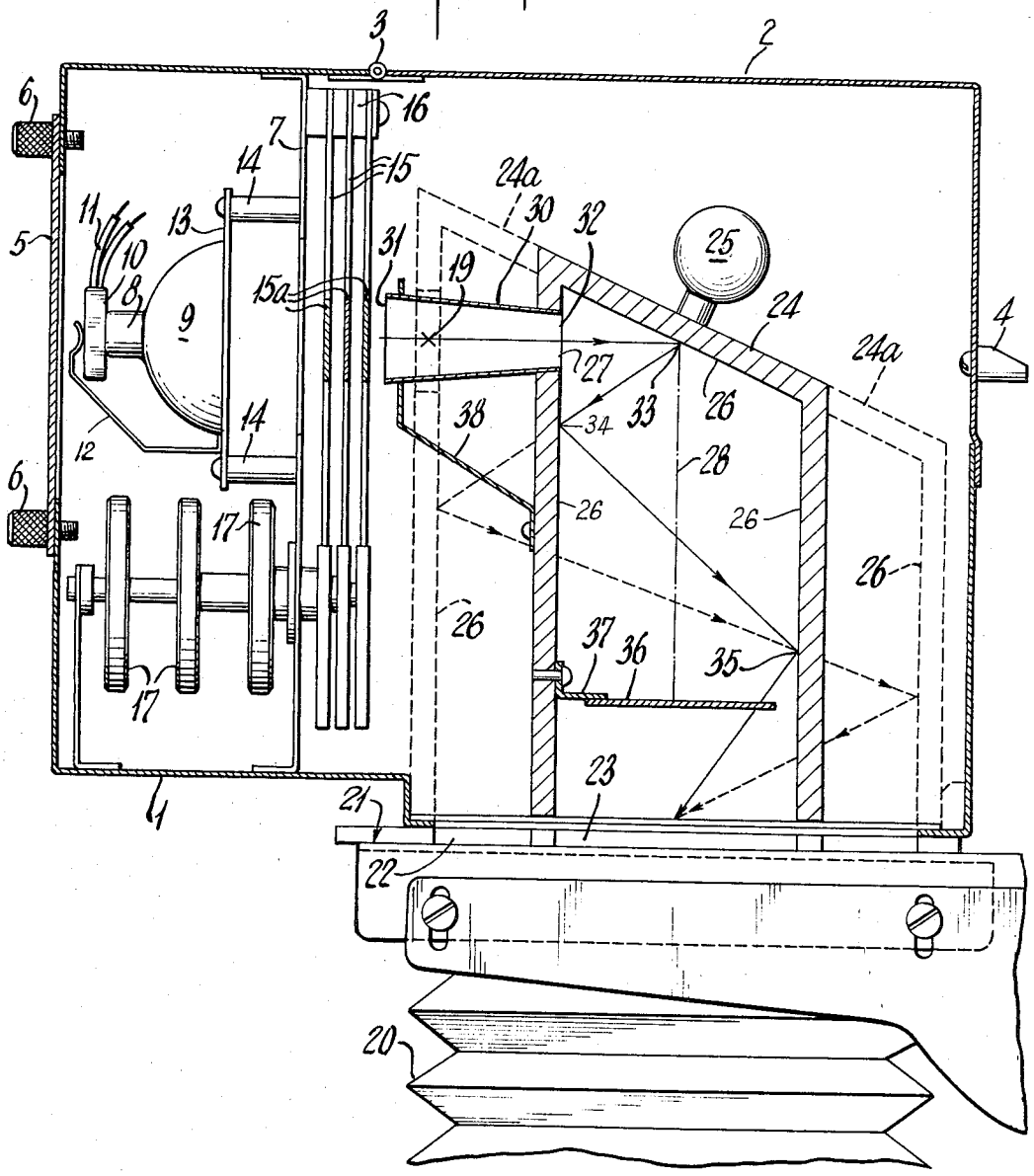
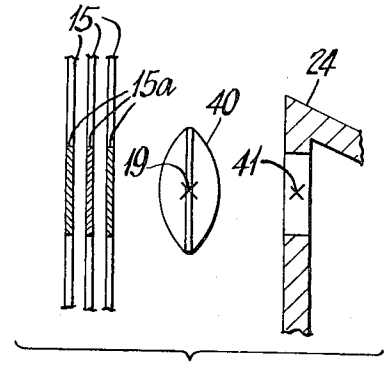


Fig. 2.



