

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN AND RELATING TO OPTICAL COPYING APPARATUS

(71) We, AGFA-GEVAERT AKTIEN-GESELLSCHAFT, a body corporate organised according to the laws of the Federal Republic of Germany, of
5 Leverkusen, Federal Republic of Germany, 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
10 and by the following statement:—

The invention relates to optical copying apparatus.

The invention provides optical copying apparatus which comprises means for
15 supporting an original, means for supporting a record support, and a projection system for stripwise imaging of the original onto the record support, the supporting means for
20 the original and for the record support, and the projection system being arranged for relative movement between the original and the projection system and between the
25 projection system and the record support, the projection system comprising illumination means which, in operation, produces light whose intensity varies cyclically, and a field stop arranged to allow
30 projection of an image strip and to screen the area surrounding the image strip being projected from the illumination means, the strip having a width at each point along its
35 length that is equal to an integral multiple of the relative speed between the original and the projection system divided by the modulation frequency of the light intensity.

With the arrangement of the invention, it is possible to avoid the formation of ripples or rib-like structures formed by lighter and
40 darker areas of the copy and its background and running perpendicularly to the direction of travel of the copy support, which sometimes appear on a finished copy. It has been found that this ribbing effect
45 occurs in apparatus employing illumination whose intensity varies cyclically as is produced, for example, in the case of fluorescent tubes supplied with alternating current and is apparently caused by differing exposure of these areas. This effect

occurs especially when the number of light
50 intensity cycles during the passage of a particular image-carrying area through the projection strip is relatively small, as in the case of high-intensity illumination means,
55 sensitive record supports, narrow projection strips, and high relative speeds between record support and field stop.

In addition, it has been found that the effect in question, as will be explained in
60 greater detail hereinafter, is produced by the fact that, if the phase position of the illumination means at the beginning of the travel of each of the individual areas of the
65 record support through the projection strip varies, then the starting and end pulses of the illumination means are cut off by different amounts with the result that a noticeably different total of incident light is
70 obtained for different image areas in question.

As will also be explained in greater detail hereinafter, with the arrangement of the invention the total of incident light reaching
75 the image-carrying area in question in each case is independent of the phase position of the pulsed light during the passage through the projection strip. As a result, the finished copy can have a constantly uniform
80 appearance, without the ribbed structures mentioned initially.

The image strip may be of uniform width throughout its length. Alternatively, the
85 image strip may comprise portions along its length of different widths. In order to compensate for the edge fall-off in brightness of the projection system, the portions of the image strip along its length
90 may increase in width in a direction away from the point located mid-way of the length of the strip towards the ends of the strip.

In this way it is always possible, even in
95 the case where the width of the projection strip is variable over the length of the strip, to maintain the proportional relationships according to the invention which serve to eliminate the ribbed structures. Without this measure, ribbed structures darkening and

fading over the width of the copy would be produced.

Apparatus constructed in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a section through a portion of the apparatus of the invention;

Fig. 2 shows the correlation between strip exposure and the speed of the original;

Fig. 3 shows rib-like structures produced on a finished copy in the case of a projection strip of varying width, not in accordance with the invention; and

Fig. 4 shows a field stop with the width varying in bands.

Referring to the accompanying drawings, Fig. 1 shows a system for stripwise imaging of a stationary original 1 onto a moving copy support (not shown) by means of an objective 8 arranged in an apparatus frame 9. During the projection operation, the original 1 rests on a transparent support plate 2. A projection carriage 3 is moved past the original 1 at a relative speed v with respect to the original. The carriage 3, which is guided by means of rollers 10 on guide rails 11 fixed to the apparatus, carries fluorescent tubes 4 and a scanning mirror 5. Each fluorescent tube 4 is arranged in a reflector 6 which is attached to a field stop. The edges 7a of the field stop 7 which is moved with the carriage 3 relative to the original in each case liberate only one strip of the original 1, having a width s , for exposure. In order to achieve stripwise projection, it would of course be possible to move the original 1 relative to the apparatus frame 9 and objective 8 arranged therein, instead of moving the exposure carriage 3. In addition, it would also be possible to use normal glow discharge lamps or the like instead of the fluorescent tubes 6 for the illumination of the projection strip. Furthermore, as will be appreciated, the field stop could be arranged in the vicinity of the image plane instead of in the region of the object plane, as shown.

