A NEW METHOD FOR ENLARGING PHOTOGRAPHS WITHOUT THE USE OF A LENS.[1]

BY ALFRED J. LOTKA.

AN observation of a peculiar distortion presented by the appearance of certain moving objects led the writer to the development of the method of enlarging photographs described below.

This method consists in moving the negative to be enlarged past a narrow slit source of light, and at the same time moving a sensitive plate under the negative at a speed equal to some constant multiple n of the speed of the negative.

On development of the sensitive plate a positive transparency is obtained, in which all lines of the original negative which were parallel to the slit during the exposure are unaltered, while all lines at right angles to the slit are magnified in the ratio $n : 1$.

This positive is subsequently subjected to a repetition of the process practised on the original negative, but with the motion now at right angles to the lines drawn out n-fold in the first operation. The result of the second operation is a negative geometrically similar to the original, but with the linear dimensions enlarged n times, or the area n^2 times.

The apparatus employed for carrying out the process has been constructed on exceedingly simple lines, with the use of material readily obtainable on the market. The slit is made with two strips of brass picked from the stock of a wholesale hardware store and having received no other treatment than a cleansing with a brass polish.

The ratio n of the velocities in the apparatus so constructed is 2, and is secured by the simple expedient shown diagrammatically in Fig. 1. In this drawing the original negative is represented at A, the sensitive plate at B, and the slit at S. The carrier C, on which the plate B rests, has attached to it at each end a silk thread D, which passes through an eye E, attached (with gummed paper) to the glass plate of the negative (when a celluloid film is used, such film may be attached with gummed tape to a glass plate). The further end of the silk cord D is attached to the end block of the box containing the negative and plate during exposure. The carrier C slides on the bottom of the box, between guides adjusted to fit the sides of the plate.

[1] Demonstrated at the New York meeting of the American Physical Society, February 26, 1916.

It will readily be seen that, in accordance with the principle of the single movable pulley, the velocity of the sensitive plate is always double that of the negative.

Any means, such as a hand-pull at P, may be employed to impart uniform motion to the negative. A cylinder containing water through which a fairly snug-fitting perforated piston is drawn makes a good dash-pot to regulate the motion. This and a still simpler and exceedingly compact device for this purpose is a subject of a pending patent application.

The adjustment of the lamp vertically above and in the plane of the slit is effected by looking down at the lamp and its reflection in the glass covering the slit. When the filament, its image, and the line of the slit coincide in the line of sight, the filament is in the plane of the slit. It was found that with a slit 6½ inches long good results were obtained with a filament of six or seven coils placed about one foot from the slit.

Among the advantages which the new method presents is uniformity of illumination over the entire field; geometric similarity to the original of the image produced, *i. e.*, absence of distortion such as spherical aberration introduces; compactness and simplicity of apparatus, replacement of lens by a simple slit and hence low cost of the apparatus.

The process necessitates two successive exposures, but this is true also of the ordinary method when a negative is to be prepared from a negative.

The example shown in the accompanying half-tone illustration gives an idea of the working of the process, though it does not represent the best that can be done in the way of definition.

The limiting separation which the apparatus will effect can be figured as follows:

Consider a point right on the edge of the negative. This will begin to be reproduced on the sensitive plate as soon as the negative and plate are in the position shown in Fig. 2*a*. (The slit is here shown on a greatly enlarged scale.) The same point will continue to be reproduced until negative and sensitive plate are in the position shown in Fig. 2*b*. It will therefore be drawn out into a line of length $ns - s = (n - 1)s$.

Now consider two points, a distance d apart in the negative. In the copy they will appear as two lines $(n - 1)s$ long and with their centers nd apart. These two lines will just merge at their ends when

$$nd = (n - 1)s,$$

$$d = \frac{n - 1}{n} s.$$

This distance

$$d = \frac{n - 1}{n} s$$

between two points on the original negative represents the limit of separation: Two points a distance greater than d apart will be separated, two points nearer together than d will not be separated.

For $n = 2$, as in the apparatus constructed, we have

$$d = \tfrac{1}{2}s.$$

Thus, for example, a comparatively coarse slit 1/100 inch wide, will still separate points just a little over 1/200 inch apart.