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LIGHT HEAD WITH INTERCHANGEABLE MIXING CHAMBERS FOR HIGH SPEED ENLARGER

The present invention relates to illuminating apparatus for the copying or enlarging of photographic negatives or transparencies and constitutes an improvement over such apparatus as shown and described in my prior U.S. Pat. No. 3,488,117 issued Jan. 6, 1970 and assigned to the same assignee as the present invention.

In such apparatus as shown and described in my previous patent the negative or transparency receives light from the relatively large exit window of a hollow spherical light mixing body provided with a diffusely reflecting interior surface which is usually white. This light mixing body receives light through one or more relatively small entrance windows from a lamp placed at one focal point of an elliptical light collector having a specularly reflecting interior surface while the other focal point of such light collector coincides with the entrance window of the spherical light mixing body. Also, as is customary, adjustable color filters are utilized to produce desired color blending when a color print is to be made from a color transparency. If desired, an additional infrared and/or ultraviolet absorbing filter may be included for blocking such radiations from passing to the film transparency.

The light flux thus entering the light mixing body through the entrance windows finally emerges with relatively small losses through the exit window. The luminous energy at the same time being fairly uniformly distributed over the area of the exit window and hence over the area of the film negative or transparency which is placed in proximity to such exit window. It follows that whether the same light flux enters a large light mixing body with a large exit window or a small light mixing body with a correspondingly small exit window, the light flux leaving the exit window will in either case have about the same total energy. However, in the case of the smaller exit window such light flux is distributed over smaller area thus resulting in much higher energy per unit area. This phenomenon can be utilized to shorten the required exposure time for small transparencies which require high degrees of magnification and which heretofore have necessitated unduly long exposure times.

In the patent referred to above a pair of oppositely positioned light collector and filter sources are directed towards a spherically shaped light mixing chamber having light guides extending from the spherical light mixing chamber towards the sources of light. A light mixing chamber with its attached light guides of one size may be replaced by a light mixing chamber of another size wherein the distance between the outer ends of the light guides is the same thus providing for replaceability between fixed light collectors.

The construction shown in said patent is quite satisfactory, many thousands of the units having been sold. However, in order to exploit a lower priced market it has been considered desireable to provide a construction which utilizes a single light source or a plurality of light sources positioned adjacent to each other and arranged so that the light therefrom is directed through filters into the light mixing chamber.

It is accordingly an object of the present invention to provide a light head for photographic printers and enlargers wherein the light mixing bodies may be readily interchanged so as to produce values of light energy per unit area in accordance with the size of the transparencies to be printed or enlarged and to simultaneously shorten the exposure time.

Another object of the present invention is the provision of a light head for photographic printers and enlargers wherein the light mixing bodies are readily interchangeable so that each light integrating body has a definite relationship with respect to the size of the transparency to be printed or enlarged and the exposure time required for small transparencies necessitating higher magnification is significantly reduced by increasing the light energy per unit area falling upon the transparency.

In accordance with the invention this is accomplished by the provision of a light head for high speed printers and enlargers with interchangeable light mixing chambers in which the light exit window of the various interchangeable light mixing chambers corresponds to the size of the film transparency to be printed or enlarged. In each interchangeable light mixing chamber the exit window is positioned so that its center line coincides substantially with the center of the film transparency. In addition a light reflecting surface is positioned to receive light from a light inlet and reflect the light towards the light exit. Light directing means is interposed between the light unit assembly and the light inlet of the mixing chamber, this light directing means taking the form of a light guide in one embodiment and of a lens in another embodiment.

The light head in accordance with the invention is advantageous in that in practice a light mixing chamber may be provided, for example, for use with a 4 × 5 inch negative which may be enlarged to make an 8 × 10 inch print or a two times magnification. It has been found that such a print may be made in about 4 seconds. If the 4 × 5 inch light mixing chamber is replaced with one having a light exit suitable for use with a 35 millimeter negative to be used for making an 8 × 10 inch print the magnification is about 8 times. It is quite obvious that between a light magnification of 2 and 8 times there is a large loss of light intensity, but because of the construction used the enlargement from the 35 millimeter negative may be made in about 15 seconds. Additional speed may be achieved by providing a light source such as that for the 4 × 5 inch enlargement in which the lens is stopped down somewhat and for the 35 millimeter enlargement the lens is opened up. In this case the enlargements might be made from the 35 millimeter film in about 7 seconds using a lens with an aperture of about *f*.11.

Other objects and advantages of the invention will be apparent from the following description and from the accompanying drawing which shows, by way of example, two embodiments of the invention.

