

[54] **ELECTROPHOTOGRAPHIC COPYING MACHINE**

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[58] Field of Search **355/55, 56, 57, 60, 11**

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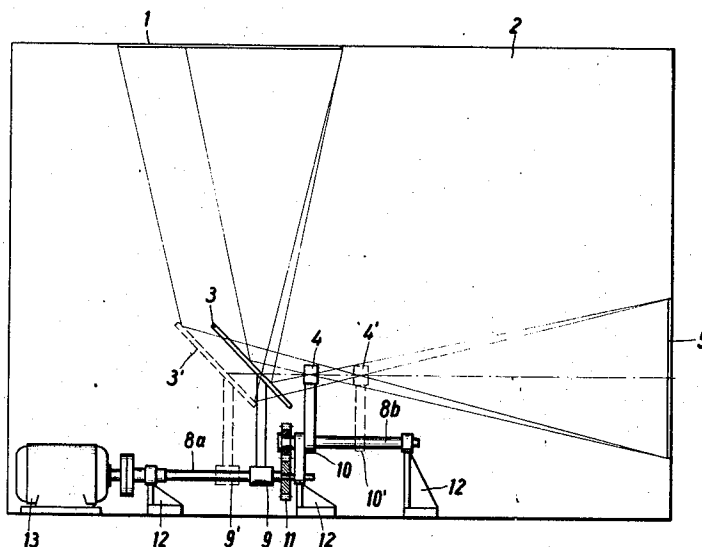
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[57] **ABSTRACT**

The invention relates to an electrophotographic copying machine comprising a stationary support for an original, of which one edge serves as a reference for locating the original that is to be copied, a likewise stationary imaging plane perpendicular thereto, in which an electrophotographic printing material is located, a mirror and an objective positively coupled for relative movement to permit different scale reproductions on the printing material in the imaging plane to be made of an original on its support.

