July 6, 1965 R. L. HEISS 3,192,842

METHOD AND APPARATUS FOR PHOTOCOPYING BOOK PAGES

Filed July 13, 1961 3 Sheets-Sheet 1

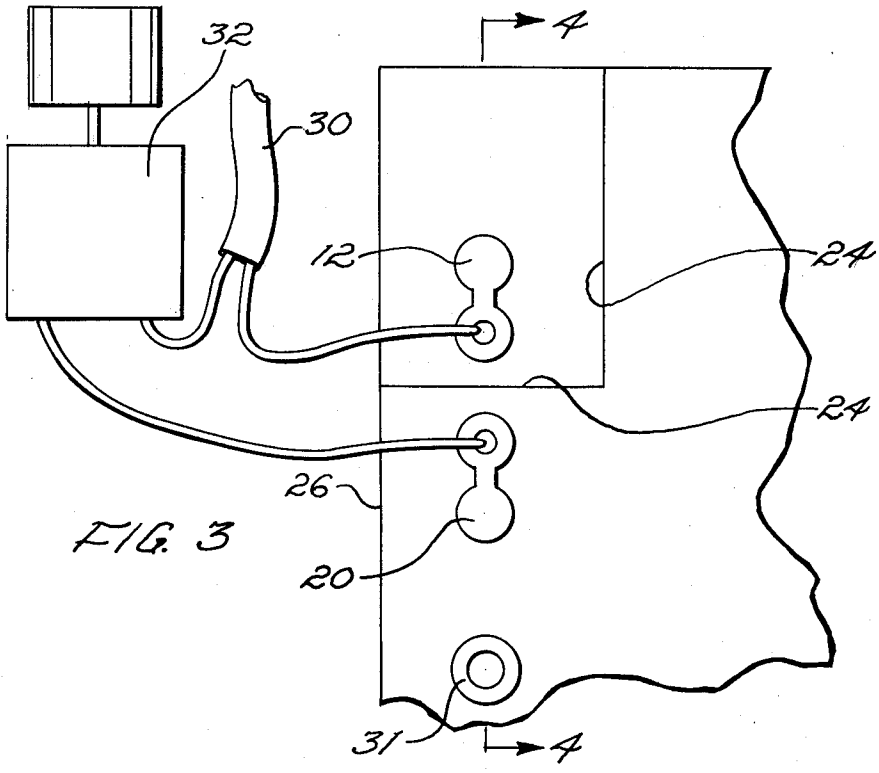


FIG. 3

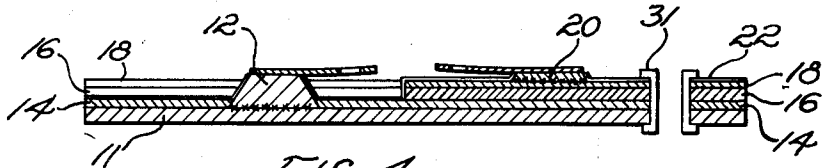


FIG. 4

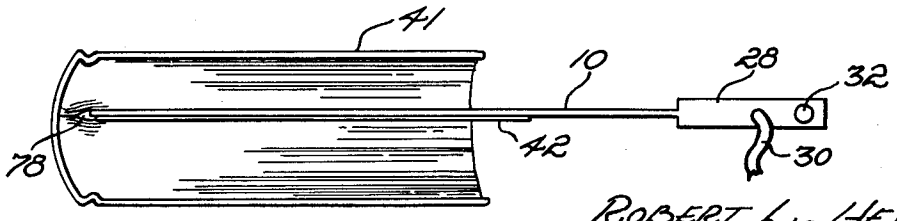


FIG. 5

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METHOD AND APPARATUS FOR PHOTOCOPYING BOOK PAGES

Filed July 13, 1961 3 Sheets-Sheet 2

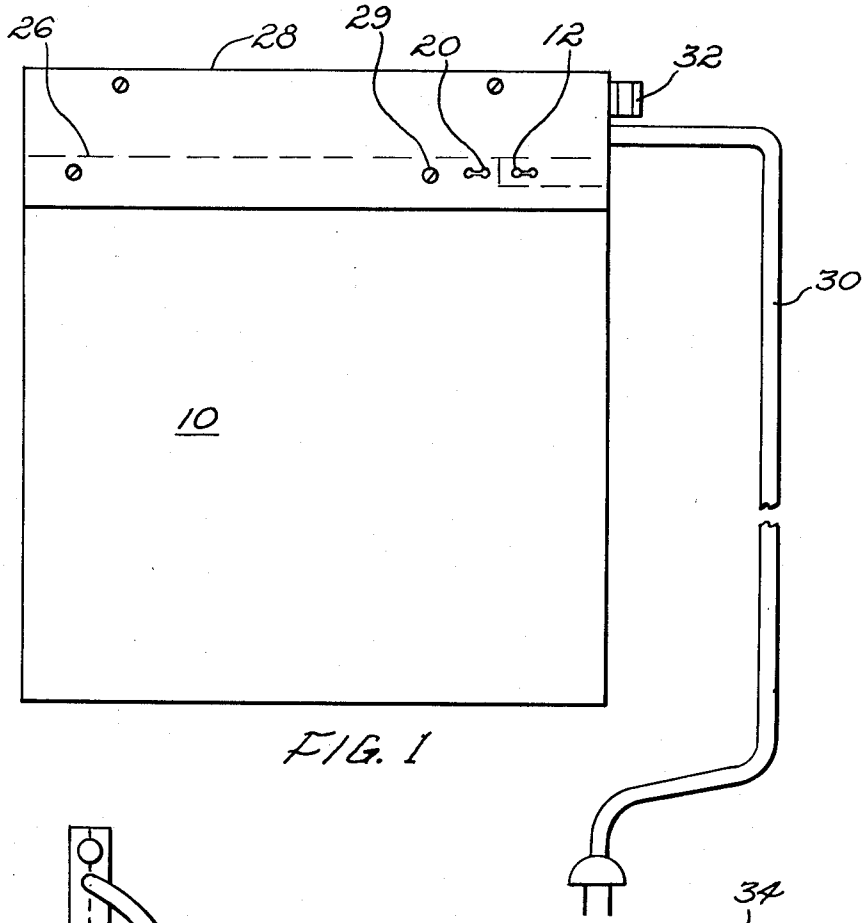


FIG. 1

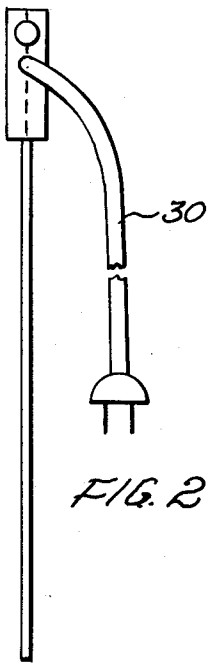


FIG. 2

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METHOD AND APPARATUS FOR PHOTOCOPYING BOOK PAGES

Filed July 13, 1961 3 Sheets-Sheet 3

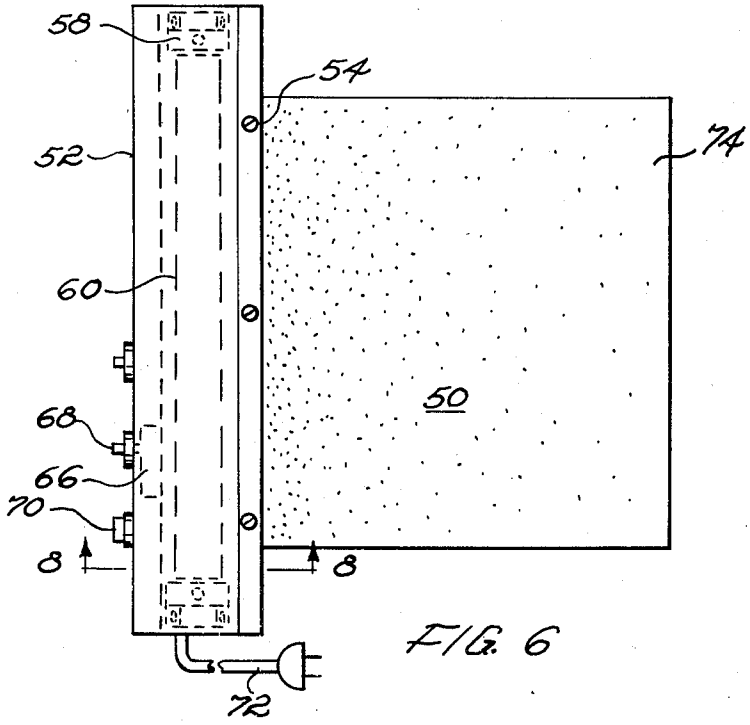


FIG. 6

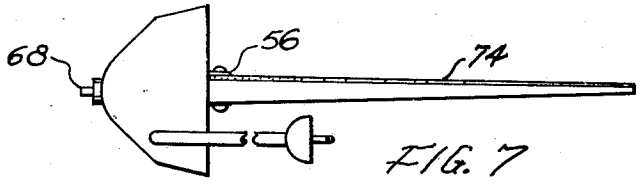


FIG. 7

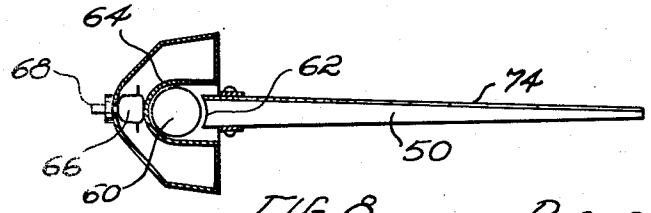


FIG. 8

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United States Patent Office 3,192,842 Patented July 6, 1965

3,192,842

METHOD AND APPARATUS FOR PHOTOCOPYING BOOK PAGES

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Filed July 13, 1961, Ser. No. 123,704
5 Claims. (Cl. 95—73)

My invention relates to a method and apparatus for photocopying book pages.

Photocopying devices have become a commonplace in today's business offices and business establishments by virtue of the development of procedures and apparatus which are far simpler and less expensive than those involved in conventional photographic processes. A common process lies in placing a translucent sheet having a photosensitive coating on the material to be copied and exposing the sheet to light. The light penetrates the sheet, reflects from the material, and exposes the coating. The areas of the material which are more or less black in terms of the sensitivity of the coating do not reflect and hence do not expose by reflection the coating portion in register therewith. The development process discriminates between the greater and less exposed areas of the coating and is capable of producing a good black-and-white negative print.