In the drawing:

FIG. 1 is a schematic drawing showing a vertical sectional view of a light head in accordance with the invention, one interchangeable light mixing chamber being shown in solid lines while dashed lines show the position taken by a light mixing chamber of larger size.

FIG. 2 shows a fragmentary view of a modified construction in which a positive lens is substituted for the light guide of the construction shown in FIG. 1.

Referring to the drawings there is shown in FIG. 1 a light head for an enlarger in accordance with the invention and including a housing 1 which may be made of sheet metal or the like provided with a cover 2 hinged as indicated at 3 and which may be lifted by a handle 4. Also positioned on the housing 1 is a removable light chamber door 5 secured in position by screws 6.

Within the housing 1 is an apertured partition 7 which provides supporting means for a projection type light source 8 which may include a condensing reflector 9 integral therewith. A connecting base or socket 10 provides a terminal for wires 11 adapted to be connected to a source of electricity. A spring member 12 may be used to press against the socket 10 to hold the light source assembly in position against an apertured member 13 held in spaced relationship with the partition 7 by studs 14 also supported by the partition 7. On the opposite side thereof from the light source 8 is one or more light filter units 15 which may be pivotably mounted as indicated at 16 and individually swung out of the range of the light 8 by rotation of knobs 17 which may project from the housing 1 for ready manipulation thereof. The light source 8, the condensing reflector 9 and the filter assembly 15 may constitute a light unit assembly fixedly positioned in the housing 1 and so constructed that light condensed by the reflector 9 and projected through the filters 15 is focused approximately at the point indicated by the numeral 19.

At the bottom of the housing 1 is positioned a bellows assembly 20 at the end of which (not shown) is positioned the usual lens. If desired the support for the housing 1 and the bellows 20 may be an autofocusing construction such as shown in U.S. Pat. No. 2,813,454 issued Nov. 19, 1957.

At the upper end of the bellows assembly 20 is positioned a negative or transparency holder 21 which may be slideably mounted and which provides a light opening adapted to receive a film or transparency. For example, the negative or transparency holder 21 may be constructed to receive a 4 × 5 inch negative in which the light opening would be as indicated at 22. Adapted means may be provided to close off a portion of the light opening 22 to provide a light opening 23, for example, to receive a 35 millimeter transparency.

Interchangeably positioned within the housing 1 is a replaceable light mixing chamber 24 which may have a knob 25 at the top thereof to facilitate the insertion and removal of the light mixing chamber 24 within the housing 1 while the cover 2 is opened. The light mixing chamber 24 is preferably of rectangular shape in a cross sectional view looking downwardly towards the bottom thereof. Alternatively, a light mixing chamber of cylindrical shape may be used, preferably with its lower end flared into cross sectional shape providing an exit window slightly larger than the size of the negative with which it is to be used, as is the case for the light mixing chamber of rectangular cross sectional shape.

The roof and the side walls of the light mixing chamber 24 provide diffused light reflecting surfaces 26 positioned so as to reflect light entering light inlet 27 towards the negative holder 21. The light inlet 27 is positioned with its center line along a line extending from the light focusing point 19 to the light source 8. The light reflecting surfaces 26 are impinged by the light from the source and direct the light towards the transparency holder 21 by multiple reflections. The light reflecting surfaces 26 preferably are white matte surfaces. A titanium dioxide coating is good and compares almost 100 per cent with a magnesium oxide standard which does not lend itself to easy application as a paint. The parts are so arranged that the center of the entering light is reflected along the center line 28 of the film transparency.

In order to prevent loss of light entering the light chamber 24 light directing means in the form of a member 30 may be provided of tubular shapes with opaque sidewalls, the inside being preferably with a highly specular reflecting surface. The light directing member 30 should have a light entering end 31 of a diameter such as to receive the majority of the light passed through the filters 15*a* carried by the filter members 15. The light exit end of the light directing member 30 indicated at 32 should have a diameter small enough to pass the light from the entering end 31 but preferably not so large as to permit the escape of an appreciable amount of reflected light back from the interior of the light mixing chamber 24. Alternatively the light directing member 30 may be of a solid piece of material which has high light transmission quality such as glass, acrylic, or similar optically suited materials.

It will be noted that the light focused at point 19 impinges against the light reflecting surface 26 of the roof of the light mixing chamber 24 generally at the point indicated at 33 and is reflected to the sidewall at the point generally indicated at 34, thence to the opposite sidewall as indicated at 35 and thence towards the center line of the transparency 28. The light path shown and indicated generally by the numerals 33, 34, and 35 should only be considered as symbolic as actually the titanium dioxide coated white surface diffuses the light beams in multidirections providing a well diffused mixture of light. This light may be passed through light diffusion means 36 secured in position to a wall of the light mixing chamber 24 by an angle member 37 or other suitable means. In the interest of economy the light reflecting surface 26 may be a flat surface adapted to reflect light rays from within the chamber towards the transparency holder 21. The light tube 30 may be secured and maintained in position at its inner end 32 by engagement with the wall of the mixing chamber 24 and its outer end 31 may be supported by a bracket member 38.

