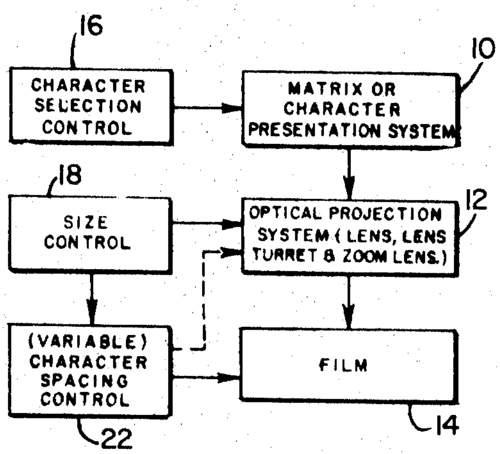

FIG. 1
(PRIOR ART)

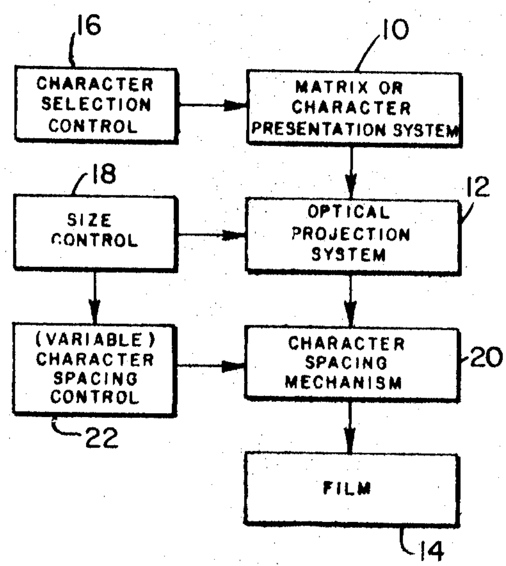

FIG. 2
(PRIOR ART)

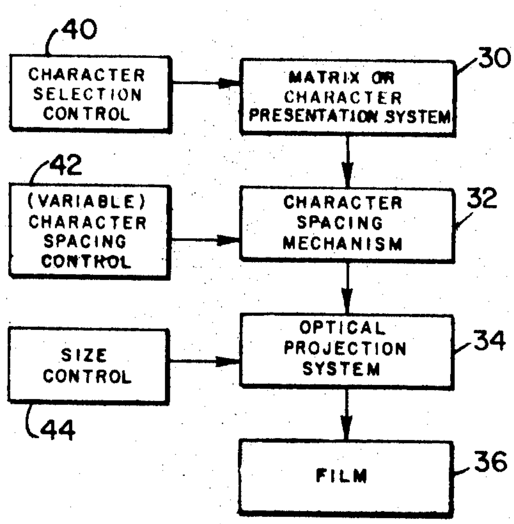

FIG. 3

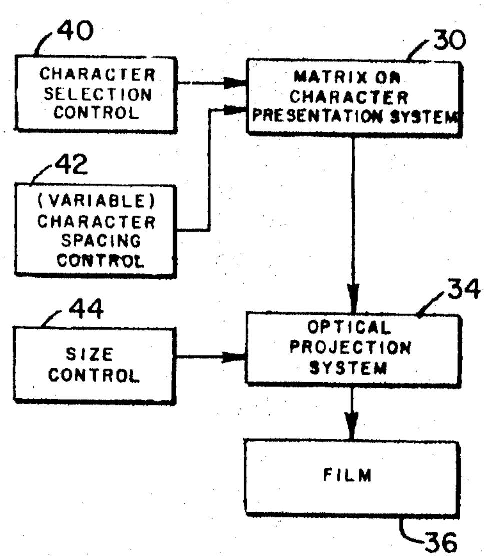

FIG. 4

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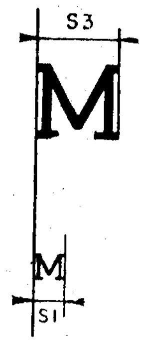

