

[54] **METHOD AND SYSTEM FOR INTER-CHARACTER SPACE MODIFICATION TO ADJUST THE LENGTH OF A LINE OF COPY TO FIT AN ALLOTTED LINE LENGTH**

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[52] U.S. Cl. **95/4.5**

[51] Int. Cl. **B41b 21/36**

[58] Field of Search **95/4.5**

[56] **References Cited**

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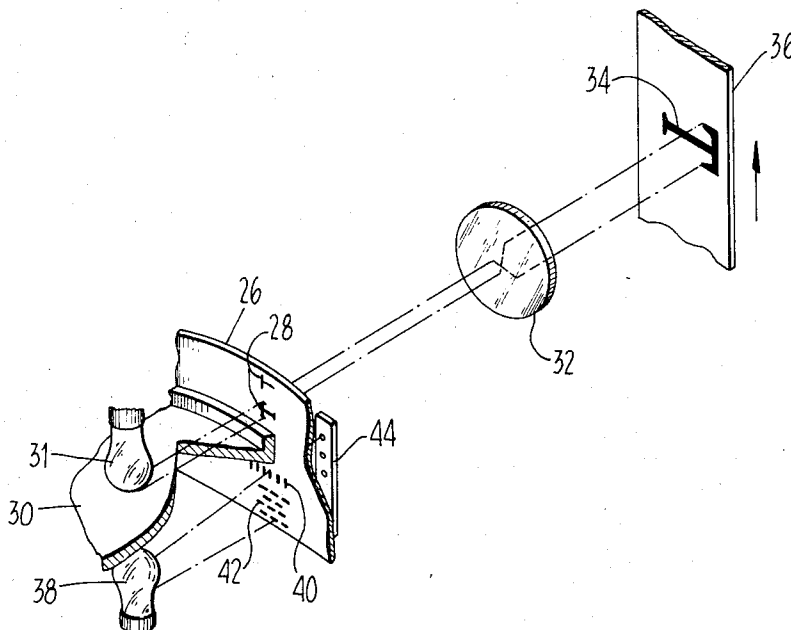
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Primary Examiner—John M. Horan

[57] **ABSTRACT**

A method and system particularly adapted for use by phototypesetting machines for adjusting the length of a line of copy to fit a line length allotted for such copy by changing inter-character spacing of the words in the copy. This fine control of copy line length is provided by changing intercharacter spacing of the words of the copy when a coarse control has been provided by the approximate harmony of the point size of the characters to be used, the allotted line length, and the line length of the copy. Initially, the length of the line of copy is determined with normal inter-character and inter-word spacing without setting the copy. Then the difference between this length and the allotted line length is converted into the amount of linear distance which is to be added to each character or to be subtracted from each character space in the line of copy. The line of copy is then set on a photosensitive medium by the phototypesetter with constant predetermined linear distance subtracted or added to each character space of the line of copy so as to precisely adjust the length of the copy line to fit the allotted line length. A particular font arrangement is utilized in the system to generate data related to the linear space allotted for each character in the line of copy.