The process and apparatus here described are protected by U. S. Pat. 1,176,384 of March 21, 1916, issued to the writer.

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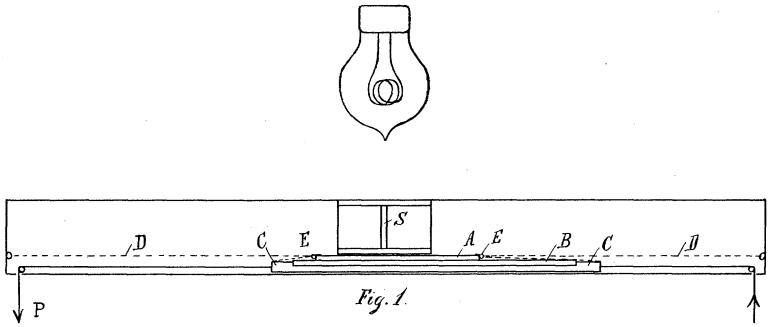

Fig. 1.

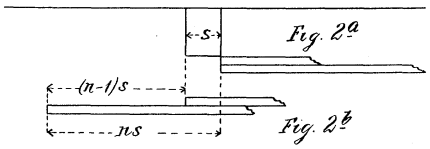

Fig. 2.

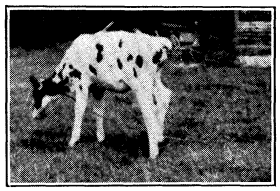

Fig. 3.

Figs. 1 and 2. Diagram of Apparatus.

Half-tone copy of original photograph.

Fig. 4.

Copy of distorted positive transparency obtained in first step of process.

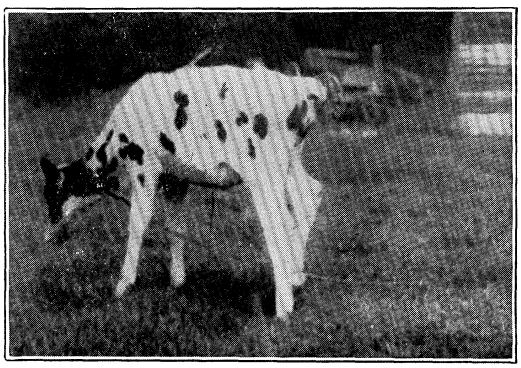

Fig. 5.

Copy of enlargement obtained in second step.

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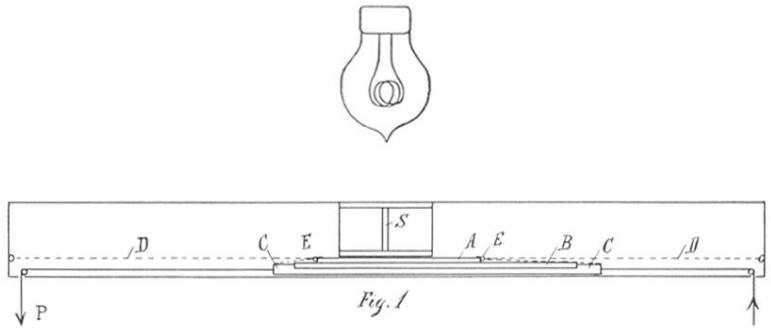

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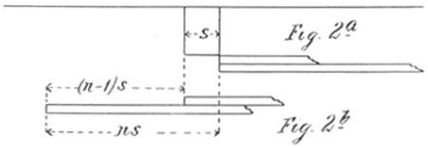

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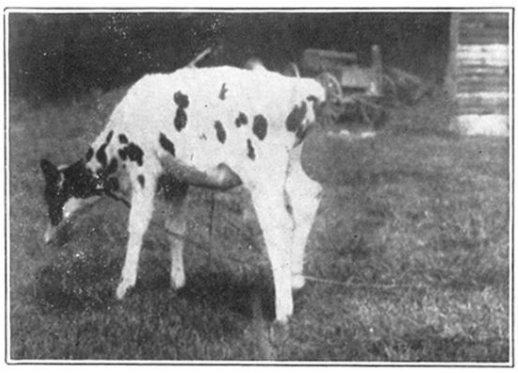

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Copy of enlargement obtained in second step.