One apparatus employed in such printing is an open fronted case with a strong light source in its top, space for the reception of material to be copied below the light, and means for holding the sensitized sheet against the material. Other apparatus projects light upward through a glass panel. The sheet is laid on the panel, and the material to be copied face down on top of the sheet.

A difficulty arises in conjunction with either of these apparatuses when a page of a book is to be copied. With an external light source of the sort described, the book must be open for exposure. When a book is open (except where a special binding is used), the portion of the page adjacent the binding has a severe curvature extending often a third of the way across the page so that the photosensitive sheet either is spaced from the curved portion of the page and hence makes, at best, a fuzzy and near illeglible copy, or if the sheet is curved to conform to the curvature of the page, the exposure in the curved area is inadequate for proper reproduction.

My invention has, as a primary object, the provision of a method and apparatus whereby a photo print may be made of a page of a book when the page is flat. The photosensitive sheet, therefore, is in direct contact with the page to be copied and is equally distant from the light source everywhere. In the effectuation of this object of my invention is directed to copying photographically a page of a book while the book is closed. In the achievement of this objective, I contemplate photocopying apparatus including a light source which is thin enough to be inserted between the pages of a closed book to a point beyond the printing and near the binding thereof without the introduction of substantial curvature in the leaves of the book.

The apparatus of my invention exists in two primary modifications. In the first of these modifications my light source is inherently uniform over its surface. In the second of my modifications the light intensity differs over its area, and another object of my invention resides in the provision I have made to equalize the light intensity in this modification.

Although my invention was developed with particular reference to copying books, it is equally well adapted to copying any flat material and may readily be used instead of or a supplement to the more elaborate systems described above, with, however, substantial advantages thereover in cost, simplicity and ease of manipulation. My invention likewise is far more easily and inexpensively

adapted to copying larger pieces of printed material than any office copying apparatus I have seen.

Other objects and advantages of my invention will be apparent from the following descriptions and drawings of which:

FIG. 1 is a top plan view of the one form of the apparatus of my invention;

FIG. 2 is a side elevation of the light source of FIG. 1;

FIG. 3 is a fragmentary plan of the light source illustrating the composition thereof and the electrical connections;

FIG. 4 is a greatly enlarged section taken along the line 4—4 of FIG. 3 looking in the direction of the arrows;

FIG. 5 is a side elevation of a book containing my light source and copying paper in position for copying;

FIG. 6 is a top plan view of a second form of my apparatus;

FIG. 7 is an end elevation thereof; and

FIG. 8 is a section taken along the line 8—8 of FIG. 6 looking in the direction of the arrows.

