Jan. 11, 1955 W. F. C. FERGUSON ET AL 2,699,101

PHOTOCOMPOSING MACHINE

Filed Sept. 1, 1950 2 Sheets-Sheet 1

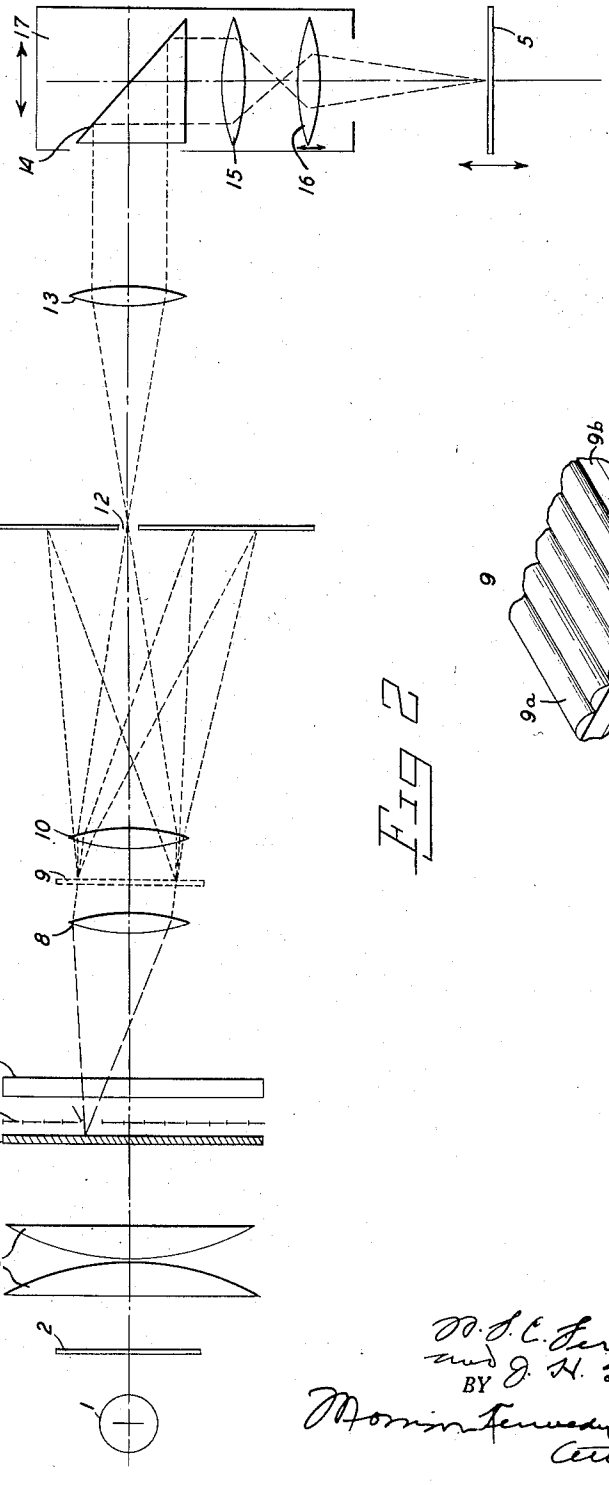


Fig 1

Fig 2

W. F. C. Ferguson INVENTORS
and J. H. Greig
BY
Morrison Kennedy Campbell
Attorneys

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2 Sheets-Sheet 2

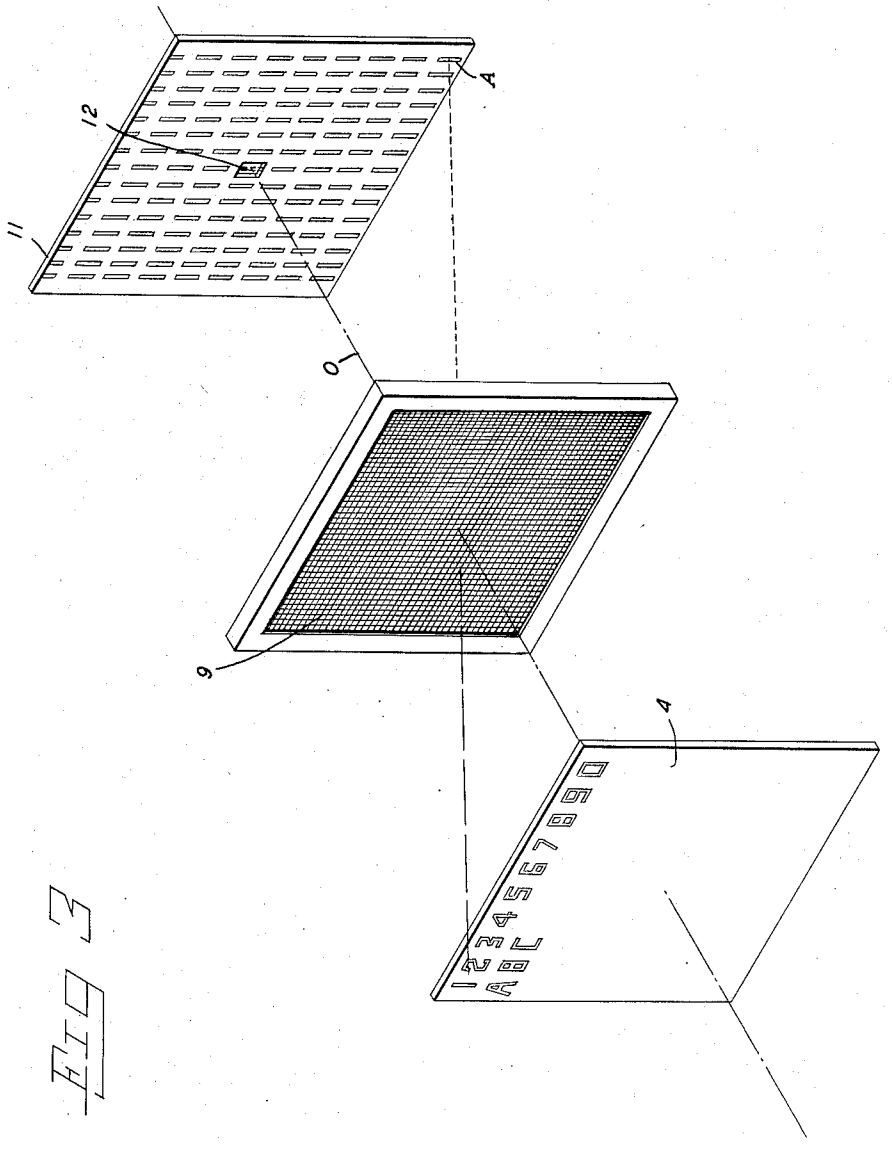


FIG 3

INVENTORS
W. F. C. Ferguson
BY and J. H. Greig
Morrison Kennedy Campbell
Attorneys

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PHOTOCOMPOSING MACHINE

Walter F. C. Ferguson, West Orange, N. J., and John H. Greig, New York, N. Y., assignors to Mergenthaler Linotype Company, a corporation of New York

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2 Claims. (Cl. 95—4.5)

This invention relates to photocomposing machines, that is to say, machines wherein images of selected characters are projected optically onto a photographic member.

In many machines of this type, it has been customary to employ character arrays consisting of either a plurality of opaque characters arranged on a translucent background, or a plurality of translucent characters arranged on an opaque background. In view of the wide range assortment of characters necessarily employed in the composition of type for printing, one of the difficulties encountered in the design of such machines is the problem of projecting any desired character of the array onto the photographic member in focus at the center of the optical axis in order that each character composed will be aligned with respect to all the other characters of the sequence. Generally speaking, only that particular character of the array located along the optical axis will be so properly projected.

Various solutions to this problem have already been proposed. One proposed solution was to arrange the characters around the periphery of a revolving drum and to instantaneously project the selected character onto the photographic member as it passes the axis of the optical system. Another proposal was to arrange the characters in vertical and horizontal rows on a shiftable plate and provide mechanism to move the plate vertically and horizontally in a plane to bring any individual character into the optical axis or, in the alternative, to move the optical system with respect to the character plate to accomplish the same result. Still another proposal was to provide each individual character of the array with a separate optical system. The foregoing proposals, while all mechanically or optically feasible, are entirely unsatisfactory due primarily to the costly, cumbersome and highly complicated apparatus required.

