

Feb. 24, 1970

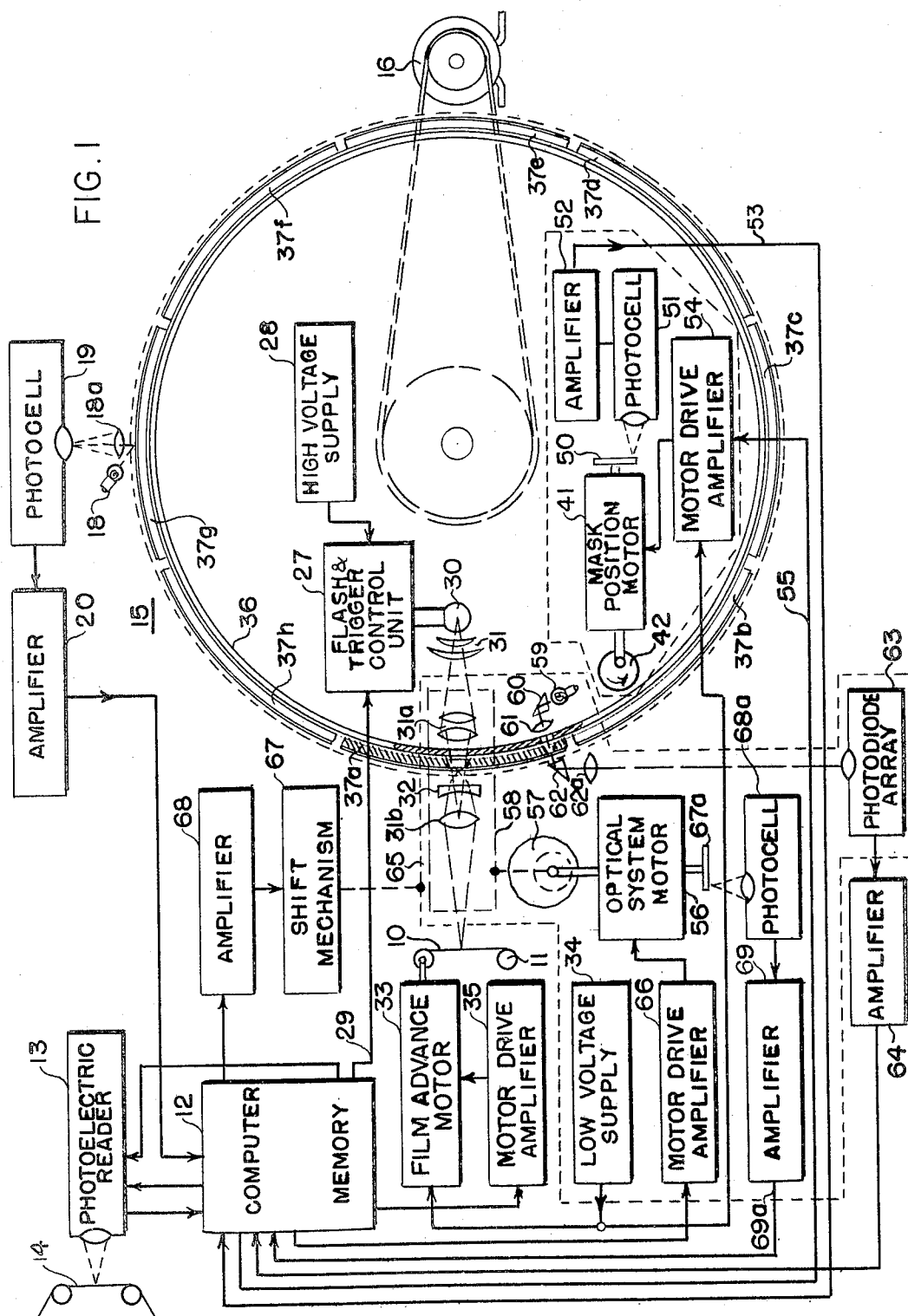
S. W. LEVINE

3,496,847

PHOTOCOMPOSING APPARATUS

Filed Dec. 29, 1966

5 Sheets-Sheet 1



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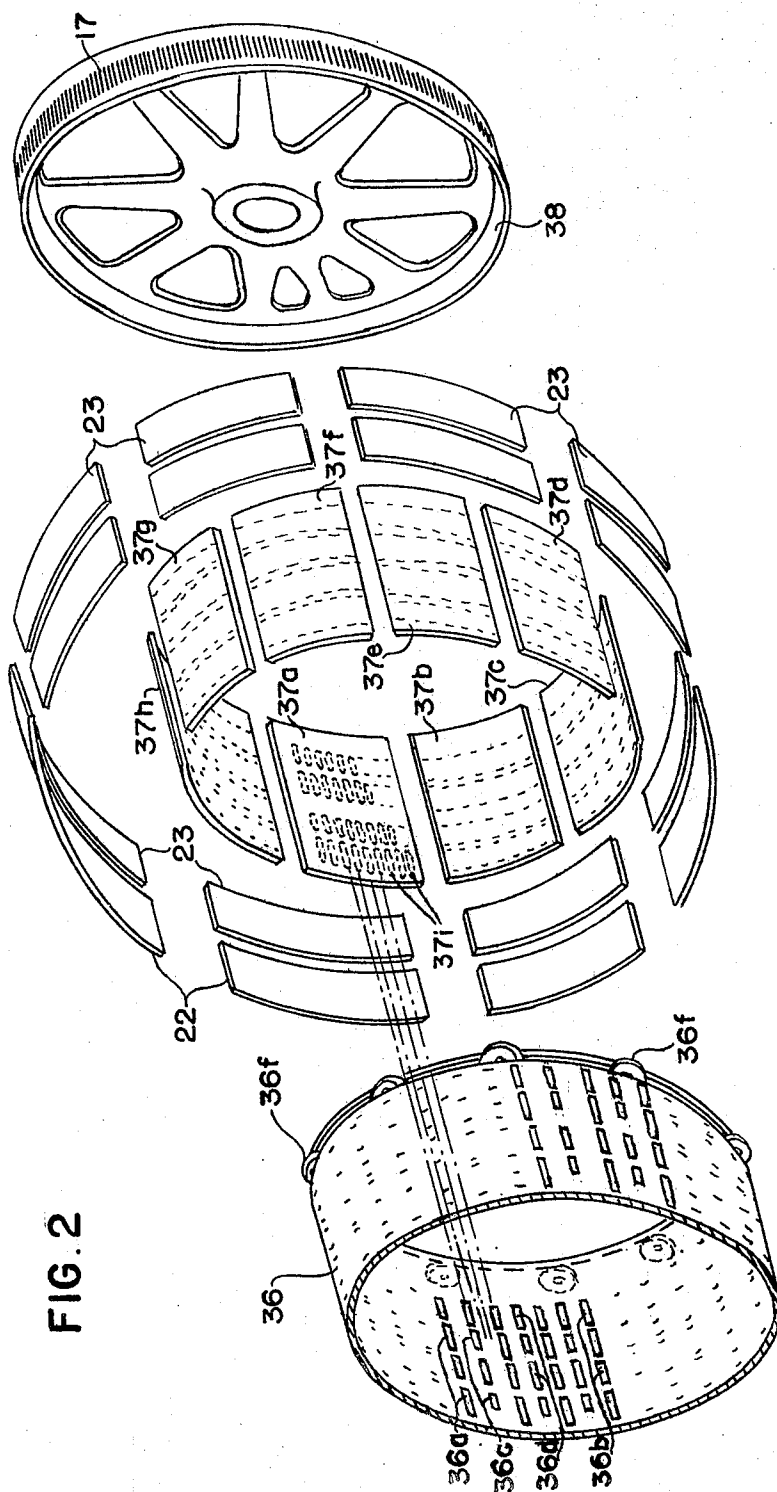
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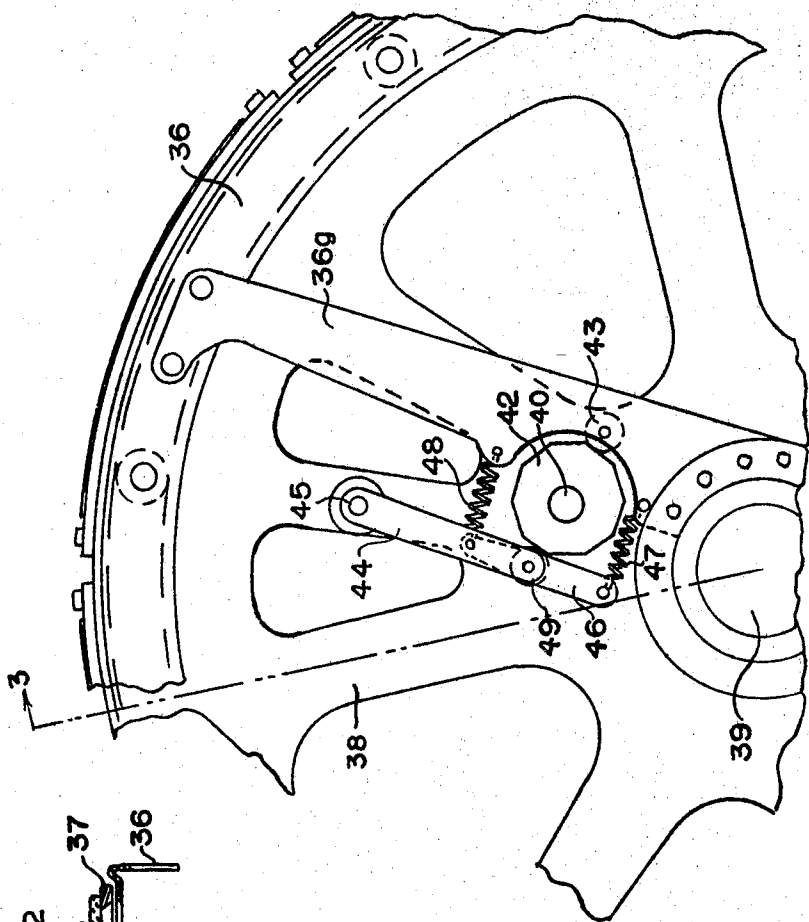