8 Claims, 25 Drawing Figures



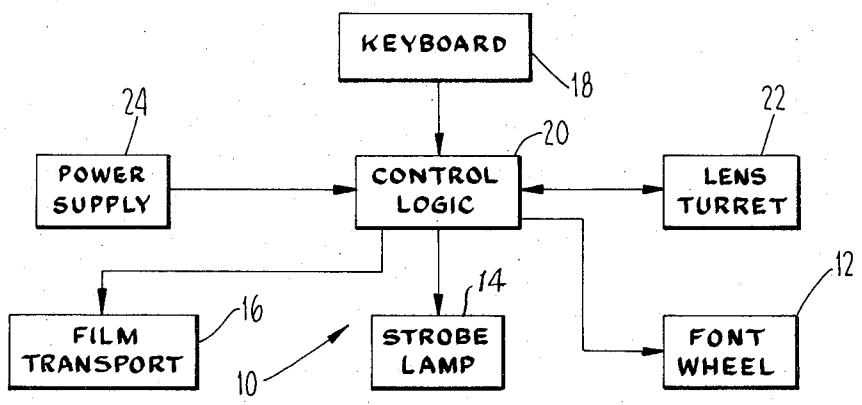


Fig-1

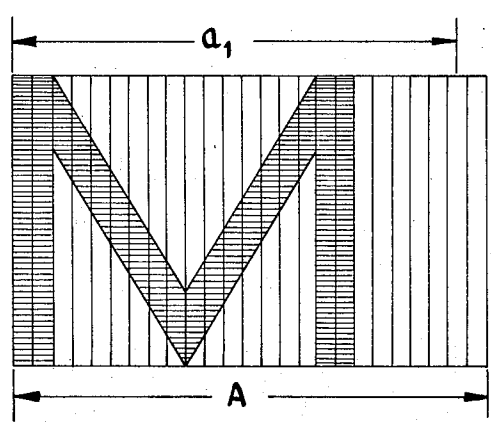


Fig-2

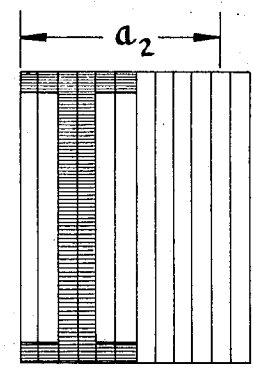


Fig-3