FIG. 5

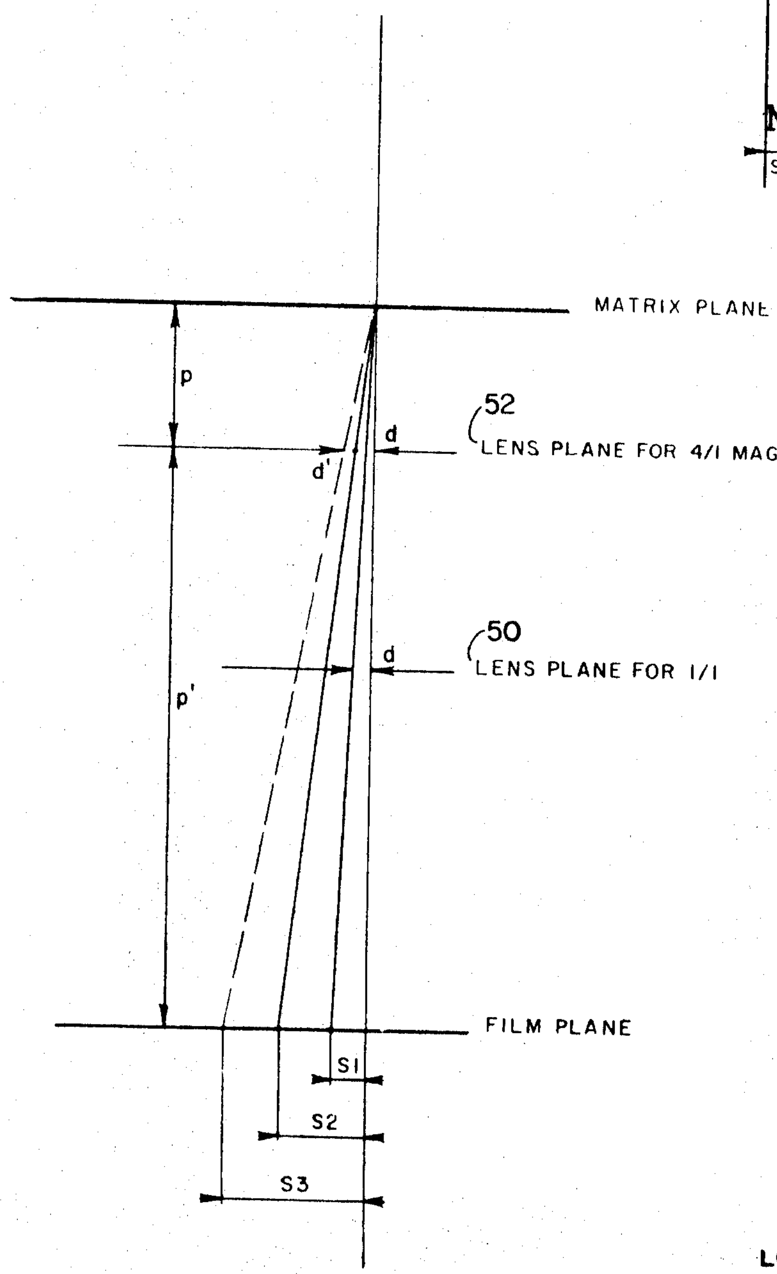

FIG. 6

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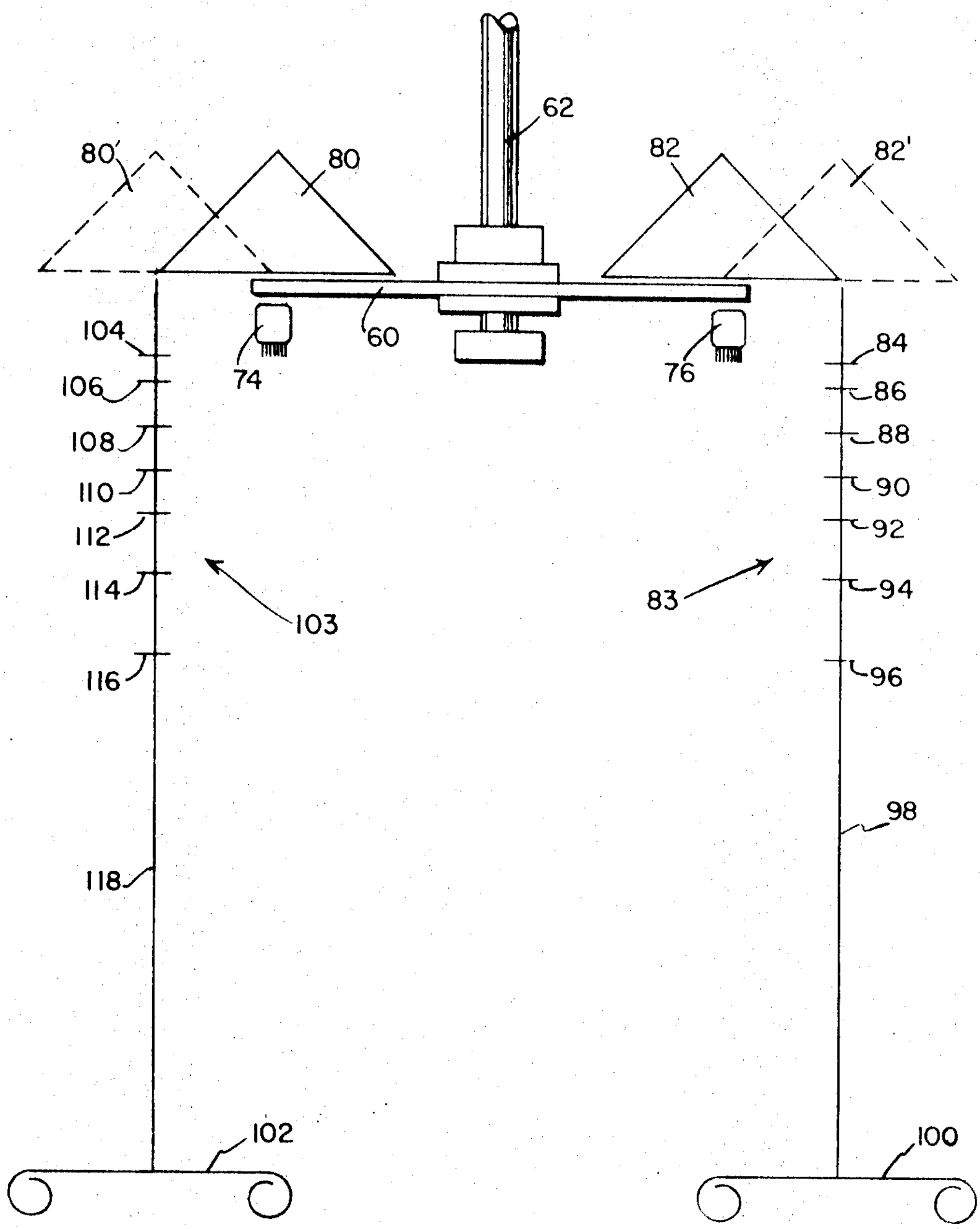