FIG. 4

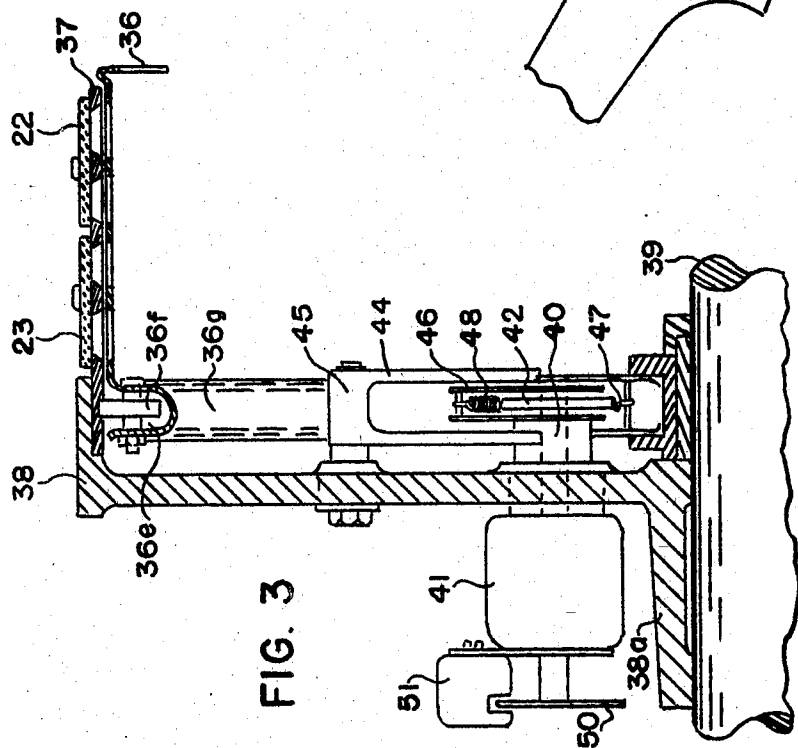


FIG. 3

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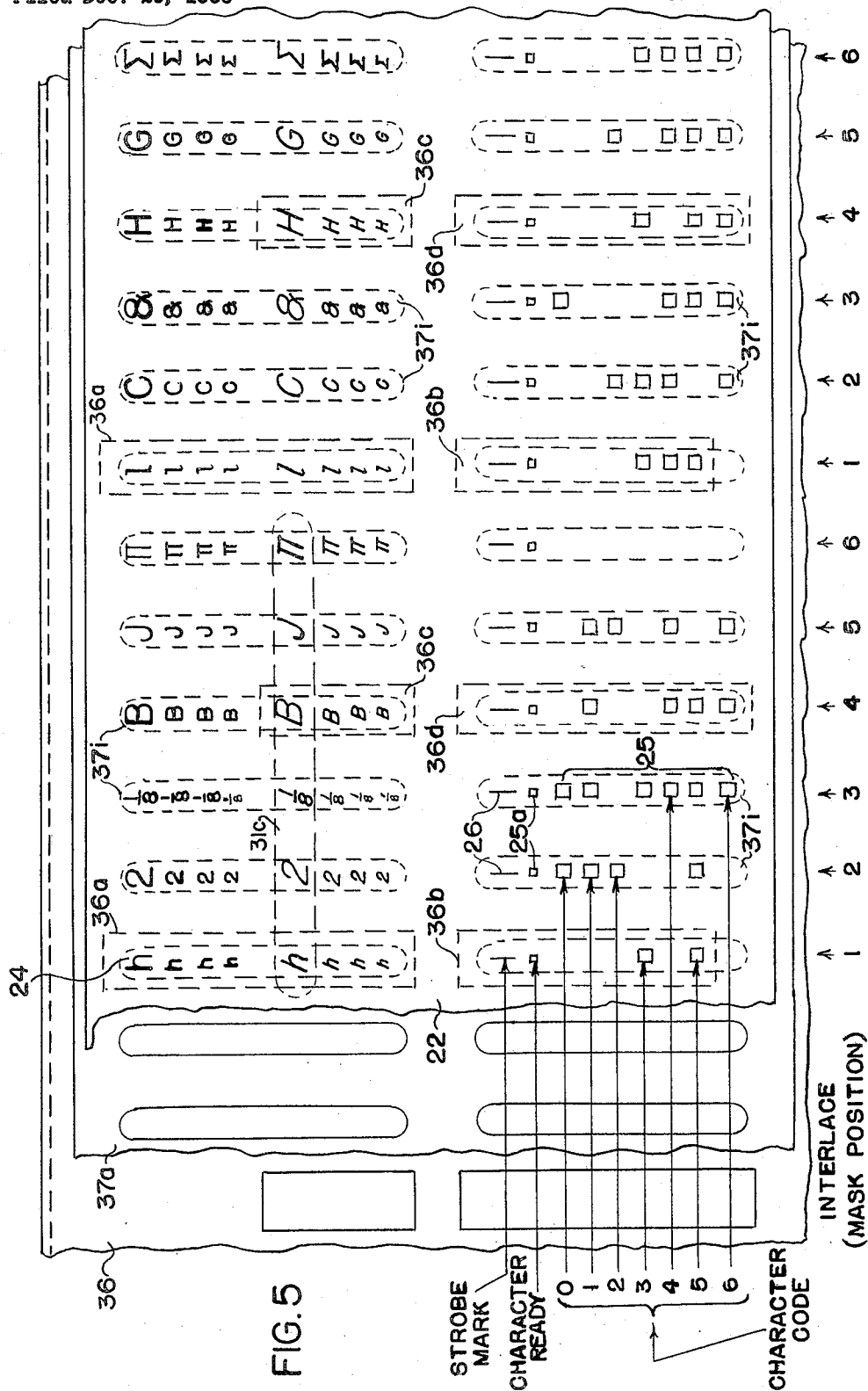
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PHOTOCOMPOSING APPARATUS