The lamps used in optical copying apparatus such as photocopying apparatus, electrostatic copiers, microfilm exposure apparatus or the like are generally supplied with alternating current. The momentary illumination intensity thereby alters cyclically at twice the frequency of the supply current which usually oscillates at a frequency of $f=50-60$ Hertz. The modulation frequency of the light intensity, which is excited both by the positive and by the negative half-wave of the supply current in the same manner, is thus $2f$.

In Fig. 2, the dependence of the luminous flux ϕ in the projection strip on the amplitude A of the supply current is shown in the solid lines in the case where the

illumination intensity in question is strictly proportional to the amplitude of the half-wave. This is approximately valid for normal glow discharge lamps. If an exposure window having the width s is now moved past the original at a speed v , each part of the original is then situated in the region of the picture gate for a time:

$$t \text{ passage through} = \frac{s}{v} \quad (\text{Equation I})$$

The duration of a half-wave in the case of a frequency f of the supply current is:

$$t \text{ half-wave} = \frac{1}{2f} \quad (\text{Equation II})$$

It is apparent from Fig. 2 that, independently of the starting point of the exposure of the part of the copy support in question, a constant exposure of this part is produced if during the time taken by the copy support to pass through, an integral number of half-waves of the illumination current occurs. In the case of a passage time $t = s/v$ fulfilling this requirement, with any required shift Δt of the starting point, for any starting section I of the first half-wave which is thereby cut off, there is a corresponding, completely similar, section I' of the last half-wave added on. This occurs when the passage time (Equation I) is an integral multiple n of the time (Equation II) taken by one half-wave. After dividing Equation I by Equation II the strip widths s are obtained, for which the above requirement is fulfilled, as

$$s \text{ integral} = nx \frac{v}{2f} \quad (\text{Equation III})$$

However, if the passage time t differs by an amount $\Delta s/v$ from an integral multiple of the time taken by one half-wave, or if the width of the exposure strip s deviates by an amount Δs from an integral multiple of the distance travelled during one half-wave, then, as can also be seen from Fig. 2, there is added to the extra section I' a further section III having the duration $\Delta s/v$ which is not compensated for by the section I and the content of which depends to a great extent on the starting shift Δt . The content of this additional section reaches its maximum when it is symmetrical to the phase position $m \times \pi/2$ where n is an odd integer. The minimum magnitude of the additional section III is produced in the case of symmetry to the phase $n \times \pi$ where n is an integer. This means that maxima and minima are at a distance from one another corresponding to the time

$$t = \frac{1}{4f}$$

taken by a quarter-wave, or the distance travelled by the exposure strip during this time $v \times t$, that is to say,

$$s \text{ quarter-wave} = \frac{v}{4f} \quad (\text{Equation IV})$$

Similar relationships are produced in the case of deviation of the characteristic of the luminous flux Φ from the amplitude of the supply current. Fig. 2 for example indicates by means of broken lines the case in which the lamps immediately emit their full luminous flux when a particular threshold value of the supply voltage is reached, and when the value falls below a particular threshold go out immediately. Such a case occurs in principle with conventional fluorescent tubes, even though the strictly rectangular form of the luminous flux characteristic indicated in the Figure might not be attained. Even when the actual characteristic approximates closer to a trapezium or even a triangle, here again, as is also clearly apparent from the Figure, in cases where the passage time $t = s/v$ is a multiple of the duration of a half-wave the additional section II' always corresponds exactly to the missing section II. When the passage time deviates from this value by an amount $\Delta s/v$ an additional section IV is added at times, which for particular values Δt of the starting shift is again completely omitted.

This means that the difference in the exposure as a function of the starting shift Δt is especially great in the case where the lighting characteristic deviates from the sinusoidal form. In general, in cases occurring in practice the difference is approximately 5—10% of the total exposure of the copy support, which would be clearly visible on the finished copy, especially with record materials having a steep gradation. This relationship arises from the fact that with normal strip widths and feed speeds and/or with the normal sensitivity of the record support, during the passage through the projection strip something of the order of five to ten half-waves can occur, whilst the exposure difference, as can be seen from Fig. 2, may constitute the greater part of one half-wave.