The mixing chamber 24 may have any desired shape but for the purpose of reference may be described as being suitable to pass light to a 35 millimeter transparency in which its bottom opening as stated above will be perhaps just slightly larger than the transparency. In the event the light mixing chamber 24 is to be replaced with a light mixing chamber for a larger transparency such as one having the dimensions of 4 × 5 inches the light mixing chamber 24 may be extended as indicated by dotted areas 24*a* so that its cross sectional area is slightly larger than the 4 × 5 inch transparency. In this case the light guide 30 may be omitted inasmuch as the light from the source 8 is focused at the point 19 and substantially all of same will enter the enlarged light mixing chamber 24*a* without the need of

a light guide. It will be noted that in the smaller mixing chamber the walls are more brilliantly lighted than in the larger mixing chamber. The increase in light is almost proportionate to size and theoretically the light increase would be proportionate but there is always a small loss. The multiple reflections from the sidewalls cause the light intensity of the light exiting from the smaller chamber to vary inversely with the area of the sidewalls. For example, with sidewalls of the light mixing chamber for the 4 × 5 inch negative illuminated with a certain lamp source intensity when replaced with the light mixing chamber for the 35 millimeter negative the intensity of the light is three times greater for the 35 millimeter light mixing chamber. Therefore with the same "*f*" number and the same magnification of the projected image the 35 millimeter light mixing chamber will decrease the exposure time of a similar negative by a factor of one third.

An alternative light directing means is shown in FIG. **2** wherein the light inlet of the light mixing chamber **24** is provided with a positive lens **40** positioned at the focal point **19**. The lens **40** is provided with a power such that its focal point is as indicated at **41** in FIG. **2** so that the light flux from the source is directed into the light chamber **24** substantially without appreciable loss.

While the invention has been described and illustrated with reference to specific embodiments thereof it is to be understood that other embodiments may be resorted to without departing from the invention. Therefore, the form of the invention set out above should be considered as illustrative and not as limiting the scope of the following claims.

We claim:

1. A light head for a high speed enlarger for projecting an image of a film transparency during the making of a print or enlargement thereof comprising:

a housing,

a light unit assembly being positioned within the housing and including a projection type light source, a condensing reflector providing a concentrated beam of light, and at least one filter unit movable into and out of said concentrated light beam,

a replaceable light mixing chamber positioned adjacent and at one side of said light unit assembly, the light mixing chamber including means defining a light inlet and a light exit, said light inlet being positioned at one side of said mixing chamber and said light exit being positioned at the bottom thereof at approximately right angles to the light inlet,

film transparency supporting means carried by said housing and being positioned to receive light transmitted through said light exit for projection of an image through a lens to an easel,

said light mixing chamber having its light exit of approximately the same size as the transparency with which it is to be used and positioned with its vertical center line coinciding substantially with the center of the film transparency, said mixing chamber being substantially rectangular and having four reflective diffusing sidewalls and a reflective diffusing flat ceiling sloping relative to said sidewalls, said inlet being located to direct light toward said ceiling, said ceiling forming a main light reflecting surface positioned so as to reflect light entering said light inlet towards said light exit, said exit being located under said ceiling, and light directing means interposed between said light unit assembly and the light inlet, said light inlet being of a size as to allow substantially all light passed by said light directing means to enter the light mixing chamber yet not of a size to permit a substantial amount of light to be reflected from the mixing chamber back towards the light source.

2. A light head for a high speed enlarger according to claim **1** in which said light directing means is a tube having its inner end of a size to direct substantially all of the light passing therethrough into the light inlet and whereby its interior surface is highly specular.

3. A light head for a high speed enlarger according to claim **1** in which said light directing means is a solid piece of material having light transmission quality.

4. A light head for a high speed enlarger according to claim **1** in which said light directing means is a lens directing substantially all of the light passing therethrough into the light inlet.

5. A light head for a high speed enlarger according to claim **1** in which said ceiling is a flat surface inclined at an angle to reflect light from the light inlet to the light exit by multiple reflections.

6. A light head for a high speed enlarger according to claim **5** in which the center of said ceiling is positioned substantially over the optical center of the transparency.

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