FIG. 7

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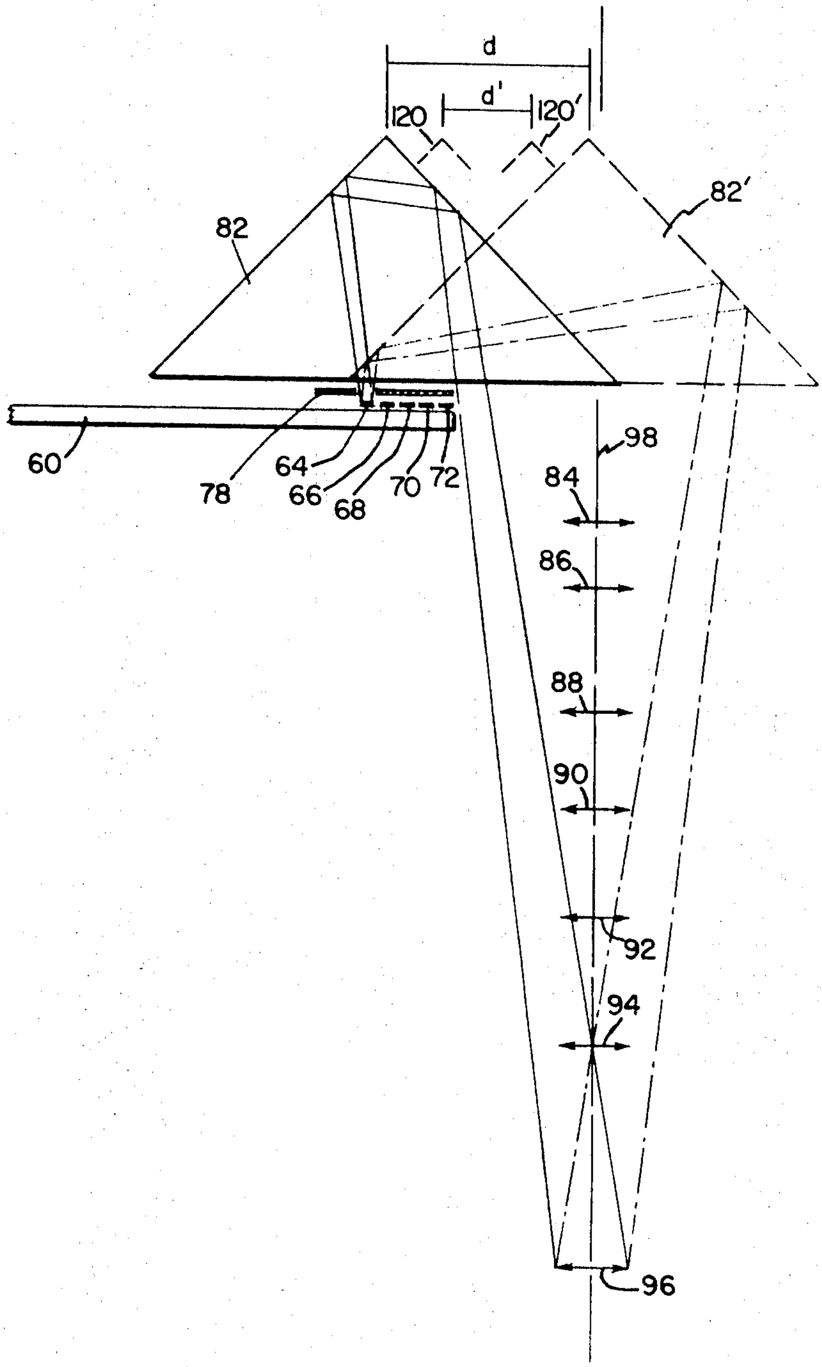