The present invention offers a satisfactory solution to the above problem, comprising in essence a rapid and efficient system for selectively projecting parious characters of a front plate in any desired sequence onto a photographic member in proper focus at the optical axis with an absence of distortion and color fringe, and without any motion of the font plate or the associated optical system.

In the accompanying drawings, the invention is shown merely in preferred form and by way of example, and obviously many changes and variations may be made within its spirit. It is to be understood, therefore, that the invention is not limited to any particular form or embodiment except inesofar as such limitations are specified in the claims.

Referring to the drawings:

Fig. 1 is a diagrammatic view illustrating the present invention;

Fig. 2 is a greatly magnified perspective of a proposed crossed diffraction grating to be employed in the present invention; and

Fig. 3 is a diagrammatic view illustrating the projection of one of the characters of the font through the diffraction grating.

The apparatus illustrated in the drawings is enclosed in a suitable dark chamber (not shown). In order to eliminate the effects of color fringe on the composed characters, a source of monochromatic light is used to supply the illumination for the field. The monochromatic light is produced by passing the light of a standard mercury vapor lamp 1 through a standard filter 2 which will transmit only light in the immediate vicinity of the green line of the mercury spectrum, that is to say, in the immediate vicinity of the wave length 5461 Angstrom units. However, any other suitable means for producing monochromatic light of other wave lengths may be employed in lieu theerof. The field light is projected by a condenser lens system 3 upon an array of characters on a font plate 4.

The array of characters may comprise, as stated, either a plurality of translucent characters against an opaque background, or a plurality of opaque characters against translucent background. The plate 4 may be made of glass or in the form of a photographic film, or otherwise, with the characters arranged thereon in vertical and horizontal rows. In addition, the plate 4 should be removable to facilitate the substitution of characters of different fonts.

The characters are adapted to be composed individually in line on a photographic film 5 by the operation of a keyboard. To this end, any suitable shutter arrangement may be employed to permit the field light to pass through the chosen character. One such possible arrangement is shown in the drawings, comprising a plurality of pivoted horizontal bars 6, there being one of such bars for each horizontal row of characters, and a plurality of pivoted vertical bars 7, there being one of such bars of each vertical row of characters. The operation of a particular key will, therefore, pivotally displace one bar of each set to uncover the particular character associated therewith.

The array of characters 4 is located at the focal plane of a collimating lens component 8 which renders the light rays coming from the single exposed character practically parallel. The parallel light rays then pass through a pair of crossed diffraction gratings 9, constituting the most important component of the present invention.

The diffraction grating is well known in the field of optics and may be briefly described as an optical device having a very large number of parallel and very narrow transmitting or light reflecting areas capable of setting up wave interference by diffraction, reflection or refraction. Only the former, that is, the transmitting type grating, is shown and described in the present application. However, it should be borne in mind that reflection gratings could also be effectively employed with but a few modifications of the present apparatus. A parallel beam of monochromatic light incident upon diffraction gratings of the transmitting type, due to the wave-like nature of the light, sets up secondary wavelets at each of the light transmitting areas, which wavelets produce interference with wavelets set up by other light transmitting areas, giving rise to an interference pattern. When an image of a figure is thus transmitted, by properly focusing the interference pattern, it is possible to form an entire row of two dimensional images of the figure, and when two gratings are crossed at right angles, it is apparent that this would add another interference pattern at right angles to the one caused by the first grating, thereby making possible the formation of an entire field of images of a given figure in two dimensions.

It is this phenomenon, which incidentally may be studied in greater detail in any elementary textbook on physics or optics, that makes possible the present invention. As shown in Fig. 2 of the drawings, the crossed grating 9 herein employed is composed of two individual gratings 9^a made of some translucent substance, such as collodion, having a furrowed or corrugated surface consisting of a multiplicity of tiny rounded ridges, there being about 600 to the inch. The gratings 9^a are mounted together back to back, preferably on some light transmitting member 9^b, such as for example a glass plate, in such a manner that the direction of the ruling of one is at right angles to the direction of the ruling of the other. Due to this peculiar construction of the gratings, the crossed rulings form a system of tiny convex lenses, This lens-like feature of the grating has two advantages over the conventional type grating. For one thing, light incident upon the system is better concentrated in the desired direction than in an ordinary grating system. Also, all, or nearly all, the light incident on the system is

utilized, none being wasted by conventional absorbing sections between transmitting slits.