5 Claims, 2 Drawing Figures



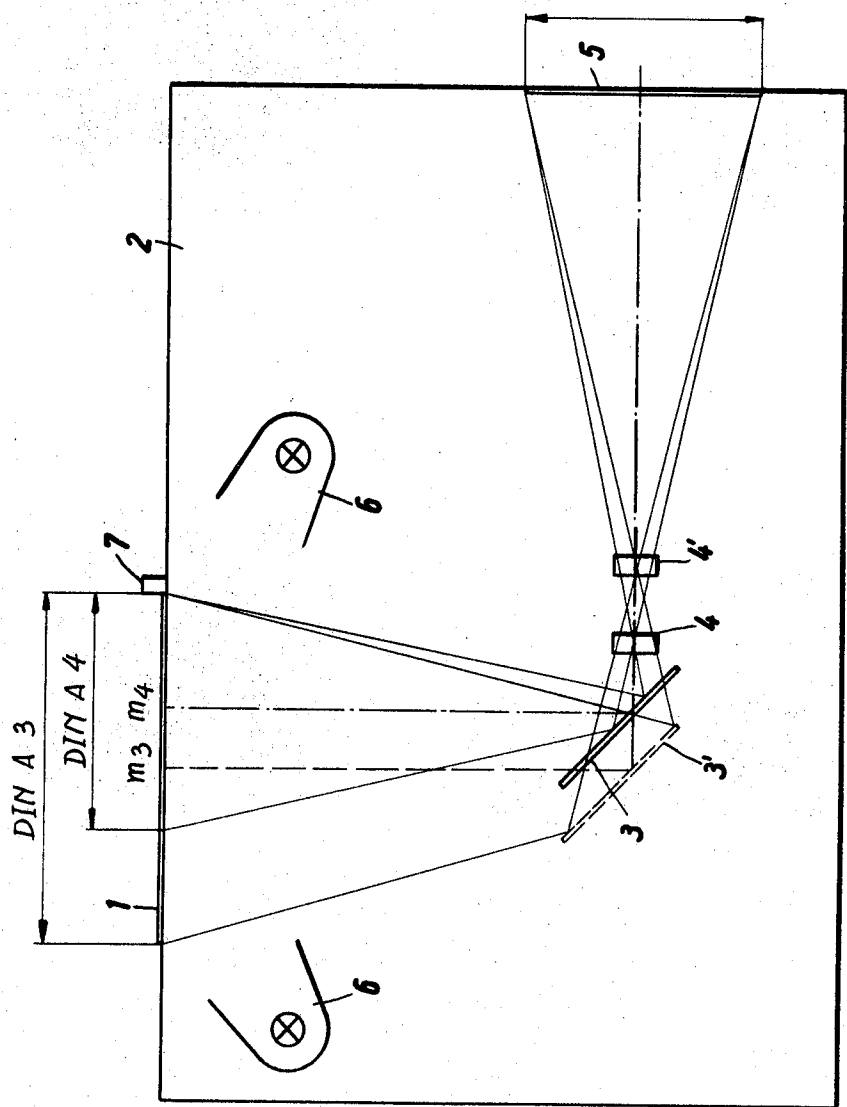
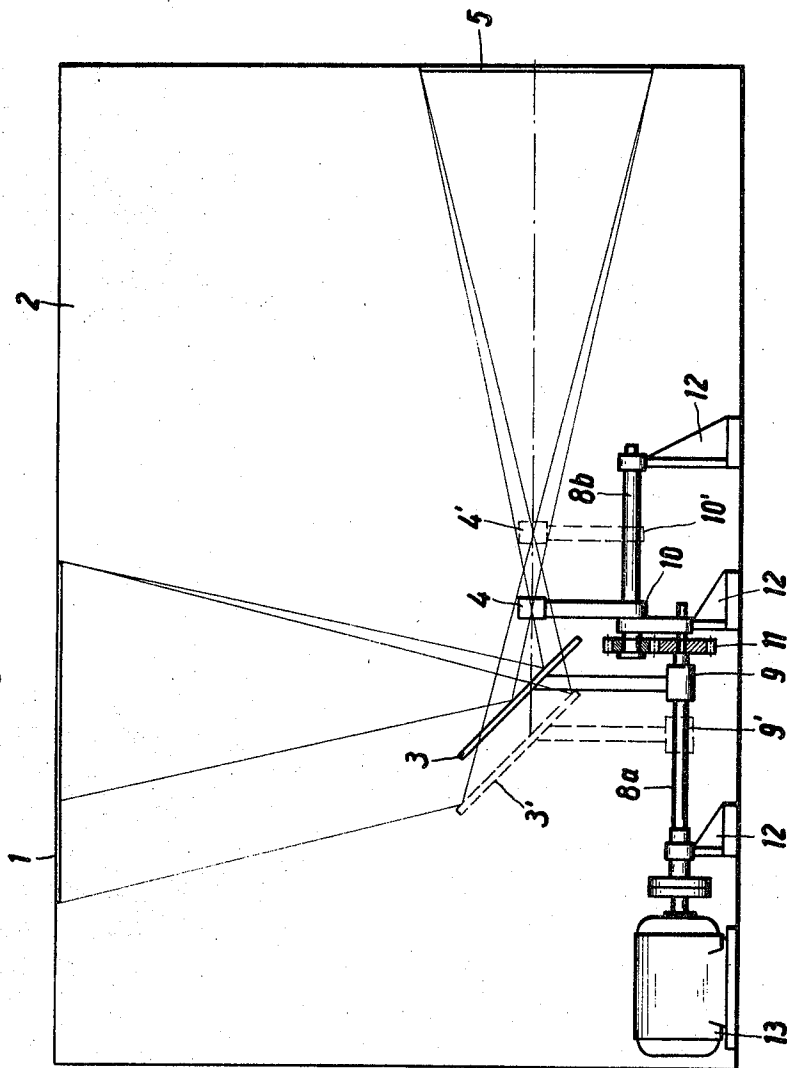