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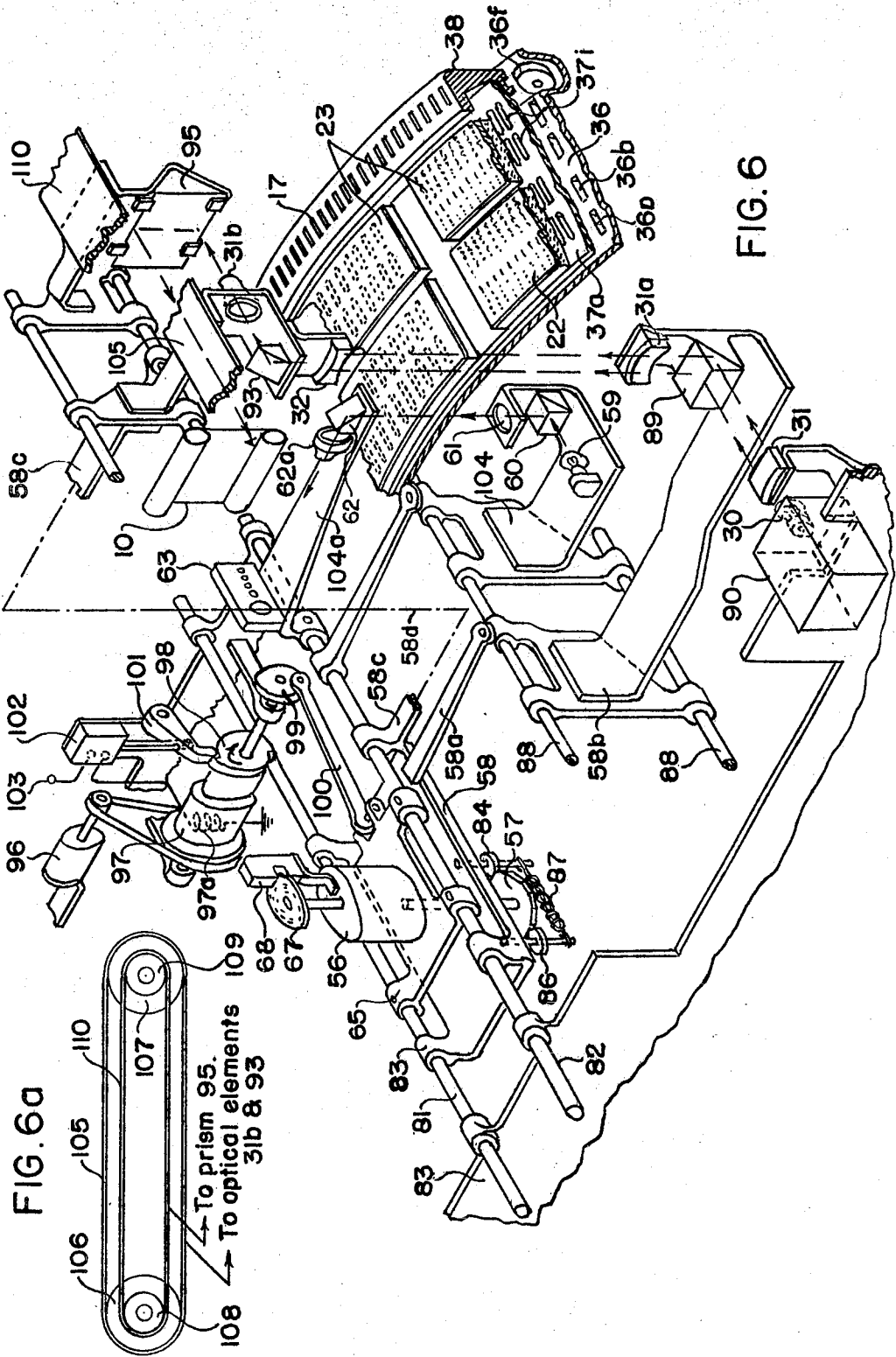
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3,496,847

PHOTOCOMPOSING APPARATUS

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Int. Cl. B41b 19/00

U.S. Cl. 95—4.5

15 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprises a drum continuously rotating at a substantially constant velocity, an endless strip of film mounted on the drum and having a plurality of axially spaced longitudinally arranged interlaced fonts of characters effectively spaced by a distance at least approximately equal to the length of a composed line, and also having position-representative indicia such as a coded group of holes in axial alignment with each character, the characters and such indicia on the one hand and their surround being of opposite extreme optical densities. The apparatus further comprises means for continuously rotating the drum to move the endless strip at substantially constant velocity and means including a single source of illumination and an optical system capable of illuminating a single given character of each of the fonts collectively at any point during its travel effectively over approximately a length of line. The apparatus further includes a film transport and means for projecting the image of the illuminated character upon a film on the film transport. The apparatus includes a mask movable with the drum but adjustable angularly relative thereto to permit illumination only of characters of a selected one of the fonts and a stepper motor and a cam driven thereby for actuating the mask to a preselected angular position relative to the font strips to permit illumination of a selected font of characters. There is also included means driven in unison with the mask for generating a position-representative signal and means jointly responsive to such signal and to the input signals to the system for actuating the mask to a preselected angular position. A portion of the optical system for projecting the image of an illuminated character onto the film is movable axially relative to the drum and means driven in unison with such portion of the optical system generates a position-representative signal. Means jointly responsive to the last-named signal and to the input signals to the system is effective to actuate aforesaid portion of the optical system to a preselected axial position relative to the font strips, thereby to illuminate a preselected font of characters. The apparatus of the invention further comprises sensing means for deriving from the groups of holes in alignment with the font characters a position signal continuously representative of the instantaneous position of a given character during movement of the font strips and means jointly responsive to such position signal and to the input position signals to the system representative of a given character for momentarily exciting the single source of illumination whenever such two signals are in time coincidence.

This invention relates to photocomposing apparatus and more particularly to such an apparatus for composing text line-by-line on a photosensitive medium from coded input electrical signals representative of the characters of text

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to be composed and the position or positions of each character in a line.

Heretofore there have been proposed several types of line-by-line photocomposing apparatus. One type of such equipments has comprised a font drum or tape having a number of columns of characters equal in number to the number of character positions in the line to be composed, together with a large number of high-intensity flash lamps for individually illuminating a character in each column as selected by well-known information processing equipment. The illuminated character is then projected directly onto a photosensitive film by a stationary optical system. An equipment of this type involving xerographic composing is described in Patent 2,726,940 to Buhler. Among the disadvantages of equipment of this type are the undesirably large size of type font required for any reasonable variety of font characters; the high cost of the multiplicity of flash lamps and control circuits therefor; the relatively slow speed of composition; and the inability to justify the composed text.

Another type of line-by-line photocomposing apparatus heretofore proposed comprises a font in the form of a stationary plate having rows of characters individually illuminated by a series of flash lamps. The illuminated characters are projected on a photosensitive film at a selected position by means of a movable optical system. A system of this type is exemplified in Patent 3,188,929 to Higonnet. Photocomposing apparatus of this latter type also has the disadvantages of a large and bulky type font, a costly and complex illuminating system, and the requirement of a complex and costly computer.

In both of the above-described prior art systems, it has been customary to project the successive characters either in the same order in which they appear in a line of text being composed, as in aforesaid Patent 2,726,940, or in the order in which the characters occur in the font. Moreover, in the system of Patent 2,726,940, only a single character is projected during each cycle of operation of the device while, in the system of Patent 3,188,929, the entire font is scanned across the line in each cycle of operation, both systems thereby materially limiting the speed of composing since, ordinarily, several characters will occur repeatedly in any given line of text.