FIG. 8

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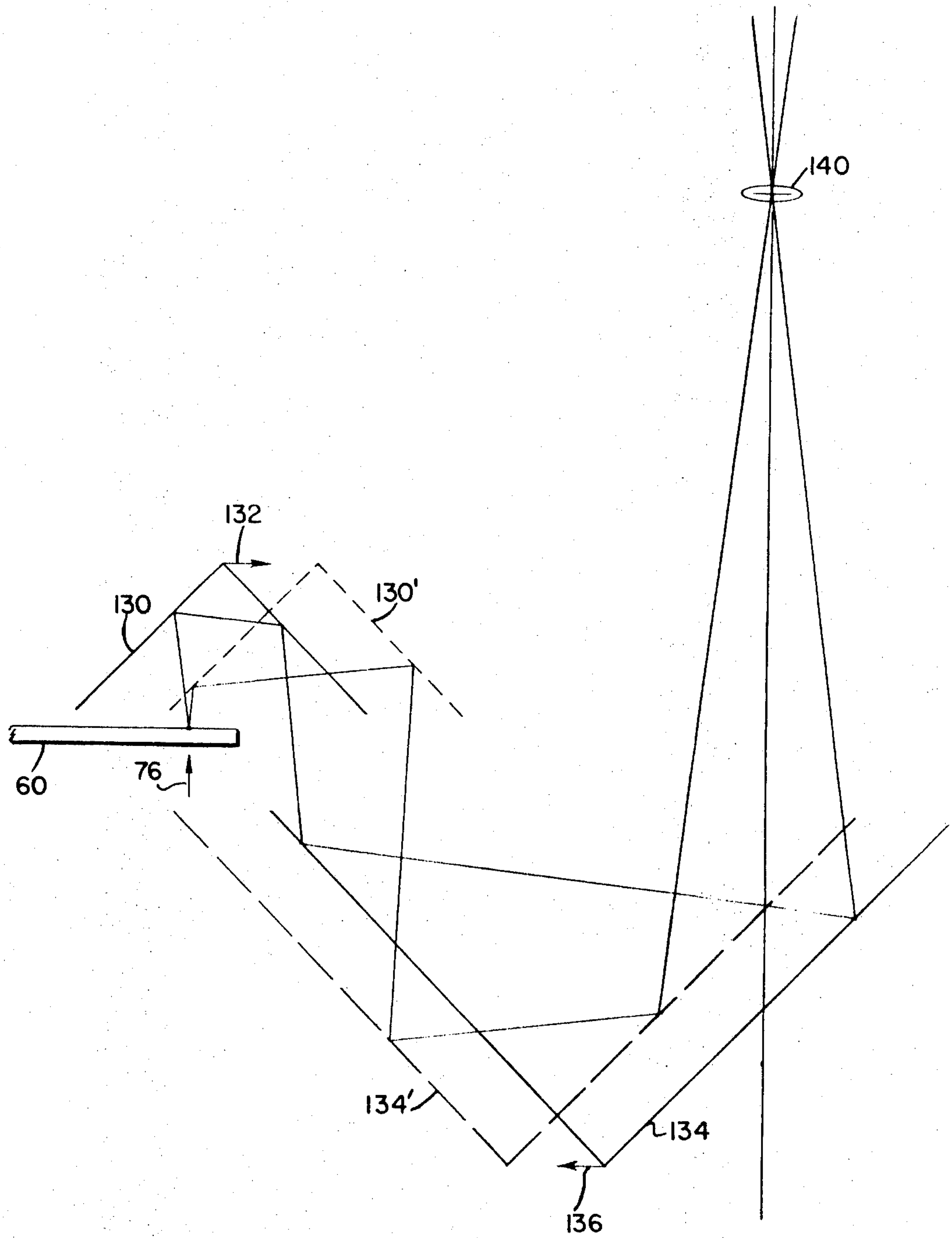

FIG. 9

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United States Patent Office

3,620,140

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3,620,140

PHOTOGRAPHIC TYPE COMPOSING MACHINE

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Continuation-in-part of application Ser. No. 506,936, Nov. 9, 1965. This application July 22, 1969, Ser. No. 843,297
Claims priority, application Great Britain, Aug. 6, 1968, 37,488/68
Int. Cl. B41b *15/34, 17/14*
U.S. Cl. 95—4.5 7 Claims

ABSTRACT OF THE DISCLOSURE

A system for rapidly imaging characters having different relative widths of a radiation-sensitive surface using the concept of optical leverage is disclosed. Character images are projected from one or more projection zones on a character matrix to a receiving surface such as a film. Prior to being focused on the film, each of the projected character images are variably spaced from one another in accordance with their respective relative widths in order to form lines of composition having proportionately spaced characters. The focusing system normally includes a size-changing mechanism. Character spacing may be accomplished by any of several embodiments which employ the optical leverage concept. One embodiment comprises at least one movable right-angle prism which is associated with a fixed, rotating character matrix—the prism spaces projected images of selected characters on the film by straight-line movement in a plane parallel to the film plane.

BACKGROUND AND BRIEF DESCRIPTION OF THE INVENTION

This invention generally relates to photocomposing machines, and particularly pertains to an improved method and means for rapidly imaging characters having different relative widths on a radiation-sensitive surface such as a photographic film or paper.