Fig. 1

Fig. 2



ELECTROPHOTOGRAPHIC COPYING MACHINE

A photographic copying machine has already been proposed in which during a displacement of the objective and of the mirror to change the scale of reproduction one of the two edges parallel to the optic axis of the support carrying the original remains the edge defining the position of one of the edges of any format of the original which is fully reproduced in the imaging plane. In this arrangement the objective and the mirror are moved obliquely to the optic axis. Although this photo-copying machine has the advantage of permitting pages in books and folders to be reproduced, the oblique adjusting motion of the optical elements necessarily requires a complicated mechanism that is liable to cause trouble. Other known machines employ two objectives of different focal lengths for the reproduction of originals of two different formats. This substantially raises the production cost of the apparatus since not only two objectives are needed but also the entire associated equipment such as shutter, mirror and parts for automating the process must be duplicated.

Objectives having variable focal lengths, though cheaper, lack the quality objectives for reproduction purposes are required to possess.

Copying machines have also been proposed in which the mirror and the objective are stationary and the support for the original as well as the imaging plane are adjustably movable. Although in principle such arrangements can be used for copying purposes they are extremely bulky and so awkward to manipulate that they are quite unsuitable for compact electrophotographic automatic copying machines equipped with electronic control means. The majority of copying machines containing mirrors are so constructed that copies of only one particular format can be produced because of the design difficulties that would otherwise have to be overcome.

The object of the present invention is to provide an electrophotographic copying machine of inexpensive and simple design, which is functionally very reliable, and which more particularly permits copies of the same format to be produced from originals of two different formats, for instance standard DIN A 4 copies to be produced from standard DIN A 4 and DIN A 3 originals.

The inventive proposal is based on the thought that if the transverse edge of the support for the original that is nearest the imaging plane is selected to provide the reference edge for locating the originals, the mechanical part of the machine can be much simpler than in the first-above mentioned photocopying machine in which the longitudinal edge of the support for the original is used as the reference edge.

It must be remembered that an optical system movable in a direction normal to the imaging plane requires not only that the original should be positioned with reference to a transverse edge but that the center of the format of the original should also always be perpendicularly above the optic axis and should therefore not be allowed to move otherwise than in the direction of the optic axis of the objective. This means that the original or the part of the original that is to be reproduced should always be located so that its transverse dimension is symmetrical about the longitudinal center line of the support. This is not the case in the conventional machine in which the "longitudinal edge" is taken as a reference line for location.

In other words, according to the invention, the direction in which the objective is moved for changing the scale of reproduction coincides with the direction in which the objective must be moved to allow for a change in position of the centers of different format originals, i.e., the direction of the optic axis of the objective.

The proposed copying machine is therefore characterized in that the transverse edge, nearest the imaging plane, of the support for the original defines the fixed edge of the located original, and that mirror and objective are adjustably movable in contrary directions in the direction of the optic axis of the objective.

In this arrangement it is possible by suitably moving the mirror and then the objective to set up the machine for reproductions in any ratio of formats between two limiting scales of reproduction. For such purpose the horizontal adjustment of the mirror would have to be independent of the adjustment of the objective. However, since in practice only a few formats are of interest, such as two different scale reproductions, for instance a 1 : 1 reproduction of a standard A 4 format or there production in the form of a standard DIN A 4 format of a standard DIN A 3 original, it is convenient to couple the movements of mirror and objective together, for instance in such a way that both elements, mirror and objective, are relatively movable in the direction of their optic axis, for instance in the horizontal, or if the positions of original and copy are interchanged, in the vertical.

Quite apart from its simplicity of design and its compactness, a machine of the proposed kind also excels by the high optical definition of the different scale copies that are produced.

The invention will be hereinafter more particularly and illustratively described with reference to the accompanying drawing in which

FIG. 1 is a schematic longitudinal section of a copying machine according to the invention,

FIG. 2 is a similar section to that in FIG. 1, showing the coupling means between the mirror and the objective in greater detail in a preferred embodiment of the invention, and

Referring to FIG. 1 a transparent supporting plate for an original, for instance in the form of a sheet of glass or transparent plastics, is provided in the top of a casing 2. Below this plate is a mirror 3 and on one side of the mirror is an objective 4. In the side wall of the casing 2 facing the objective is the imaging plane 5, defined for instance by a glass screen or a suction frame or a guideway for a printing paper.