The phenomenon of electroluminescence has been well defined in Airforce Manual 100–39, Communications-Electronics Terminology, Definitions and Abbreviations, edition of July 1, 1960, as "Excitation of luminescence by the application of an electrical potential to a crystalline phosphor or the suspension of such a crystal in a changing electrical field."

An electroluminescent sheet material has been developed which is capable, upon appropriate electrical excitation, of giving off uniform visible light over its whole surface. Such materials are described in Pat. Nos. 2,566,-349 and 2,624,857 issued Sept. 4, 1951 and Jan. 6, 1953 respectively to E. L. Mager and Pat. No. 2,838,715 issued June 10, 1958 to E. C. Payne. The first form of my invention contemplates the use of a panel 10 of this material.

It consists of a metal backing plate 11 having a terminal 12 fixed thereto at one edge or corner, a glass-based conducting layer 14, a ceramic layer 16 having electroluminescent phosphors therein, a transparent conducting layer 18 having a terminal 20 affixed thereto, and an outer, overall glaze coating 22 for sealing and insulation. The layers 16 and 18 are formed to avoid the terminal 12 by omitting that edge area, as at 24. The glaze is applied over the entire coated face and edges of the panel and may also coat the back. The glaze, of course, is easily chipped from the terminals 12 and 20 for electrical connection.

When an alternating current of 450 to 600 volts at 1000 c.p.s. to recite optimum circumstances, is applied to the terminals, the phosphors are caused to glow and emit light uniformly from the whole coated surface. The thickness of the panel depends to a large extent on the thickness of the backing plate. The several coatings, together may be as thin as .02 inch, and I contemplate the use of a backing plate to bring the total thickness to about 1/16 of an inch. Such a backing plate has sufficient rigidity to support the coatings without danger of flexing and cracking and yet be amply thin for my purposes.

I contemplate the employment of a panel of this material of, for instance, about 8½ x 11 inches, this being a size as large as almost any book page, although, as will be evident, a larger size obviously may be used.

The edge 26 of the panel along which the terminals 12, 20 are mounted, is enclosed in a relatively shallow case 28 which may be of plastic or some similar material. The case may be split to encompass opposite sides of the edge 26 and should be hollow to receive the terminals 12, 20. The halves of the case are attached together and to the edge of the plate 24 by screws 29 extending through insulating bushings 31 contained in appropriate holes in the edge of the sheet. Other methods of attachment of the

case to the sheet will, of course, be readily apparent. The case has an electric outlet cord **30** extending therefrom and an adjustable timer switch **32** thereon. The timer switch is wired in series with the terminals **12** and **20** to control the energization of the panel for any desired time interval.

It will be noted that the other three edges of the plate are unbounded or unrimmed so as to maintain minimum thickness at the edges.

While the electroluminescent plates described will glow under household voltages and frequency, greater efficiency or greater intensity of light is obtained from the application of 450–600 volts at about 1000 c.p.s. To effect this power conversion I provide a separate power converter unit **34** illustrated diagrammatically in FIG. 1. The unit consists entirely of standard electric circuitry constituting an oscillator, an amplifier and a power supply for effecting such power conversion. The power output of the unit should be in excess of 100 watts. The unit will have an outlet cord **36**, an on-and-off switch **38** and a receptacle **40** into which the outlet cord **30** of the luminescent panel will be plugged. By separating the power conversion unit from the panel, the panel will be much lighter and easier to manipulate, although, of course, it would be possible to mount the power conversion unit within the case **28** to make a unitary structure.

The process of my invention may be understod from the foregoing description of the one form of my apparatus. To copy a page from a book **41**, a sheet of copying paper **42** having a photo-sensitive coating on one side thereof is introduced into the open book with its edge brought as closely as possible to the binding. The sheet is oriented with the coating thereof facing and in contact with the page to be copied. My electroluminescent area light source is then placed on the back of the copying sheet, again, with a free edge thereof well in toward the binding from the inside edge of the printing on the page. The book is closed, the power conversion unit of the copier is plugged into an electric outlet, the panel is plugged into the power converter, and the timer is turned to the desired period of exposure of the copying sheet. The terminals **12** and **20** of the plate are energized and the panel glows, sending light through the copying sheet to reflect back to the coating thereof from the printed page. When the exposure is completed the copying sheet is removed and developed as in conventional photocopying procedures.