The present application is a continuation-in-part of copending U.S. application S.N. 827,128, filed May 21, 1969, of S.N. 690,720, filed Dec. 13, 1967, and of S.N. 506,936, filed Nov. 9, 1965, now U.S. Pat. 3,416,420. The foregoing cases are expressly incorporated by reference into the present disclosure.

A photocomposing machine comprises at least the following units: a character presentation system (e.g., a character matrix), a focusing or projection system (e.g., a lens), and a radiation-sensitive surface (such as film). The character presentation system is controlled by character selection means (e.g., shutters, flash lamps, a start-stop matrix etc.). Generally, the various characters necessary to compose a line appear one after another at a common projection point. Each character image is projected onto a sensitive surface and character spacing means are utilized to space characters on the surface in proportion to the size of the projected image.

In the prior art, character spacing was obtained either by displacing the film in the time interval between each character projection (as shown in U.S. Pat. 2,790,362), or by displacing a light spacing mechanism comprising, for example, a reflector and a lens (as described in U.S. Pat. 2,670,665) or by moving a reflector unit (as described in U.S. Pat. 2,388,961), or by rotating a mirror (as described in U.S. Pat. 2,787,654), or by moving a lens (as described in U.S. Pat. 3,188,929).

In each of these arrangements, the "character spacing means" actuated either the projection system (lens), or the film, or light-deflecting means located between the

character projection lens and the film. The disadvantage of these systems is that character spacing mechanism must be adjusted by different amounts depending on the magnification ratio (point size) of the projector characters. The ramifications of the disadvantage will be fully explained below.

In order to produce composition having good typographical quality the characters of the alphabet must be of variable widths. The width of each character of the matrix is conveniently expressed in units or fractions of an em, there being usually 18 units per em of a given (point) size. Moreover, the composed characters must be proportionately spaced from one another according to their respective widths, as opposed to "typewriter" spacing, which is non-proportional. In the prior art the function of the spacing mechanism was not limited to the task of spacing characters by amounts equal to their "relative" width (i.e., so many units for each character). It was also necessary to take into account the (point) size of the image as determined by the size of the object (matrix character), and the magnification ratio of the optical system. Previous systems coped with this problem either through the use of replaceable gears or gear boxes, to actually change the value of a unit according to size (as shown in British Pats. 669,608 and 669,532), or by using a very small increment as a basic width unit (for example, one-eighteenth of one point) and multiplying this unit by the relative width of the character and its size (as explained in U.S. Pat. 2,876,687). In the first case, the use of interchangeable gears makes it difficult to automatically change size—moreover, the use of gears introduces inertia forces that decrease the speed of the machine. The inertia of the spacing mechanism generally limits the speed of this class of machine in proportion to the size of projected images. The larger the size, the greater the inertia, the lower the speed goes. This is also true of the class of machines utilizing a multiplier because the spacing mechanism which may include a stepping motor, will have many more steps to produce in order to space a character having a large point size, compared to the identical character in a smaller point size. If, for example, the "M" is eighteen relative units wide and the size of the large and small capital "M" are 18 and 6 points respectively, the number of steps which must be produced in order to space the smaller size "M" will be 6 times 18 or 108 units or steps, whereas the number of steps necessary for spacing the 18-point "M" will be 18 times 18 or 324 units. Thus, it is apparent that the shortcomings of previous systems in these areas have severely limited their performance.

On the other hand, in the present invention the character spacing means is located at or between the plane of the character presentation means and the optical focusing means. Various embodiments may be employed so long as the principle of optical leverage is adhered to. The principle of optical leverage may be succinctly stated as follows: You must space characters (or character images) before you change size. Thus, the concept of of optical leverage may be implemented by moving the character matrix itself relative to the lens and film (as explained in S.N. 690,720), by moving a light beam deflector (such as a right angle prism) relative to the matrix, lens, and film (as more fully described hereinafter), or by varying the instant of projection of a character image as a character sweeps through a projection zone (as set forth in S.N. 827,128 and Pat. 3,416,420).

Since each of the foregoing embodiments "spaces before sizing," the characters are automatically correctly spaced on the film independently of the magnification ratio or point size in use. The obvious advantage of the inventive embodiments is that the spacing mechanism can deal exclusively in relative units, an "M," for example, causing an 18-unit displacement of the spacing mechanism regardles of the magnification (or demagnification) of the optical projection system. Thus, it is immaterial whether the size in use is 6 point or 72 point—the speed of the machine is completely unaffected by a change in point size. Moreover, there is no need for interchangeable gears, a gear box or a multiplier. In addition, in order to further increase the speed of the machine, the value of one spacing unit can be reduced by utilizing small sized characters on the matrix.

In a machine of this nature, it is desirable that the speed of character imaging be as rapid as possible. However, it is equally desirable that accurate spacing between characters be maintained. In many instances during the projection of a line of text on a film, at least part of the character generation and projection system must be moved relative to the film or vice-versa. Physical motion inherently results in a certain amount of inertia, which varies with the mass of the object being moved. Thus, the greater the mass of a character generation and projection system, the more difficult it is to accurately move the system in the short, rapid steps required to properly space characters while forming a line of text.