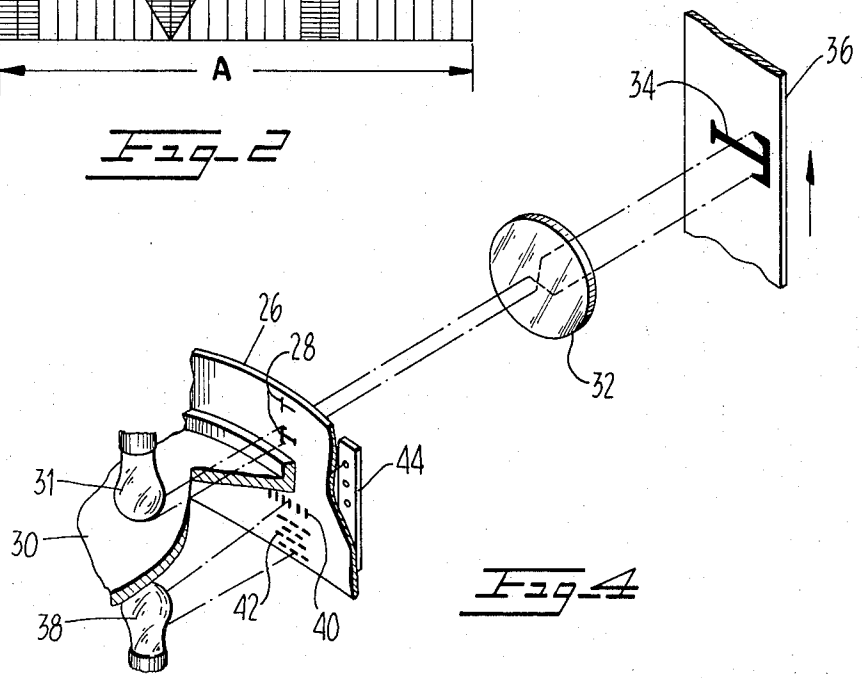
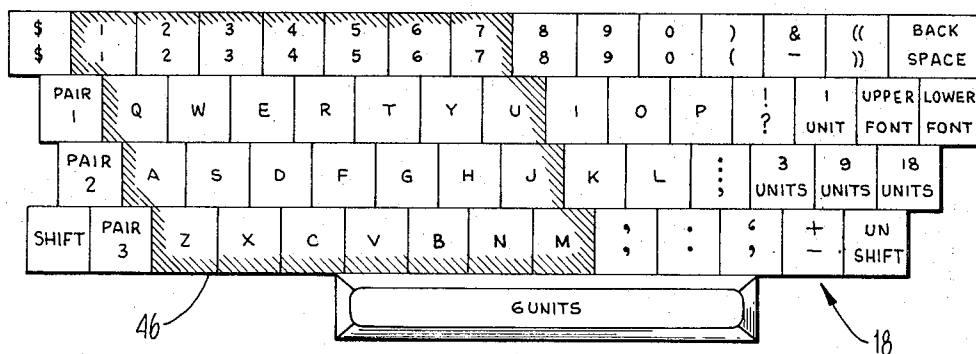
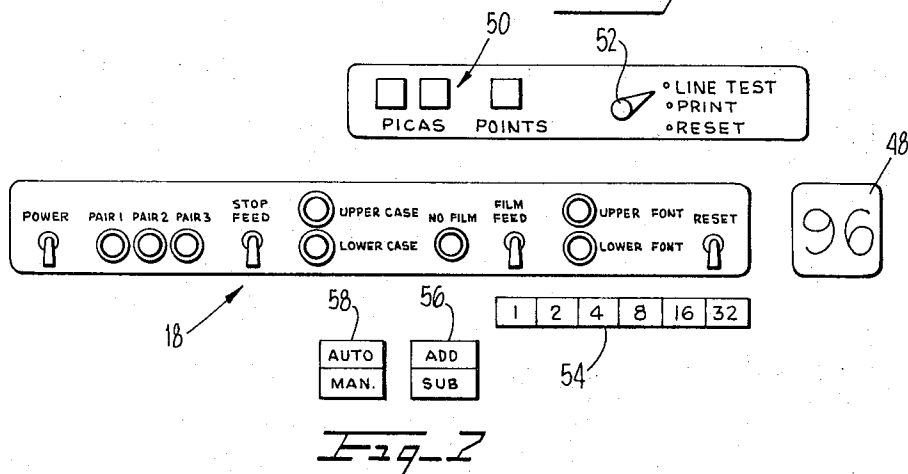
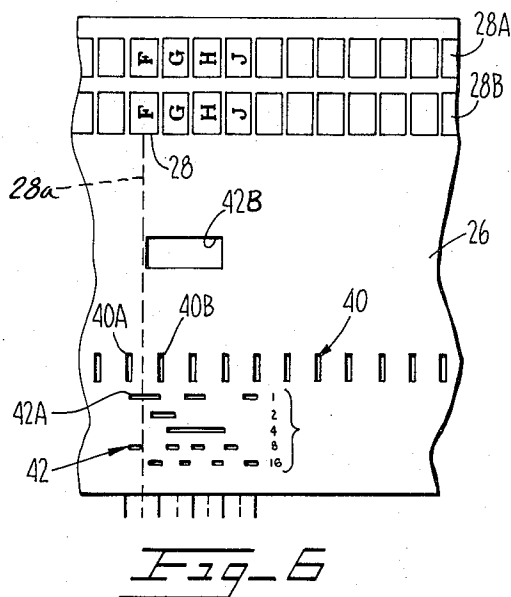
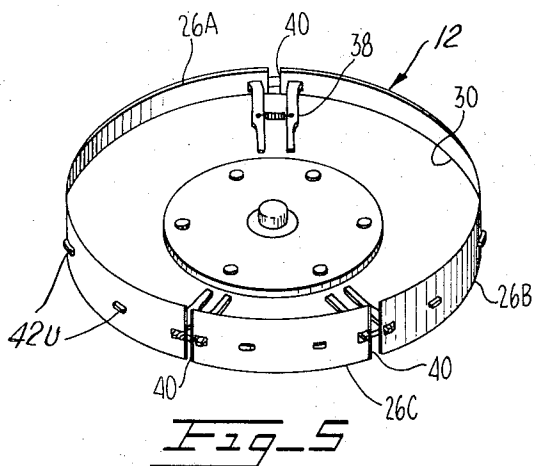