It is an object of the invention, therefore, to provide a new and improved photocomposing apparatus of the type described which obviates one or more of the above-mentioned disadvantages of prior apparatus of this type.

It is another object of the invention to provide a new and improved photocomposing apparatus of the type described in which each character is projected onto a photosensitive medium as many times as it occurs in a given line of text within a single cycle of operation of the apparatus and before any other character is exposed.

It is a further object of the invention to provide a new and improved photocomposing apparatus in which the text being composed is fully and accurately justified.

It is a still further object of the invention to provide a new and improved photocomposing apparatus by means of which the speed of composition is significantly higher than heretofore possible.

In accordance with the invention, there is provided an apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising an endless strip of material having a longitudinally arranged font of characters effectively spaced by a distance at least approximately equal to the length of a composed line, such characters and their surround

being of opposite extreme optical densities, means for continuously moving the font strip at substantially constant velocity, and means including a single source of illumination capable of illuminating a single given character at any point during its travel effectively over approximately a length of line, the light through such character when illuminated being effective to act upon a photosensitive medium cooperatively associated therewith. The apparatus further comprises sensing means for developing a position signal continuously representative of the instantaneous position of such given character during movement of the font strip and means jointly responsive to the position signal and to input position signals representative of said given character for momentarily exciting the illumination source whenever the two signals are in time coincidence. The term "endless strip" is used herein and in the appended claims to mean either a continuous strip or a series of segments disposed essentially end-to-end, in either case forming a path effectively closed upon itself. The phrase "effectively spaced by a distance at least approximately equal to the length of a composed line" is used herein and in the appended claims in a sense taking into account any optical magnification between the font strips and the photosensitive medium on which the images of the font characters are projected.

The phrase "optical density" is used herein and in the appended claims to refer to the effectiveness of the font strips either optically to transmit or optically to reflect illumination, dependent upon whether the font strips are imaged by light transmitted through them or by light reflected therefrom.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description, taken in connection with the accompanying drawings, while its scope will be pointed out in the appended claims.

Referring now to the drawings:

FIG. 1 is a schematic diagram of a complete photocomposing apparatus embodying the invention;

FIG. 2 is an exploded perspective view of the character fonts, their supporting drum, and associated mask embodied in the apparatus of FIG. 1;

FIG. 3 is a partial sectional view through the character fonts, their supporting drum, and associated mask embodied in the apparatus of FIG. 1;

FIG. 4 is a partial detail end view of the apparatus shown in FIG. 3;

FIG. 5 is a detail view of a portion of one segment of one of the character fonts;

FIG. 6 is a perspective view, partly schematic, of the actuating mechanism for shifting and adjusting the optical systems of the apparatus of FIG. 1, while

FIG. 6a is a fragmentary detail of a portion of the mechanism of FIG. 6.

Referring now more specifically to FIG. 1 of the drawings, there is represented an apparatus for composing line-by-line text on a photosensitive medium such as a film 10 disposed on an associated film transport 11. The text is composed in accordance with received coded input electrical signals representative of the characters of the text to be composed and the sequential position or positions of each character in a line, for example from a digital information storage and processing computer 12. The computer 12, per se, forms no part of the present invention but may be of the form described and claimed in the copending application of John Joseph Tortorici et al., Ser. No. 605,887, filed concurrently herewith. As described in that copending application, the computer 12 receives basic information from a photoelectric reader 13 scanning a perforated tape 14, which elements also may be entirely conventional. The tape 14 includes multichannel code perforations representative of the characters of the text to be composed and their relative sequence of appearance in the text of the line, as well as auxiliary functions such as end-of-line signals. The computer 12 coupled to the reader

13 receives character-representative signals, stores them in a memory compartment as indicated, processes them, and delivers them to control the several functions of the photocomposing apparatus, as hereinafter described. For the purposes of this application therefore, it will be assumed that the computer 12 receives from the reader 13 the described signals, processes them, and delivers to the photocomposing apparatus the several required signals for controlling and effecting operation of the apparatus as a whole, as hereinafter described.

The photocomposing apparatus of FIG. 1 includes a font drum 15 driven by a motor 16 and continuously rotating at a substantially constant velocity. The drum 15 has a series of peripheral accurately and equally spaced position-representative indicia 17 in the form of alternate light and dark lines, shown more clearly in FIGS. 2 and 6, and sometimes termed a "picket fence." The indicia 17 are scanned by a photoelectric system including a light source 18, an optical lens 18a, a photocell unit 19, and an amplifier 20 which feeds relatively constant-frequency periodic position-representative signals to the computer 12 where they are counted to obtain a continuous and accurate representation of the position of the drum 15 with respect to some arbitrary zero reference position.

Mounted on the drum 15 is an endless strip of material having a plurality of axially spaced, longitudinally arranged, interlaced fonts of characters and position-representative indicia, the characters of each font style or type being effectively spaced by a distance at least approximately equal to the length of a composed line. As shown more clearly in FIG. 2, this endless font strip is in the form of two axially adjacent rings of font segments 22 and 23, the font segments of each ring being secured to a supporting drum segment as described hereinafter and, as so supported, abutting one another as closely as permitted by mechanical considerations.

A section of one of the segments 22, 23 is shown in detail in FIG. 5. In this figure, it is seen that each row of font characters, such as the row 24, has associated therewith a series of character-representative indicia or code holes 25 in axial alignment therewith, a character-ready hole 25a, and a single narrow position-representative slit 26 also in axial alignment therewith. The slit 26, sometimes termed a strobe mark, has a longitudinal width which is a minor fraction of that of its associated character-representative holes. The characters, such as the row of characters 24, the coded character-representative holes 25, the character-ready hole 25a, and the slit 26 on the one hand, and the surrounding field of the font segment on the other hand, are of opposite extreme optical densities. For example, it is preferred to make the font segments 22, 23 opaque with the characters, holes, and slits transparent, as by photographic printing. As shown in FIG. 5, each font segment includes a plurality of tracks or peripheral groups of characters in axial alignment, all of the characters in any axial row being the same except for size, type style, etc. Each character is accompanied by a group of code holes identifying that particular character. In one embodiment of the invention, there are included two rings of type font segments, each ring comprising 8 segments and each segment having 8 character tracks, each track including 6 groups of 6 interlaced characters or a total of 4,608 font characters.

The photocomposing apparatus of FIG. 1 further comprises means capable of illuminating a single selected character of a single one of said fonts during its travel over a length of line, the image of such character, when illuminated, being projected upon a photosensitive medium cooperatively associated therewith, such as the film 10 disposed on a film transport 11. This latter means includes a flash and trigger control circuit 27 energized from a high-voltage supply circuit 28 and controlled from computer 12 via a connection 29 and energizing a flash lamp 30. The light from the lamp 30 is projected onto the film 10 via a conventional optical system including a large-

aperture condenser lens assembly 31, a collimating lens assembly 31a, an objective lens 31b, and a plano-concave field-flattening lens 32 to take into account the curvature of the font strips 22, 23.

For clarity of illustration, the film 10 and transport 11 are shown as though they were scanned by the optical system 30, 31, 31a, 31b, 32 longitudinally thereof while, in fact, the arrangement is that the scanning is transverse of the film 10. In accordance with usual practice, the film 10 is held stationary while a transverse line is composed thereon and then advanced line-by-line for successive line compositions. This line-by-line advance is effected by a film-advance motor 33 energized from a low-voltage supply unit 34 and controlled by the computer 12, under the control of the input signals from the reader 13, via an amplifier 35. The motor 33 is effective to advance the film transport 11 one line upon the receipt of an end-of-line signal from the computer 12, as represented by the storage of a line of text in the memory unit of the computer 12.