The second form of my apparatus is based on the use of a more commonplace material. In this form I provide a thin sheet **50** of Lucite (polymerized methyl methacrylate) or some similar transparent material having a very high index of refraction. The property which Lucite possesses of "piping" light is well known and is an attribute of its index of refraction. The Lucite panel may again be about 8½ inches wide and 11 inches long so as to be applicable to the page of almost any book, although, as will be evident, the panel may be larger. One side of the panel is intended as a light source and is sand blasted or similarly roughened.

The Lucite panel **50** has three free edges and a case **52** secured to the fourth edge thereof as by screws **54**. The case may be of plastic or metal and is substantially parabolic in section. The case includes strips **56** on its front edge between which the sheet **50** is mounted by the screws **54**.

Internally of the case, fluorescent tube fittings **58** are provided which support a fluorescent tube **60**. The fluorescent tube is in exact alignment with the fourth, enclosed edge of the panel **50**. The enclosed edge must be carefully polished and desirably is given a concave radius to conform to the radius of the light source for optimum, perpendicular reception of light from the light source. The fluorescent tube is housed in a highly efficient reflector **64** to direct a maximum of light to the edge **62** of the Lucite panel.

The case **52** will also have conventional starter mechanism **66** therein with an external switch **68** on the back side of the case and a timer switch **70** in series with the fluorescent tube circuit for operating the fluorescent tube a predetermined length of time. The case will likewise have an external outlet cord **72** for attachment to a conventional electric outlet.

The operation of this modification of my invention will likewise be readily apparent. As light is beamed from the fluorescent tube through the edge of the plastic panel and travels across the sheet, the light will encounter surfaces on the roughened side substantially at right angles to the direction of projection of the light, and light will therefore be emitted from this surface. There will be no substantial emission of light from the polished back surface because of the sharp angle of incidence of light from the source on it. The Lucite panel may be tapered, as shown, or may have parallel sides. It was first thought that the tapering sides would improve light emission but further experiment demonstrated that parallel sides functioned as well. A taper does enlarge the area of light reception from the light source and thins the opposite free edge for easier reception in a book although the parallel sided Lucite panel is less expensive and functions entirely adequately.

It will, of course, occur to anyone skilled in the art that the light emission from the roughened surface of the Lucite panel will not be uniform. There will be a greater emission from that portion of the sheet adjacent the light source than from the more remote portions. I have solved this difficulty by laying a sheet of ordinary photographic negative on the roughened surface on each of my assembled copiers and operating the light source to obtain negligible exposure at the farthest edge of the Lucite sheet and progressively greater exposure toward the light source. The negative material is then developed in conventional fashion and cemented to the roughened surface of the Lucite sheet. The areas of greater exposure will of course be darkened and the areas of least exposure will be substantially clear. I have found this expedient entirely effective in deriving uniform intensity over the face of the copier. This modification of my invention will, of course, be employed in exactly the same fashion as that first described.

It will be appreciated in this last described form that incandescent light source may be used as well as a fluorescent light source. Linear incandescent tubes are readily available, and recent developments have greatly increased their intensity. In such case it is obvious the internal equipment of the case will be altered accordingly.

This second modification of my invention will necessarily be somewhat thicker at its free edge than the $\frac{1}{16}$ of an inch mentioned in connection with my first form, particularly when a parallel-sided panel is used. However it is still possible to keep the thickness of the sheet down to $\frac{1}{8}$ to $\frac{3}{16}$ of an inch which will permit completely satisfactory copying of a book page.