Fig-4



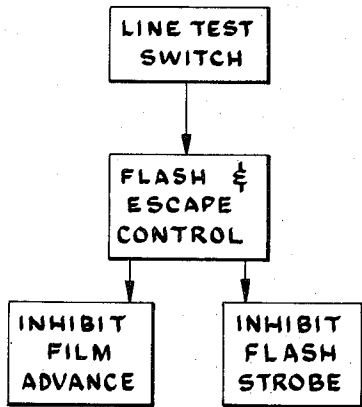


Fig-9

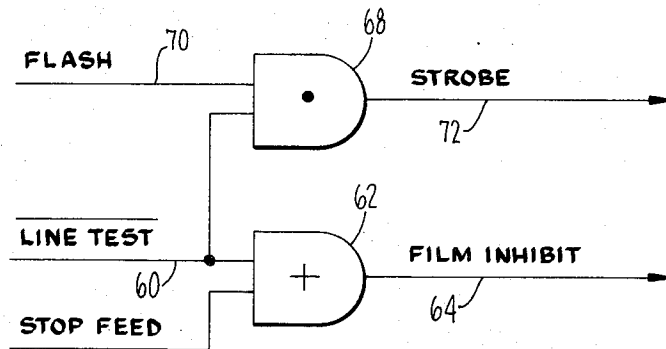


Fig-10

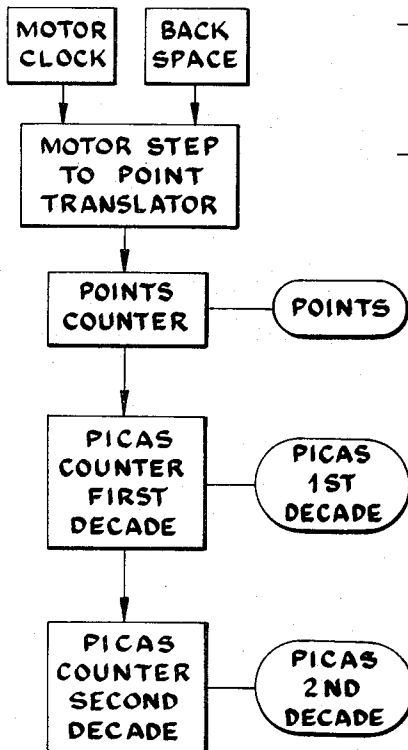