The supporting drum 15 for the font segments 22, 23 comprises a series of cylindrical segments 37a-37h secured to a spoked wheel or disc 38 (FIG. 2) on which the timing indicia 17 are disposed in accurate registration with the font strobe slits 26. Cooperating with drum 15 is a mask 36 which includes a plurality of peripheral groups or tracks of axially extending slots 36a (FIG. 2). There are two peripheral tracks of slots 36a, one for the font characters of each font and two peripheral tracks of slots 36b, one for the character code and strobe slots of each font. Each peripheral track of slots 36a, 36b includes one slot for each group of interlaced characters in the corresponding peripheral channel or track of one of the font segments 22, 23. For composing a line of approximately one-half the normal length when utilizing the mask slots 36a, 36b, there are interdigitated therewith slots 36c and 36d respectively, the slots 36c being half the length of the slots 36a in the same peripheral track, as shown in FIG. 5.

The apparatus is shown in FIG. 1 in the position in which a character of a font segment 22 is being illuminated through one of the axial slots 36a in the mask 36. As shown more clearly in FIG. 2, the type font segments 22, 23 are individually mounted in the drum segments 37a-37h, each having a series of peripheral groups of tracks of slots 37i, each group of slots registering with a group of character tracks of one of the fonts 22, 23 or with their associated code holes. Two axially adjacent font segments are mounted on each drum segment. The mask 36 is rotatable with the font segments 22, 23 and their supporting drum segments 37a-37h, but it is adjustable angularly relative thereto to permit illumination of only a single character, from a selected track of characters on one of the font segments 22, 23.

The apparatus for adjustably mounting the mask 36 relative to the type fonts 22, 23 is shown more particularly in FIGS. 3 and 4. The mask 36 is mounted to rotate freely on a shaft 39 to which the disc 38 is secured via a hub 38a. The mask 36 has a peripheral channel 36e at its end adjacent the disc 38 in which are disposed a series of rollers 36f engaging the inner periphery of the outer flange of disc 38 and the drum segments 37a-37h to assist in maintaining these elements in alignment. Journalled in the web of the disc 38 is a shaft 40 driven by an attached motor 41, preferably of the stepper type. Mounted on the shaft 40 is a ten-sided cam 42. Mounted on an arm 36g of the mask 36 is a cam-follower roller 43 biased into engagement with the cam 42 via a link 44 mounted on a pivot shaft 45 secured to a spoke of disc 38 and an auxiliary link 46 pivoted at the end of link 44 and engaged by a pair of biasing springs 47 and 48 attached to the arm 36g of the mask 36. Mounted on arm 44 is a second cam-follower roller 49 engaging the cam 42 diametrically opposite follower 43. The spring and linkage mechanism 44-48 is of the type in which the net work upon the springs 47, 48, or delivered by the springs 47, 48 during angular adjustment of cam 42 is substantially zero while, at the

same time, the mask 36 and follower 43 are firmly biased into engagement with cam 42. The cam 42 has five active sides or flats engaging the follower 43 and disposed at equal incremental distances from the center of rotation and five inactive sides or flats engaging the follower 49, two sides doubling as both active and inactive sides, or a total of ten sides. The cam 42 is given a configuration such that the distance between followers 43 and 49 remains constant during angular adjustment of the cam so that it is unnecessary to do work on the springs 47, 48 during such adjustment to adjust the angular position of the mask 36 relative to the drum 15 and its attached type fonts.

The action of the mechanism just described is that, as the cam 42 is stepped to its successive positions by its driving motor 41, the mask 36 is angularly adjusted to six successive angular positions so that, for each position, the several axial rows of slots 36a will register with the characters of one axial row of the six interlaced characters of the eight peripheral groups or tracks of characters of one of the font segments 22 or 23, for example as shown by the slots 36a in FIG. 5.

The mask-adjusting mechanism shown in FIGS. 3 and 4 also includes means driven in unison with the mask 36 for generating a mask position-representative signal, this means being in the form of a code disc 50 on the opposite end of the motor shaft 40 from the cam 42 cooperating with a photocell 51 and amplifier 52 (FIG. 1) for supplying position-representative signals via the connection 53 to the computer 12. There is also provided means jointly responsive to such position-representative signals and to the input signals for actuating the mask 36. This latter means may be in the form of an amplifier 54 controlled via a connection 55 from the computer 12, which thus compares the input signals from the computer 12 with the mask-position signals from amplifier 52 and utilizes the difference signal for actuating the mask-position motor 41.

The photocomposing apparatus of FIG. 1 further comprises means, specifically the optical system 31, 31a, 31b, 32, capable of illuminating collectively one interlaced group of six characters of any of the peripheral tracks of font characters, as indicated by the trace 31c, FIG. 5, from the flash lamp 30. To this end, there is provided means for effecting relative axial movement between the font strip segments 22, 23 on the one hand and the optical system 31, 31a, 31b, 32 on the other hand. Specifically, there is provided an optical system motor 56 which drives a sixteen-sided cam 57 which, in turn, drives a carriage indicated schematically at 58 on which is mounted the optical system 31a, 31b, 32.

The photocomposing apparatus of FIG. 1 further comprises sensing means for deriving from either of the endless font strips 22, 23 a position signal continuously representative of the instantaneous position of a given character during movement of the strips. Specifically, this sensing means comprises an optical system for responding to the character-code and character-ready holes 25, 25a and the strobe slits 26 in the type fonts 22, 23 (FIG. 5). This sensing means comprises a source of constant illumination 59 and an optical system 60, 61, 62, 62a for projecting light beams from such holes and slits onto a photodiode array 63 preferably comprising a series of photosensitive semiconductor diodes, one for each of the light beams. Signals developed in the unit 63 are fed to the computer 12 via an amplifier 64, thus supplying the computer 12 with an identification of the font character then being illuminated, together with an accurately timed strobe signal to start counting of the signals from the indicia 17 and the character-ready signals to initiate comparison of the character-representative signals from the character code holes 25 with the desired character signals from reader 13. The devices 59-63 are disposed on a carriage 65 on which is adjustably mounted the carriage 58 for the optical system. 31a, 31b, 32 described above. Carriage 58 is adjusted

with respect to the carriage 65 by the motor 56 and cam 57 in response to signals from the computer 12 via amplifier 66. Carriage 65 is actuated by a shift mechanism 67 energized from computer 12 via an amplifier 68.

The photocomposing apparatus of FIG. 1 further comprises means responsive to the input signals from the reader 13 for actuating the carriages 58 and 65 for the optical means 31a, 31b, 32 and 59-63 to preselected axial positions to illuminate a preselected peripheral row or track of font characters and associated character code holes. This means includes means driven in unison with the optical means 31a, 31b, 32 for generating a position-representative signal, specifically a disc 67a disposed on the shaft of the motor 56 and provided with a group of position-representative holes which are illuminated by a light source (not shown), coded light impulses being picked up by a photocell 68a coupled to an amplifier 69 for generating a position-representative signal and applying it via a connection 69a to computer 12. The computer 12 comprises means jointly responsive to the position-representative signal delivered via the connection 69a and to input position signals from the reader 13 representative of the given character for actuating the optical systems 31a, 31b, 32 and 59-63 to preselected axial positions and for momentarily exciting the flash lamp 30 whenever such two signals are in time coincidence.

In brief, the shift mechanism 67 is effective to actuate carriage 65 to shift both of the optical systems to a selected one of the type font rings 22, 23 while the motor 56 is effective to adjust the carriage 58 with respect to the carriage 65 to position the optical system 31a, 31b, 32 to a selected track of font characters of the selected font ring. The details of the driving mechanisms for the optical systems 31a, 31b, 32 and 59-63 under the control of computer 12 are described hereinafter with respect to FIG. 6.