Lamps 6 are provided in suitable positions inside the casing 2 as is conventional.

The position 3' of the mirror 3 and the position 4' of the objective 4 when both have been moved are shown in the drawing in discontinuous lines.

The edge of the supporting plate 1 nearest the imaging plane is provided with a reference 7, for instance in the form of a lay or possibly only of a mark for locating one edge of an original of any format against the lay or on the marking. The positions of the centers of different formats are marked m_3 and m_4 .

In such an apparatus an original is copied in the following way.

An original of say standard DIN A 4 size is placed on the supporting plate 1 with its edge against the side lay

7. In this position the original is imaged by the mirror and the objective 4 in the imaging plane, the sole of reproduction being 1 : 1.

In the same way a different original of say standard DIN A 3 size is placed on the supporting plate 1 with one edge bearing against the lay 7. This original is imaged in the imaging plane after the mirror and the objective have been moved into the positions 3' and 4', the size of the image again corresponding to that of a standard DIN A 4 format.

It will be understood from the drawing that the center m_4 of a standard DIN A 4 format will be located on the right of the center m_3 of a standard DIN A 3 format. In order to allow for this difference the mirror 3' must be moved into the position e and the objective 4' into the position 4. In the positions 3' and 4' of the mirror and the objective they will produce an image of standard DIN A 4 format from an original of standard DIN A 3 format. On the other hand, in the positions 3 of the mirror and 4 of the objective the image of an original of standard DIN A 4 format will again be of standard DIN A 4 format, so that the scale of the reproduction in this case is 1 : 1.

For changing over from the position in which a DIN A 3 format original will be reproduced on a reduced scale, into the position in which an original DIN A 4 format will be reproduced on a 1 : 1 scale, the mirror and the objective must therefore be moved in contrary directions.

The distance between the centers of a DIN A 3 and a DIN A 4 format original on the supporting plate is 43 mm. From the laws of optics it follows that an objective having a focal length of about 305 mm will be required. A standard 300 mm objective will be satisfactory, bearing in mind that advantage can be taken of the available depth of focus.

The described apparatus can be modified in various respects without departing from the essential feature of the invention. Instead of moving the mirror and the objective by means of a common screw spindle, independent adjustment could also be made. A screw spindle could be replaced by gear wheels, racks, articulated rod linkages and the like. Moreover, the positions of original and imaging planes could be interchanged so that the original would be vertically disposed and the imaging plane would be horizontal. The adjusting means might also be electrically lockable and adjustable.

The mechanical coupling means between the mirror and the objective may firstly have the form of a screw spindle. The threads on a common spindle for moving the mirror and the objective would have to be of opposite hands to produce the contrary motions of mirror and objective, and in the majority of cases, particularly in smaller copying machines such as are used in offices, the objective would be associated with the threads of higher pitch and the mirror with threads of opposite hand having a lower pitch. However, this arrangement would be expensive, since a spindle bearing the required two kinds of thread would have to be specially made. A preferred form of construction of the coupling means between the mirror and the objective is that shown in FIG. 2. In this embodiment the screw spindle for moving the mirror a shorter distance and the objective a longer distance when changing over from one

scale of reproduction to another, can be simplified in so far as identical screw spindles of standard pitch can be used in any machine. The above described single screw spindle with screw threads of opposite hands, is replaced by two separate parallel screw spindles 8a and 8b of the same hand and pitch disposed in tandem with their adjacent ends coupled together by an interposed transmission 11. Conveniently the transmission may be a gearing. Preferably the two screw spindles 8a and 8b are radially and axially offset and so disposed that their adjacent ends overlap, and these two ends are geared together by two gearwheels. By suitably choosing the transmission ratio of these gearwheels, the distances traversed by the objective 4 and the mirror 3 can be determined, the holders 9 and 10 of the mirror and of the objective being in engagement with the screw threads of the spindles. The spindles are mounted in brackets 12 and drivable by a motor 13.