In accordance with the present invention, the width of the field stop aperture s , and hence of the image strip is, in accordance with equation III, equal to an integral multiple of the relative speed between the original and the projection system or the imaging speed divided by the modulation frequency of the light intensity.

The image strip may be of constant width along its length, or portions of the strip along its length may be of different widths. In Fig. 4 is shown a field stop 7 having numerous portions of different widths along the image strip. The field stop is composed of individual portions, each of which has a constant width $S_1, \dots, S_n$ over a certain length corresponding to an integral multiple of the relative speed of the copy support divided by the modulation frequency of the light, intensity the widths increasing in each direction away from a point located mid-way of the length of the field stop. This increase in width is provided to compensate for the fall-off in brightness towards the edges.

Fig. 3 shows the rib structure darkening and fading over the width of the copy support in the manner which is produced in the case of a field stop 7 of variable width but increasing gradually and continuously away from the centre and not in accordance with the invention. The distance e between the ripples—as otherwise in the case of the continuous ripples—corresponds to the distance

$$s = \frac{v}{2f}$$

(see equation III) travelled during one half-wave of the supply current.

WHAT WE CLAIM IS:—

1. Optical copying apparatus which comprises means for supporting an original, means for supporting a record support, and a projection system for stripwise imaging of the original onto the record support, the supporting means for the original and for the record support, and the projection system being arranged for relative movement between the original and the projection system and between the projection system and the record support, the projection system comprising illumination means which, in operation, produces light whose intensity varies cyclically, and a field stop arranged to allow projection of an image strip and to screen the area surrounding the image strip being projected from the illumination means, the strip having a width at each point along its length that is equal to an integral multiple of the relative speed between the original and the projection system divided by the modulation frequency of the light intensity.

2. Optical copying apparatus as claimed in claim 1, wherein the image strip is of uniform width throughout its length.

3. Optical copying apparatus as claimed in claim 1, wherein the image strip comprises portions along its length that are of different widths.



* C L M S *

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Similar relationships are produced in the case of deviation of the characteristic of the luminous flux Φ from the amplitude of the supply current. Fig. 2 for example indicates by means of broken lines the case in which the lamps immediately emit their full luminous flux when a particular threshold value of the supply voltage is reached, and when the value falls below a particular threshold go out immediately. Such a case occurs in principle with conventional fluorescent tubes, even though the strictly rectangular form of the luminous flux characteristic indicated in the Figure might not be attained. Even when the actual characteristic approximates closer to a trapezium or even a triangle, here again, as is also clearly apparent from the Figure, in cases where the passage time $t = s/v$ is a multiple of the duration of a half-wave the additional section II' always corresponds exactly to the missing section II. When the passage time deviates from this value by an amount $\Delta s/v$ an additional section IV is added at times, which for particular values Δt of the starting shift is again completely omitted.

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Fig. 3 shows the rib structure darkening and fading over the width of the copy support in the manner which is produced in the case of a field stop 7 of variable width but increasing gradually and continuously away from the centre and not in accordance with the invention. The distance e between the ripples—as otherwise in the case of the continuous ripples—corresponds to the distance

$$s = \frac{v}{2f}$$

(see equation III) travelled during one half-wave of the supply current.

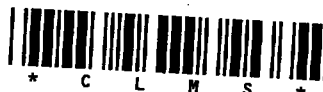
WHAT WE CLAIM IS:—

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2. Optical copying apparatus as claimed in claim 1, wherein the image strip is of uniform width throughout its length.

3. Optical copying apparatus as claimed in claim 1, wherein the image strip comprises portions along its length that are of different widths.

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4. Optical copying apparatus as claimed in claim 3, wherein the portions of the image strip along its length increase in width in a direction away from the point located mid-way along the length of the strip towards the ends of the strip.

and as shown in, Figures 1 to 4 of the accompanying drawings.

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5. Optical copying apparatus as hereinbefore described with reference to,

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