In our system disclosed in S.N. 690,720, character spacing with automatic adjustment for various enlargements through "optical leverage" has been achieved by mounting a matrix disc on a slidable carriage, thus permitting the disc to move relative to the rest of the system. However, we have discovered that if a movable light beam deflection means is used and the rotating matrix disc remains stationary, the weight of a slidable carriage for the light beam deflection means will be approximately 5 times as light as the carriage of S.N. 690,720. Thus, both character generation speed and character spacing accuracy are enhanced, since the mass of the movable part of the system has been significantly reduced. In addition, the light deflection carriage moves by smaller increments than said disc carriage.

Moreover, since it is no longer necessary to move the matrix disc from side to side, a single disc may be used to simultaneously project or generate characters for two distinct imaging or focusing systems by providing at least two projection zones on the disc. Thus the speed of the character projection may be effectively doubled without materially increasing the dimensions of the machine. This arrangement may be employed to simultaneously produce independent lines of proportionately spaced composition on each film, or to compose lines of extended length on a single film by using the output of each character image projection zone to compose one-half of each line.

Moreover, if desired, a pair of movable right-angle prisms associated with each projection zone can be used to practically double the speed of composition of the machine. Light beams deflected from the first prism are again deflected by a second prism onto the film. The prisms are driven in opposite directions to one another. The advantage of this system is that since each prism simultaneously moves only one-half the distance normally moved by a one-prism embodiment for each character projection, the composing speed can thus be increased by almost 100%.

The foregoing invention will be more fully described in the detailed description which follows, in which:

FIGS. 1 and 2 of the drawings are block diagrams representing prior art systems;

FIGS. 3 and 4 are block diagrams representing several embodiments of the present invention;

FIG. 5 is a schematic representation of the manner in which a change in size affects prior art systems;

FIG. 6 is a graphic representation of the fact that changing the focus of the optical system does not allow prior art systems to achieve optical leverage;

FIG. 7 is a schematic plan view of rotating disc embodiment of the invention, including a showing of a separate prism and film for each character image projection zone;

FIG. 8 is an enlarged, fragmentary partial cross-sectional plan view of the machine of FIG. 7; and

FIG. 9 is a schematic view of an alternative embodiment in which a pair of oppositely—movable prisms are associated with a single character projection zone.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGS. 1 and 2 of the drawings, the basic components of the conventional prior art systems are shown in block diagram form. Characters are projected from a character presentation system **10** through an optical projection system **12** to a film **14**. Matrix **10** may take one of many forms such as a disc, drum, endless belt, grid etc., and is controlled by a character selection control **16**. Optical projection system **12** may be a lens, a lens turret, or a zoom lens. Size changes in focusing system **12** are achieved by size control **18**. As mentioned previously, prior systems spaced characters either by physically moving the film **14** after the projection of each character image, by moving or rotating the optical system **12**, or by moving a separate character spacing mechanism **20** which is positioned between projection system **12** and film **20** (see U.S. Pat. 2,670,665). In any event, regardless of the particular component which is moved, variable character spacing control **22** governs this movement. However, control **22** always receives, in prior art systems, an input from size control **18**. Thus, as described previously, whenever the size is changed, the input from control **18** to control **22** also changes by differing amounts, thus compelling users to rely upon relatively slow interchangeable gears etc. The inertia forces associated with arrangements of this nature further decrease the speed of the machine. For example, it is evident from an examination of FIG. 5 of the drawings that more inertia will have to be overcome in spacing the larger capital "M" by its actual width **S3**, than is involved in spacing the smaller capital "M" by its actual width **S1**. The drawbacks inherent in previous systems is due to the fact that they failed to recognize the necessity of spacing characters (or character images) before changing size.

The present invention, on the other hand, has grasped the importance of "spacing before sizing" and thus fully exploits the concept of optical leverage. Referring to FIGS. 3 and 4 which depict the invention, characters are projected from a matrix **30** through character spacing means **32**, then through a focusing system **34** onto an image-receiving surface **36** such a a film. Character selection control **40**, character spacing control **42**, and size control **44** are as described above, except for this crucial difference—character spacing control **42** is not ever saddled with an input from size control **44**. This enables one to obtain character images of different sizes while simultaneously changing the magnification ratio of the space occupied by the projected character images. Thus, properly spaced characters can be projected onto film **36** at a constant speed regardless of the number of size changes made during composition. FIG. 3 schematically sets forth the embodiment which will be described more fully in relation to FIGS. 7 through 9, whereas FIG. 4 is a diagrammatic representation of the various embodiments of optical leverage which are fully described in S.N.'s 690,-720, 827,128, and patent 3,416,420. Character presentation means **30** may be any character matrix in which a plurality of characters are adapted to pass repetitively and successively through at least one character projection zone. For example, the matrix could be a disc, drum, or endless band. What the various embodiments represented by FIG. 4 have in common is that matrix **30** receives inputs from both character selection control **40** and variable character spacing control **42**. Thus, character images projected from matrix **30** are properly spaced from the moment they leave the character projection zone. Although controls **40** and **42** are shown as separate boxes, it should be understood that they may be part of the same general control circuit for the machine.