It must be borne in mind that the focal lengths of commercial objective are subject to a tolerance of up to 5 percent. The actual focal lengths of 300 mm objectives may therefore vary between 285 mm and 315 mm. In photo-copying machines such deviations are magnified by virtue of the laws governing reproduction by lenses (four times when the scale of reproduction is 1 : 1). Consequently, a screw spindle having opposed hand threads of different pitch would have to be calculated and manufactured specially for each particular objective.

In order to compensate differences between the focal lengths of different objectives without having to use other than standard screw spindles, the transmission coupling the two parts of the divided spindle together may preferably be variable. This can be done for instance by providing a coned friction wheel transmission having a ratio that can be varied continuously or in steps. However, in the above-described embodiment comprising two meshing gearwheels it is preferred to make use of so-called "corrected" gearwheels which are widely used in mechanical engineering. The center distance between the two spindles and the transmission ratio required for an objective of the correct focal length determine the pitch circles and hence the diameters of the gearwheels. Whereas the center distance and the pitch circles are fixed, the number of teeth on one of the two gearwheels can be changed if desired. In other words, if the normal ratio of the cooperating numbers of teeth is 15 : 34, a difference in focal length of appropriate magnitude can be compensated by varying the relative displacements of mirror and objective, and this can be accomplished by substituting for the wheel having 34 teeth a wheel of the same pitch circle having only 33 teeth or 35 teeth, as the case may be, to provide a correspondingly smaller or larger transmission ratio.

I claim:

1. An electro-photographic copying machine comprising a stationary support for an original, of which one edge serves as a reference for locating the originals that are to be copied, a likewise stationary imaging plane, perpendicular thereto, in which an electro-photographic recording material is located, a mirror and an objective positively coupled for relative movement to permit different scale reproduction on the recording material in the imaging plane to be made of

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an original on its support, the transverse edge nearest the imaging plane of the support for the original defining the fixed edge of the located original and the mirror and objective being adjustably movable in contrary directions in the direction of the optic axis of the objective, the relative displacement of the mirror and the objective being effected by a common screw spindle having threads of opposite hands and extending in the direction of the optic axis normal to the imaging plane.

2. The copying machine of claim 1 in which the threads of the screw spindle for displacing the mirror have a shorter pitch than the threads for displacing the objective whereby rotation of the screw spindle moves the mirror a shorter distance than the objective.

3. An electro-photographic copying machine comprising a stationary support for an original, of which one edge serves as a reference for locating the originals that are to be copied, a likewise stationary imaging plane, perpendicular thereto, in which an electro-photographic recording material is located, a mirror and an objective positively coupled for relative movement to permit different scale reproductions on the recording material in the imaging plane to be made of an original on its support, the transverse edge nearest the imaging plane of the support for the original defining

ing the fixed edge of the located original and the mirror and objective being adjustably movable in contrary directions in the direction of the optic axis of the objective, support for and the objective being coupled for relative movement by a pair of screw spindles extending parallel to the optic axis, one of the screw spindles being connected to the mirror whereby rotation of said one screw spindle moves the mirror along the optic axis, the other screw spindle being connected to the objective whereby rotation of the other screw spindle moves the objective along the optic axis, and gear means connecting the screw spindles.

4. The copying machine of claim 3 in which the screw spindles are radially and axially offset in parallel to provide overlapping ends, the gear means including a gear wheel on each overlapping end of the spindles, the transmission ration of the gear wheels being chosen according to the required relative displacements of the mirror and the objective.

5. The copying machine of claim 4 in which the gear wheels are replaceable by corrected gear wheels having the same pitch circles for adapting the transmission ratio to variations in the focal length of the objective.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,687,544 Dated August 29, 1972

Inventor(s) Rudolf Muller

It is certified that error appears in the above-identified patent
and that said Letters Patent are hereby corrected as shown below:

In column 6, line 4, "support for" should be
--the mirror--.

Signed and sealed this 6th day of February 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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