When a plate of only $\frac{1}{16}$ of an inch thick is introduced into a book, there will be a certain distortion of the leaves on either side thereof. However books are printed with an inside margin between the printing and the binding of at least one quarter of an inch. The light source of my invention, therefore, may be introduced closer to the binding than the printing extends. There will be curvatures in the leaves beyond the edge of my light source as at **78** (FIG. 5) which, of course, are outside the desired area of printing and therefore worthy of no notice. There may also be a very slight curvature immediately under the inmost edge of the light source, and the light source and the copying sheet may not therefore lie dead flat against this portion of the page. It should be noted, however that this area will lie outside of the area of the printing on the page except in a few instances where the printer may have crowded the binding unduly. Even here, the separation of the copying sheet and light source from this inner line across the page will amount to so slight a sepa-

ration that the clarity of the copy is unimpaired. I have emphasized this point because in the claims appended hereto I have defined the thickness of the light source as being thin to induce no more than insignificant curvature in the printed portion of the page.

In my first described form, employing the electroluminescent sheet, it will be appreciated that the panel itself presents a certain shock hazard. The hazard involved in the exposed terminals is avoided by the case 28 which covers them. However, any break in the glaze might expose a user to this danger. The case 28, therefore, serves not only to enclose the terminals and mount the timer switch, but also as a handle whereby the panel may be safely manipulated.

It will be evident from the foregoing description that I have invented a wholly new concept both as to apparatus and to method for copying pages of books. My invention is dependent on the use of uniform area sources of light which are thin enough to be inserted between the pages of a book. The advantages flowing from this are many and substantial. My method and appaartus permits making clear copies of the entire printed portion of a page which has hitherto been substantially impossible without special bindings for the books. My apparatus is inexpensive and convenient to use, and, of course, is applicable to other copying jobs of common flat work as well as its stated purpose of book copying.

It will also be evident from the foregoing description that it will likewise be apparent that alternatives in the structure and practice of my invention may readily suggest themselves to those skilled in the art and I therefore desire that my invention be regarded as being limited only as set forth in the following claims:

1. A book copier comprising a thin flat panel having substantially parallel sides formed of material having the optical characteristics of polymerized methyl methacrylate, a linear source of light extending along one edge of said panel, one of said parallel sides being rough and the other of said parallel sides being polished and a variable density filter on said rough side to achieve equal light emission therethrough at all points, said substantially parallel sided panel being sufficiently thin to be received, together with said filter, between the leaves of a closed book adjacent the binding thereof and induce no significant curvature, with reference to photocopying, in the printed portion of the leaf which said rough side faces.

2. A book copier comprising a thin flat panel having substantially parallel sides formed of material having the optical characteristics of polymerized methyl methacrylate, a linear source of light extending along one edge of said panel, one of said parallel sides being rough to present surfaces to the light transmitted through said panel at more than the critical angle thereto and the other of said parallel sides being polished and a variable density filter on said rough side to achieve equal light emission therethrough at all points, said substantially parallel sided panel being sufficiently thin to be received, together with said

filter, between the leaves of a closed book adjacent the binding thereof and induce no significant curvature, with reference to photocopying, in the printed portion of the leaf which said rough side faces.

3. A method of deriving equal light emission from a roughened edge-illuminated panel having the optical characteristics of polymerized methyl methacrylate which comprises placing a photographic negative on the roughened surface and illuminating said negative for a period to obtain insignificant exposure at the edge of the panel remote from said illuminated edge and progressively greater exposure toward said illuminated edge, developing said negative, and mounting said negative to said panel in the same position as that of the exposure.

4. A book copier comprising a panel of material having the optical characteristics of polymerized methyl methacrylate, a linear source of light aligned with and closely adjacent one edge of said panel, said panel having a rough side to present surfaces to the light transmitted through said panel at more than the critical angle thereto and a polished side and a variable density filter on said rough side to achieve equal light emission therethrough at all points, said panel being thin at the edge thereof remote from said light sources to be received, together with said filter between the leaves of a closed book adjacent the binding thereof and induce no significant curvature, with reference to photocopying, in the printed portion of the leaf which said rough side faces, said filter comprising a developed photographic negative substantially clear at the edge remote from said light source and progressively more dense toward said light source, said density increasing in the same proportion as the intensity of emitted light from said surface.

5. A book copier comprising a thin flat panel having substantially parallel sides formed of material having the optical characteristics of polymerized methyl methacrylate, a linear source of light extending along one edge of said panel, one of said substantially parallel sides being rough and the other of said substantially parallel sides being polished, said substantially parallel sided panel being sufficiently thin to be received between the leaves of a closed book adjacent the binding theerof and induce no significant curvature, with reference to photocopying, in the printed portion of the leaf which said rough side faces.

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EVON C. BLUNK, *Primary Examiner.*