The timing of the momentary energization of the flash lamp 30 is effected by the computer 12, which responds to the timing signals derived from the accurate character position-representative slits or strobe marks 26 in the font strips 22, 23, the drum position-representative signals from the pickup system 17, 18, 19, the character-representative signals for each of the characters derived from the character-representative code holes 25, the character-ready signals from the font holes 25a, and the coded position input signals derived from the reader 13 for momentarily exciting the flash lamp 30 whenever and wherever the selected character being illuminated appears in the line of text being composed, as described hereinafter.

Referring now more specifically to FIG. 6, there are represented the mechanisms for actuating the carriages 58 and 65 to position the optical systems 31a, 31b, 32 and 59-63, respectively, axially relative to the type fonts 22, 23 to select a desired font track. Specifically, the motor 56 is mounted on carriage 65 secured to a pair of rods 81, 82 slidably mounted in a stationary frame member 83. The flash lamp 30 is mounted in a housing 90 attached to frame 83. The cam 57 driven by the motor 56, cooperates with a cam-follower 84 disposed on the sub-frame 58, the cam being biased into engagement with the follower 84 by a second follower 86 biased by spring 87. While the arrangement for biasing the cam 57 into engagement with the follower 84 has been shown schematically for clarity, this biasing arrangement is preferably of the type shown in FIG. 4 for biasing the cam 42 into engagement with the follower 43. Extending from the sub-frame 58 is an arm 58a secured to a sub-frame 58b slidably mounted on guide rods 88, 88 and carrying a prism 89 comprising a portion of the optical system 31, 31a, 31b, 32 (FIG. 1). The light from source 30 emerges from housing 90 and passes through condenser lens 31 in the form of a flat beam which is reflected by the prism 89 and illuminates one group of six interlaced characters of a selected track of a selected font, as shown by the pattern 31c (FIG. 5). Thus, mask 36 blocks the peripheral tracks of characters except for a selected group of axial rows of interlaced characters, while the lamp 30 and its asso-

ciated optical system illuminate a single interlaced group of characters except for a selected group of the axial rows of interlaced characters, while the lamp 30 and its associated mask holes 36a, the drum segment holes 37i, and the illumination pattern 31c of FIG. 5, a selected character is illuminated and projected onto the film 10.

The light beam from a character illuminated as described then passes through an optical system comprising the field-flattening lens 32, a reflecting prism 93, the objective lens 31b, and a reflecting prism 95 to the film 10.

Neglecting for the moment the mechanism for shifting from one type font to the other, as the computer 12 calls for exposing font characters in the different tracks of the selected font, for example the font 22, the stepping motor 56 is actuated the appropriate number of steps to drive the cam 57 to position the carriage 58, the sub-carriage 58b, and the prism 89 carried thereby to the appropriate peripheral track of the type font 22. The photoelectric position-sensing elements 67 and 68, driven by the motor 56, feed back to the computer the information on the position of the carriage 58 and the prism 89 to deenergize the motor 56 when the former elements have reached their desired position.

In FIG. 6 there is also represented apparatus necessary to shift the optical systems 31a, 31b, 32, and 59-63 axially for registering with either of the type fonts 22, 23. To this end, the carriage 65 is shifted axially by a continuously running motor 96 which, through an electromagnetic slip clutch 97, drives a half-revolution latch disc 98 and a crank disc 99 driving a crank arm 100 pivotally connected to the carriage 65. The latch disc 98 is controlled by a latch arm 101 controlled by a solenoid and microswitch unit 102 energized from a terminal 103 connected to amplifier 68 (FIG. 1). The microswitch of the unit 102 is connected to energize a coil 97a of clutch 97, the arrangement being such that, upon receipt of a control pulse at terminal 103, the clutch 97 is engaged and the latch arm 101 is momentarily retracted, allowing the latch disc 98 to rotate through one-half of a revolution, whereby the crank disc 99 adjusts the carriage 65 from one of its extreme positions to the other, in which the optical systems 31a, 31b, 32, 89, 95 and 59-63 register with one or the other of the type fonts 22, 23. The operation just described assumes that the operator of the machine knows by observation when initially setting up the machine, the particular one of the type font sections 22, 23 with which the optical systems are in registry and sets the switches LM and UM in the unit 288 of FIG. 7g to correspond. The LM FF and UM FF signals from unit 287 of FIG. 7g are applied in common to terminal 103, FIG. 6, to effect the operation described.

Connected to the sliding rods 81, 82 is a sub-frame member 104 carrying the optical system elements 59, 60, 61 and a sub-frame member 104a carrying the optical elements 62, 62a and the photodiode array 63, as shown schematically in FIG. 6. The optical system 59-63 is disposed to register with the character-code holes 25, the character-ready holes 25a, and strobe slits 26 of the selected one of the fonts 22, 23. With this arrangement, it is seen that both of the optical systems are moved axially upon shifting from one type font to the other but only the optical system 31a, 31b, 32, 89, 95 is moved axially in response to the motion of the stepping motor 56 to select a given font track of the selected type font.

Since the film remains stationary, as prisms 89, 93 and lenses 31a, 32, and 31b are moved axially to select a given track of a type font 22 or 23, the length of the optical path from the font 22 or 23 to the film 10 would vary, thereby changing the focus and the size of the illuminated character as projected on the film 10. In order to compensate for this, the prism 95 is arranged to move in the same direction as the optical elements 32, 93, 31b but by one-half the distance. It can be shown that, with such an

arrangement, the length of the optical path from the font 22 or 23 to the film 10 remains constant. To this end,

the film 10 are then shown in the following table for the composition of the phrase at the top of the table:

Cycle	s	o	m	e	a	d	m	i	n	i	s	t	r	a	t	i	v	e	l	e	a	d	e	r	s
1.....					a									a						a					
2.....						d																d			
3.....				e														e		e			e		
4.....								i	i							i									
5.....																			l						
6.....			m				m																		
7.....									n																
8.....		o																							
9.....												r												r	
10.....	s										s													s	
11.....												t			t										
12.....																	v								

there is provided a motion-reduction mechanism in the form of an endless steel tape 105 mounted on a pair of idler rollers 106 and 107 (FIG. 6a). Attached to the rollers 106, 107 are secondary rollers 108 and 109, respectively, of diameters one-half the diameters of the rollers 106, 107 respectively. Disposed about the rollers 108, 109 is a second endless steel tape 110. The carriage 58 and connected optical elements 31b, 32 and 93 are connected to drive outer tape 105, as schematically indicated, while the prism 95 is secured to the inner tape 110. The tape 105 is driven by, and moves with, the carriage 58 through arm 58c, interrupted for the sake of clarity, the interconnection between the broken portions being shown schematically by the dot-dash line 58d. Thus the optical elements 31b, 32, and 93 move in unison with the optical element 31a and the prism 89 while, through the steel tape and roller mechanism 105-110, the prism 95 moves in the same direction but through one-half the distance.

In explaining the operation of the above-described apparatus, it will be helpful initially to consider an important objective of the invention, namely, to project onto the film 10, during the composition of each line, each character as many times as it occurs in the line and during a single scanning of the line across the film 10 by such character which may be termed, for convenience, one cycle of operation of the apparatus. The several characters occurring in the line of text being composed are illuminated in succession under the control of computer 12 in the order in which they occur on the font strips 22, 23 during rotation of the drum 15, usually in the order of statistical frequency of occurrence. Specifically, each time a strobe slit of a font character is sensed by the devices 59-63, there is supplied to the computer 12 a character-position signal which initiates operation of a counter therein responsive to signals from the position indicia 17. Each time the reading of the counter corresponds to the position of the character to be illuminated in the line being scanned, the lamp 30 is momentarily illuminated by the unit 27 under the control of the computer 12 and the selected character is projected onto the film 10. At the end of the line, the counter of computer 12 is reset to zero, ready to respond to a signal from the strobe slit of the next character selected by the computer.