FIG. 6 demonstrates the fact that moving a variable focus (zoom) lens, or lenses of various focal length (e.g., in a lens turret) does not result in the achievement of optical leverage. If lens **50** is moved a distance *d* (⅛″) to produce a spacing S1 for a given character, and lens **50** has a 1:1 magnification ratio (i.e., the same size as the matrix characters), lens **52** (having a 4:1 ratio) will have to move *d*+*d*' (¼″)in order to space an image of the same character which is four times larger.

Referring to FIGS. 7–9 of the drawings, matrix disc **60** is rotatably mounted on shaft **62**. Disc **60** includes a plurality of concentric rings of transparent characters, designated **64, 66, 68** and **70** in FIG. 8. The characters in each ring may be a single typeface, or two different typefaces, depending on the point size of the master characters. Although four rings of characters are shown, it is apparent that the number of rings can be varied if desired. Each of the characters may be of a predetermined point size, such as 5 point. A pair of xenon flash tubes **74** and **76** emit brief, intense flashes of light which illuminate the characters on disc **60**. Flash timing for tube **74** is obtained by a plurality of slits **72** and a conventional lamp and photo diode arrangement (not shown). A movable window or aperture **78** is employed to change style by selecting one or another of the character rings on disc **60**. It should be understood that an identical arrangement is associated with tube **76**. The flash timing systems function in a manner substantially identical to that disclosed in our copending U.S. application S.N. 690,720 filed Dec. 13, 1967. In this manner, a light beam carrying a selected character may be generated or projected from the matrix.

A pair of light beam deflection means such as a right angle prism **80** and a right angle prism **82** are positioned adjacent to the disc face. If desired, a pair of right angle mirrors or equivalent devices could be used instead of the prisms. Each prism is mounted on a separate carriage (not shown) for lateral movement relative to disc **60**, as depicted by **80'** and **82'** in FIG. 7. Prism **80** is moved independently of prism **82** by a suitable conventional drive system such as stepping motor and a rack/pinion arrangement (not shown). Of course, prism **82** may be moved by an identical drive system. The drive system must be able to displace the prism in short, rapid, discrete steps with a minimum of "carriage bounce". Prisms **80** and **82** cooperate with said drive systems such that the actuation of the latter causes the former to be moved in a plane parallel to the plane of a radiation sensitive surface, in a manner more fully described hereinafter.

Positioned near the movable light beam deflection means **82** is the imaging or optical focusing system, generally indicated by numeral **83**. Numerals **84, 86, 88, 90, 92, 94,** and **96** indicate representative lens positions on a common optical axis **98**. An imaging or focusing lens of a given magnification ratio is mounted at one of the lens positions. A lens mounting arrangement which would enable a lens to be readily inserted, removed and repositioned should be employed. For example, an elongated bar having a plurality of spaced notches may be used. Or if desired, a plurality of lens can be placed in a lens turret, as is known in the art, or a wide-angle zoom lens could be employed. The optical focusing system **83** is adapted to focus a character image which has been deflected by prism **82** on an image plane **100**. A radiation sensitive surface such as photographic film or paper may be placed in the image plane. Similarly, a character image deflected by prism **80** is imaged on image plane **102** by a second optical projection system **103** including representative lens positions **104, 106, 108, 110, 112, 114** and **116** having a common optical axis **118**.

It is apparent therefore, that there are two independent projection systems disclosed herein. In other words, two completely different texts may be simultaneously projected on respective image planes **100** and **102**. This is accomplished in a manner more fully described hereinafter. In order to ensure simplicity of description, the operation of only one of the projection systems will be described. It is understood that this description is equally applicable to the remaining projection system.

The operation of the machine is as follows: To compose a text, a punched paper tape or other known record medium is introduced into a reader associated with the circuit of the machine. After the justification computation has occured, for example as described in our copending U.S. application S.N. 690,720, the first character identity code and width information are entered respectively into flash timing and spacing circuits of the type set forth in U.S. application 690,720. As the selected character appears in the projection zone the flash tube flashes light through the transparent character. The light beam which carries the character image is then deflected by prism **82** and projected on image plane **100** by the imaging system. Then, in the interval before the next character flash, the drive system displaces prism **82** to a predetermined character spacing position **82'** and a second character is projected on image plane **100**. This procedure is repeated until an entire line of text has been recorded on image plane **100**.

It is apparent that prism **82** may be moved either before or after a given character flash. Likewise, the enlargement or reduction ratio of the optical projection system can be varied for example, by simply removing an imaging lens positioned at **96** and inserting one having a different magnification ratio at lens position **84**. Thus, if the optical projection system shown schematically in FIG. 8 is replaced by a system having a greater enlargement ratio, the prism **120–120'** need only be moved a lesser distance *d'* in order to compose a line of text, as opposed to a greater distance *d* for the previously discussed system **82–82'**.