The field light, therefore, creates an image of the single character selected by the shutter arrangement, and the light from the character so exposed is divided by the crossed diffraction grating **9** so that a single principal image, as well as a multiplicity of higher order images, is formed on a masking screen **11**, the images being focused thereon by the lens **10**. The spacing between the images projected on the masking screen **11** is a function of the focal length of the lens **10** and the number of lines per inch of the gratings 9^a, and the lens **10** should be selected or corrected so that all the potentially useful images will be projected in a flat field. If the spacing between the characters on the plate **4** is entirely uniform and equal, the spacing between images of the field will not be precisely uniform and equal, although it will be very nearly so (the spacing between lower order images differing from the spacing between higher order images by a few thousandths of an inch), but by corrective spacing of the characters on the plate **4**, it is possible to insure that one image of each of the different selected characters of the array falls along a path of projection common to all characters. It is also possible to employ a square symmetrical array of characters and at the same time insure that one of the images falls along the common path of projection by corrective bending of the light rays which form the image to be photographed. In this way, a symmetrical array of several hundred characters can be employed, the central character of the array being located squarely on the optical axis, and a multiplicity of images of any individually selected character can be created, the number of such images and the spacing between them being so controlled that one image of the character will always fall on the optical axis. The masking screen **11** is provided with an aperture **12** located in line with the optical axis to transmit the single image so falling.

Figure 3 will be helpful in understanding the foregoing explanation. In that figure, the principal image A of one of the characters located in the vicinity of the upper left hand portion of the plate **4** (the numeral "1" being chosen for purpose of illustration) is shown falling in the vicinity of the lower right hand region of the masking screen **11** after having been projected through the crossed diffraction grating **9**. Well over 500 distinguishable images can be formed about the principal image A of which the central 400, more or less, will be of practically equal intensity, at least for purposes of printing. As already explained, while the principal image A merely falls on the masking screen **11**, nevertheless one of the plurality of images formed will always fall on the optical axis **0** and be transmitted through the aperture **12**. Thus, a camera focused upon this point can photograph, in turn, each of the characters of the array **4** so projected.

The image is thereafter (Fig. 1) projected through a collimating lens **13** and reflected by a prism **14** through the image lenses **15** and **16** onto the photographic film **5**. In the embodiment shown in the drawings, the heavy-carriaged photographic film **5** remains stationary while the comparatively light prism **14** and lenses **15** and **16** are mounted on a movable carriage **17**, which latter is adapted to scan the said film **5**, moving a set distance after the composition of each character. The masking screen **11** should be located at the focal plane of the collimating lens **13**, said lens serving to render the rays of light parallel so that neither focus nor magnification is disturbed by the movement of the carriage **17**. It should be noted that the point size of the characters to be composed can be quickly changed by moving the lens **16** and the film **5** in the directions indicated by the arrows in Fig. 1.

What is claimed is:

1. In a typographical photocomposing machine, the combination of a stationary font plate comprising an array of type characters arranged in different positions thereon and in spaced relation to each other, means for illuminating any selected type character in the array, a diffraction grating system for producing, by means of interference of the light waves emanating from each different selected character in the array, a multiplicity of images of the selected character, a lens system for focusing all of said images in a common plane, with one image falling on the optical axis of the system, a mask located in said plane and containing an aperture positioned on the optical axis, said mask permitting transmission of the light waves forming the image falling on the optical axis while preventing transmission of the light waves forming the other images, and a light sensitive member onto which the projected images of the different selected characters are recorded, one after another, as they are successively formed at the mask aperture.

2. A combination according to claim 1, including a photographic lens system interposed between the mask and the light sensitive member for focusing onto the light sensitive member the images of the different selected characters as they are successively formed at the mask aperture.

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