Assume that, initially, it is desired to compose a line of text all the characters of which are of the same font style, for example lower case letters of a given type and size. Under these conditions, the mask 36 and the optical systems on the carriages 58, 65 remain in the same positions throughout the composition of the line. For the sake of simplicity, it will be assumed that the font characters appear in alphabetical order. The order and manner in which the several characters are projected on

Thus, twenty-five characters are projected on the film 10 during twelve cycles of operation of the apparatus.

Next, assume that the line of text to be composed includes one or more letters of different type style, or other characters such as punctuation marks, found in another of the peripheral rows or tracks of characters from that being exposed in the example described above, requiring an angular shift of the mask 36. The computer 12 then compares the input signal representative of the particular one of the interlaced rows of characters in which the desired character is found with the position signal supplied to it by the optical system position-sensing units 50, 51 and supplies a signal to the motor 41 via amplifier 54 to advance the cam 42 in a number of discrete steps until the two position signals are in coincidence. The computer 12, via the unit 27, then momentarily excites the lamp 30 when the selected character is in proper position or positions during the scanning of a line on the film 10, as described above.

Similarly, if the line of text being composed includes letters of a different type style, for example capital letters, found in a different one of the peripheral tracks of characters of the same type font ring from that of the letters in the above tabular example, the computer 12 will then compare the particular input signal received from the reader 13 and representative of the peripheral track of characters in which the desired character is found with the track position-representative signal supplied to it by the position-sensing units 67a, 68a and will supply to the mask positioning motor 56, via the amplifier 66, a signal to advance the cam 57 a number of discrete steps until the two position signals are in coincidence.

Referring to FIG. 6, stepping of the motor 56 is effective to move the carriage 58 to shift the optical system, including elements 89, 93, and 95, axially of the type fonts and into position to illuminate the track including the desired group of interlaced font characters. The computer 12, via the unit 27, will then momentarily excite the lamp 30 each time the selected character is in proper position or positions during the scanning of a line on the film 10. When the apparatus is composing a full-length line, the optical system is operated to illuminate only a selected one of the upper four tracks of characters as represented in FIG. 5; when composing a half-length line, the optical system is operated to illuminate only a selected one of the lower four tracks.

Again, if the line of text being composed includes characters found in a different one of the type fonts 22, 23 from that of the letters in the above tabular example, the computer 12 will compare the particular input signal received from the reader 13 and representative of the particular one of the type fonts 22 or 23 in which the desired character is found with the track position-

representative signal supplied to it by the position-sensing units 67a, 68a and will supply a signal to terminal 103 which is effective momentarily to engage the clutch 97 and release the latch 101, effecting a half revolution of crank disc 99 and a shift of the carriage 65 to its opposite extreme position and concurrently carrying with it the carriage 58. This shift is effective to move both of the optical systems from registration with one type font to the other. It is noted that while the optical system 89, 93, 95 is shifted both in response to the rotation of the cam 57 and to the shift mechanism 96-100, the optical system 59-63, which scans only the character-code information, is moved only upon actuation of the shift mechanism since this information is the same for either type font regardless of which track is being utilized.

While there has been described what is, at present, considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein, without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising:

an endless strip of material having a longitudinally arranged font of characters effectively spaced by a distance at least approximately equal to the length of a composed line, said characters and their surround being of opposite extreme optical densities;

means for continuously moving said strip at substantially constant velocity;

means including a single source of illumination capable of illuminating a single given character at any point during its travel effectively over approximately a length of line, the light through said character when illuminated being effective to act upon a photosensitive medium cooperatively associated therewith;

sensing means for developing a position signal continuously representative of the instantaneous position of said given character during movement of said strip;

and means jointly responsive to said position signal and to input position signals representative of said given character for momentarily exciting said illumination source whenever said two signals are in time coincidence.

2. An apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising:

an endless strip of material having a plurality of longitudinally arranged interlaced fonts of characters effectively spaced by a distance at least approximately equal to the length of a composed line, said characters and their surround being of opposite extreme optical densities;

means for continuously moving said strip at substantially constant velocity;

means including a single source of illumination capable of illuminating a single given character of a single one of said fonts at any point during its travel effectively over approximately a length of line, the light through said character when illuminated being effective to act upon a photosensitive medium cooperatively associated therewith;

sensing means for developing a position signal continuously representative of the instantaneous position of said given character during movement of said strip;

and means jointly responsive to said position signal and to input position signals representative of said given character for momentarily exciting said illuminating means illumination source whenever said two signals are in time coincidence.

3. An apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising:

an endless strip of material having a plurality of longitudinally arranged interlaced fonts of characters effectively spaced by a distance at least approximately equal to the length of a composed line, said characters and their surround being of opposite extreme optical densities;

means for continuously moving said strip at substantially constant velocity;

means capable of illuminating a single given character of each of said fonts collectively during its travel effectively over approximately a length of line, the light through said character when illuminated being effective to act upon a photosensitive medium cooperatively associated therewith;

a mask movable with said strip but adjustable angularly relative thereto to permit illumination only of characters of a selected one of said fonts;

sensing means for developing a position signal continuously representative of the instantaneous position of said given character during movement of said strip;

and means jointly responsive to said position signal and to input position signals representative of said given character for momentarily exciting said illuminating means whenever said two signals are in time coincidence.

4. An apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising:

an endless strip of material having a plurality of longitudinally arranged interlaced fonts of characters effectively spaced by a distance at least approximately equal to the length of a composed line, said characters and their surround being of opposite extreme optical densities;

means for continuously moving said strip at substantially constant velocity;

means capable of illuminating a single given character of each of said fonts collectively during its travel effectively over approximately a length of line, the light through said character when illuminated being effective to act upon a photosensitive medium cooperatively associated therewith;

a mask movable with said strip but adjustable angularly relative thereto to permit illumination only of characters of a selected one of said fonts;

means responsive to said input signals for actuating said mask to a preselected angular position relative to said strip to permit illumination of a selected font of characters;

sensing means for developing a position signal continuously representative of the instantaneous position of said given character during movement of said strip;

and means jointly responsive to said position signal and to input position signals representative of said given character for momentarily exciting said illuminating means whenever said two signals are in time coincidence.

5. An apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising:

an endless strip of material having a plurality of longitudinally arranged interlaced fonts of characters effectively spaced a distance at least approximately equal to the length of a composed line, said characters and their surround being of opposite extreme optical densities; 5

means for continuously moving said strip at substantially constant velocity;

means capable of illuminating a single given character of each of said fonts collectively during its travel effectively over approximately a length of line, the light through said character when illuminated being effective to act upon a photosensitive medium cooperatively associated therewith; 10

a mask movable with said strip but adjustable angularly relative thereto to permit illumination only of characters of a selected one of said fonts; 15

a stepper motor and a cam driven thereby for actuating said mask to a preselected angular position relative to said strip to permit illumination of a selected font of characters; 20

means responsive to said input signals for energizing said stepper motor;

sensing means for developing a position signal continuously representative of the instantaneous position of said given character during movement of said strip; 25

and means jointly responsive to said position signal and to input position signals representative of said given character for momentarily exciting said illuminating means whenever said two signals are in time coincidence. 30

6. An apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising: 35

an endless strip of material having a plurality of longitudinally arranged interlaced fonts of characters effectively spaced by a distance at least approximately equal to the length of a composed line, said characters and their surround being of opposite extreme optical densities; 40

means for continuously moving said strip at substantially constant velocity;

means capable of illuminating a single given character of each of said fonts collectively during its travel effectively over approximately a length of line, the light through said character when illuminated being effective to act upon a photosensitive medium cooperatively associated therewith; 45

a mask movable with said strip but adjustable angularly relative thereto to permit illumination only of characters of a selected one of said fonts; 50

means driven in unison with said mask for generating a position-representative signal; 55

means jointly responsive to said last-named signal and said input signals for actuating said mask to a preselected angular position relative to said strip;

sensing means for developing a position signal continuously representative of the instantaneous position of said given character during movement of said strip; 60

and means jointly responsive to said position signal and to input position signals representative of said given character for momentarily exciting said illuminating means whenever said two signals are in time coincidence. 65

7. An apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising: 70

an endless strip of material having a plurality of axially spaced longitudinally arranged fonts of characters, the characters of each font being effectively spaced by a distance at least approximately equal to the 75

length of a composed line, said characters and their surround being of opposite extreme optical densities; means for continuously moving said strip at substantially constant velocity;

means including an optical system and capable of illuminating a single given character of a single one of said fonts during its travel effectively over approximately a length of line, the light through said character when illuminated being effective to act upon a photosensitive medium cooperatively associated therewith;

means for effecting relative axial movement between said strip and said optical system to illumine any preselected font of characters;

sensing means for developing a position signal continuously representative of the instantaneous position of said given character during movement of said strip; and means jointly responsive to said position signal and to input position signals representative of said given character for momentarily exciting said illuminating means whenever said two signals are in time coincidence.