Although the foregoing example discusses composition in one direction only, it is apparent that the prisms may be adapted to deflect images onto the films while the prims are travelling in either direction, thus resulting in "forward" and "backward" composition, with a corresponding increase in composing speed. It is also evident that the output of prisms **80** and **82** could be directed to a common image plane in order to compose lines having twice the normal length. To accomplish this, each prism could project a separate half of the extended line of composition. To correct for character orientation where both prisms are used to produce the same line, different character rows could be used, or appropriate beam deflectors could be positioned on the optical paths **98** and **118** between the respective lens system and the image plane. For example, one of a pair of rhomboid prisms (not shown) could have a third reflecting surface plus a roof in order to invert character images.

Referring to FIG. 9 of the drawings, an embodiment is disclosed for doubling the speed of the embodiment of FIGS. 7 and 8. First mirror assembly **130** is adapted to be stepped in the direction of arrow **132** by a first stepping motor (not shown), and second mirror assembly **134** is adapted to be stepped in the direction or arrow **136** by a second stepping motor. At the end of a line, mirror **130** has moved to position **130'** and mirror **134** has moved to **134'**. The focusing lens is shown at **140**, and light rays or beams corresponding to a point object are also shown. Since each mirror assembly is moved by one-half (or one-half plus one unit) the width of each character projected, rather than the full width of the character (see FIGS. 7 and 8), composing speed can be increased by almost 100% if this embodiment is used. If desired, mirrors **130** and **134** could be replaced by equivalent right angle prisms of the type disclosed in FIGS. 7 and 8 of the drawings.

The advantages of the inventive system of FIGS. 7–9 are apparent. Rather than displacing the relatively heavy matrix disc carriage or a complex optical system, we are moving a relatively lightweight prism or mirror. This means that the stepping procedure can be rapidified without impairing character spacing accuracy since the drive system moves a much lighter mass. Moreover, since a single matrix disc forms the basis for two simultaneous character projection systems, the speed of the machine is effectively doubled. It should be understood, of course, that a single character projection system may be used if desired.

The foregoing description is intended to be illustrative only. Various changes or modifications in the disclosed embodiments may occur to those skilled in the art. It is understood, therefore, that all such modifications as would be apparent to one skilled in the art are included within the scope of the present invention.

What is claimed is:

1. A photographic type composing machine comprising:

character presentation means comprising a plurality of characters adapted to be selectively projected,

a source of illumination for selectively illuminating said characters,

control means for selecting characters which are to be projected in accordance with a predetermined sequence,

an image-receiving surface for receiving images of selected characters projected from said character presentation means in order to form lines of composition on said surface,

optical means for focusing images projected from said character presentation means onto said image-receiving surface, said optical focusing means including size-changing means, and

means for variably spacing character images on said image-receiving surface in accordance with their respective relative widths, said character spacing means being positioned in the optical path between said character presentation means and said optical focusing means such that lines of composition are formed in which the characters of each line are proportionately spaced from one another, said machine including control means for said variable spacing means.

2. The machine of claim **1** in which:

said character presentation means comprises a rotating character matrix, and

said variable character image spacing means comprises movable character image deflection means.

3. The machine of claim **2** in which said movable character-image deflection means comprises a right-angle prism.

4. The machine of claim **2** in which said character-image deflection means comprises:

first image deflection means for deflecting said images in a first direction, and

second image deflection means positioned in the optical path of said first-directed images for deflecting said directed images in a second direction through the optical focusing means onto said image-receiving surface.

5. The machine of claim **1** in which said character presentation means includes at least two discrete character image projection zones, each of said zones having associated therewith a source of illumination, an image-receiving surface, optical focusing means, means for variably spacing character-images on the image-receiving surface, control means for said variable spacing means, and control means for selecting characters whose images are to be projected in accordance with a predetermined sequence from each of said character image projection zones, such that said machine may simultaneously produce independent lines of proportionately-spaced composition on each of said image-receiving surfaces.

6. A photographic type composing machine comprising a character matrix at a fixed position, a focusing system and a radiation-sensitive surface, said focusing system being positioned to project selected characters from said matrix to said radiation-sensitive surface, characterized in that movable light beam deflection means are located between said matrix and said focusing system, said beam deflection means adapted to space character images on said surface by causing the images of the selected matrix characters to be moved in a plane parallel to the plane of the sensitive surface, whereby the character images projected onto said surface are spaced in accordance with the magnification ratio of said focusing system through the effect of optical leverage.

7. In a photographic type composing machine, a method of composition comprising the steps of:

passing a plurality of characters repetitively and successively through a character projection zone,

selecting characters which are to be projected from said zone to a character-image receiving surface,

projecting an image of each of said selected characters as said character passes through said projection zone,

variably spacing each of said selected character images in accordance with their respective relative widths prior to focusing said character images on the image-receiving surface.

changing the magnification ratio of at least some of said projected, variably-spaced character images in order to obtain character images of different sizes while simultaneously changing the magnification ratio of the space occupied by said character mages, and

focusing said projected, variably-spaced character images on said image-receiving surface, in order to form thereon lines of composition in which the characters of each line are proportionately spaced from one another.

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JOHN M. HORAN, Primary Examiner