8. An apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising: 80

an endless strip of material having a plurality of axially spaced longitudinally arranged fonts of characters, the characters of each font being effectively spaced by a distance at least approximately equal to the length of a composed line, said characters and their surround being of opposite extreme optical densities;

means for continuously moving said strip at substantially constant velocity;

means including a first optical system and capable of illuminating a single given character of a single one of said fonts during its travel effectively over approximately a length of line;

a second optical system for projecting the image of said illuminated character upon a photosensitive medium cooperatively associated therewith;

means for effecting relative axial movement between said strip on the one hand and said optical systems on the other hand to illumine any preselected font of characters;

sensing means for developing a position signal continuously representative of the instantaneous position of said given character during movement of said strip;

and means jointly responsive to said position signal and to input position signals representative of said given character for momentarily exciting said illuminating means whenever said two signals are in time coincidence.

9. An apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising: 85

an endless strip of material having a plurality of axially spaced longitudinally arranged fonts of characters, the characters of each font being effectively spaced by a distance at least approximately equal to the length of a composed line, said characters and their surround being of opposite extreme optical densities;

means for continuously moving said strip at substantially constant velocity;

means including a single source of illumination and an optical system and capable of illuminating a single given character of a single one of said fonts at any point during its travel effectively over approximately a length of line, the light through said character when illuminated being effective to act upon a photo-

sensitive medium cooperatively associated therewith; means responsive to said input signals for actuating said optical system to a preselected axial position relative to said strip to illuminate a preselected font of characters;

sensing means for developing a position signal continuously representative of the instantaneous position of said given character during movement of said strip; and means jointly responsive to said position signal and to input position signals representative of said given character for momentarily exciting said illumination source whenever said two signals are in time coincidence.

10. An apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising:

an endless strip of material having a plurality of axially spaced longitudinally arranged fonts of characters, the characters of each font being effectively spaced by a distance at least approximately equal to the length of a composed line, said characters and their surround being of opposite extreme optical densities; means for continuously moving said strip at substantially constant velocity;

means including a single source of illumination and an optical system and capable of illuminating a single given character of a single one of said fonts at any point during its travel effectively over approximately a length of line, the light through said character when illuminated being effective to act upon a photosensitive medium cooperatively associated therewith;

means for effecting relative axial movement between said strip and said optical system;

means driven in unison with said optical system for generating a position-representative signal;

means jointly responsive to said last-named signal and said input signals for actuating said optical system to a preselected axial position relative to said strip, thereby to illuminate a preselected font of characters;

sensing means for developing a position signal continuously representative of the instantaneous position of said given character during movement of said strip; and means jointly responsive to said position signal and to input position signals representative of said given character for momentarily exciting said illumination source whenever said two signals are in time coincidence.

11. An apparatus for comprising text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising:

an endless strip of material having a longitudinally arranged font of characters effectively spaced by a distance at least approximately equal to the length of a composed line, said characters and their surround being of opposite extreme optical densities;

means for continuously moving said strip at substantially constant velocity;

a film transport;

means including a single source of illumination capable of illuminating a single given character at any point during its travel effectively over approximately a length of line;

means for projecting the image of said illuminated character upon a film on said film transport;

means responsive to said input signals for actuating said transport to advance said film line-by-line;

sensing means for developing a position signal continuously representative of the instantaneous position of said given character during movement of said strip;

and means jointly responsive to said position signal

and to input position signals representative of said given character for momentarily exciting said illumination source whenever said two signals are in time coincidence.

12. An apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising:

an endless strip of material having a longitudinally arranged font of characters effectively spaced by a distance at least approximately equal to the length of a composed line and position-representative indicia in axial alignment with each character, said characters and indicia on the one hand and their surround being of opposite extreme optical densities;

means for continuously moving said strip at substantially constant velocity;

means including a single source of illumination capable of illuminating a single given character at any point during its travel effectively over approximately a length of line, the light through said character when illuminated being effective to act upon a photosensitive medium cooperatively associated therewith;

sensing means for deriving from said strip indicia a position signal continuously representative of the instantaneous position of said given character during movement of said strip;

and means jointly responsive to said position signal and to input position signals representative of said given character for momentarily exciting said illumination source whenever said two signals are in time coincidence.

13. An apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising:

an endless strip of material having a longitudinally arranged font of characters effectively spaced by a distance at least approximately equal to the length of a composed line and a coded group of holes in axial alignment with each character, said characters and holes on the one hand and their surround being of opposite extreme optical densities;

means for continuously moving said strip at substantially constant velocity;

means including a single source of illumination capable of illuminating a single given character at any point during its travel effectively over approximately a length of line, the light through said character when illuminated being effective to act upon a photosensitive medium cooperatively associated therewith;

sensing means for deriving from said groups of holes a position signal continuously representative of the instantaneous position of said given character during movement of said strip;

and means jointly responsive to said position signal and to input position signals representative of said given character for momentarily exciting said illumination source whenever said two signals are in time coincidence.

14. An apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising:

a drum continuously rotating at substantially constant velocity;

an endless strip of material mounted on said drum and having a longitudinally arranged font of characters effectively spaced by a distance at least approximately equal to the length of a composed line, said characters and their surround being of opposite extreme optical densities;

means capable of illuminating a single given charac-

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ter during its travel effectively over approximately a length of line, the light through said character when illuminated being effective to act upon a photosensitive medium cooperatively associated therewith; sensing means for developing a position signal continuously representative of the instantaneous position of said given character during movement of said strip; and means jointly responsive to said position signal and to input position signals representative of said given character for momentarily exciting said illuminating means whenever said two signals are in time coincidence.

15. An apparatus for composing text line-by-line on a photosensitive medium from input electrical signals representative of the characters of text to be composed and the sequential position or positions of each character in a line comprising:

a drum continuously rotating at substantially constant velocity and having a series of peripheral accurately and equally spaced position-representative indicia; an endless strip of material mounted on said drum and having a longitudinally arranged font of characters effectively spaced by a distance at least approximately equal to the length of a composed line and a single position-representative slit in axial alignment with each character and with one of said drum indicia and of a longitudinal width a minor fraction of that of its associated character, said characters and said slits on the one hand and their surround being of opposite extreme optical densities;

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means capable of illuminating a single given character during its travel effectively over approximately a length of line, the light through said character when illuminated being effective to act upon a photosensitive medium cooperatively associated therewith; sensing means for developing a position signal continuously representative of the instantaneous position of said given character during movement of said strip; means for deriving first timing signals from said drum indicia; means for deriving second timing signals from said strip slits; and means jointly responsive to said position signal, to said timing signals, and to input position signals representative of said given character for momentarily exciting said illuminating means whenever said signals are all in time coincidence.

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