Fig-11

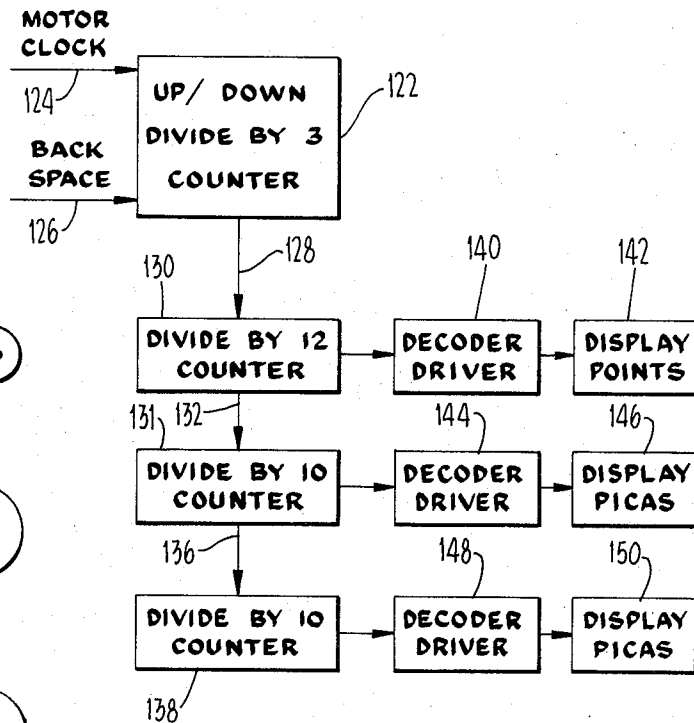
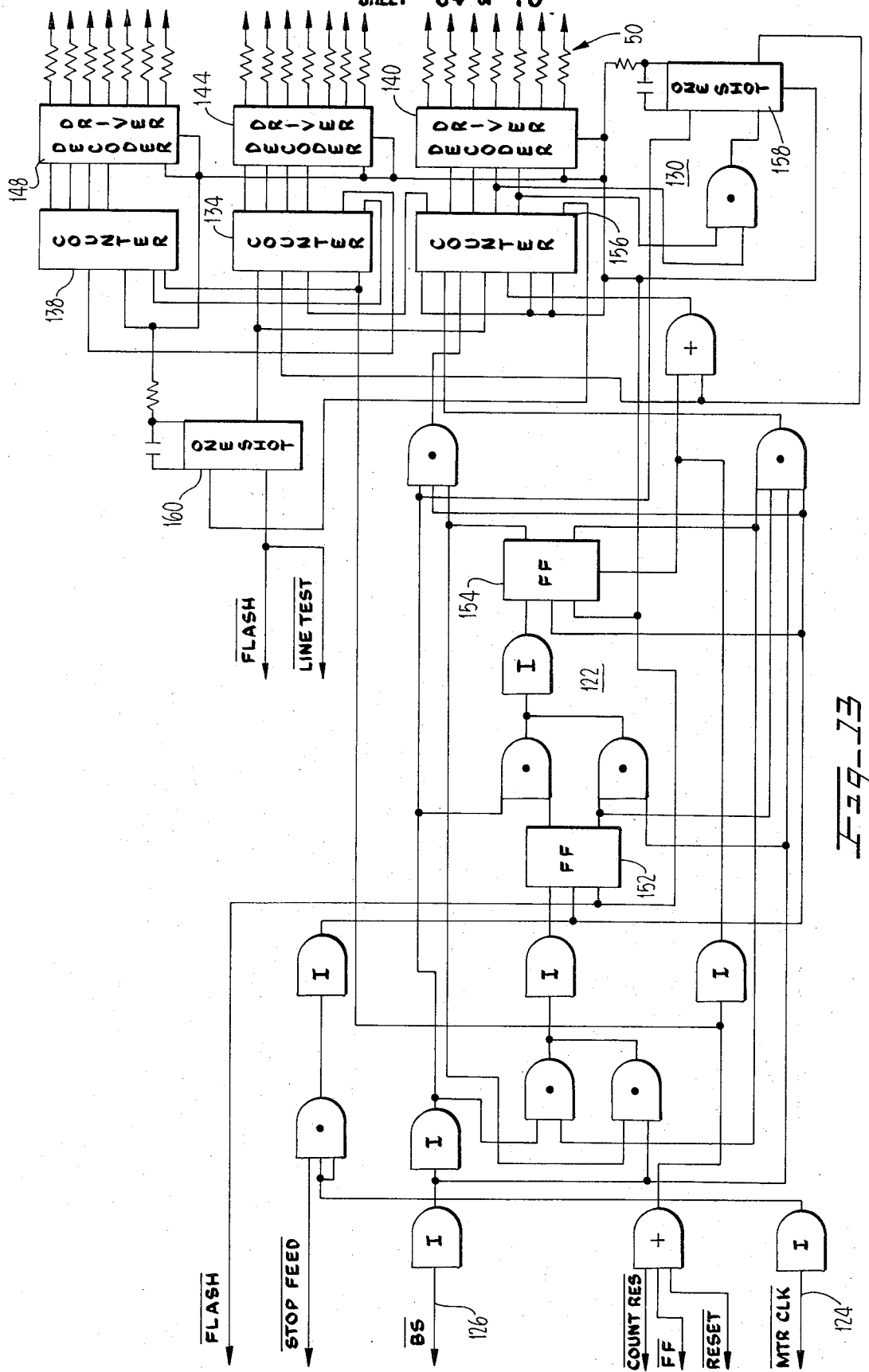


Fig-12

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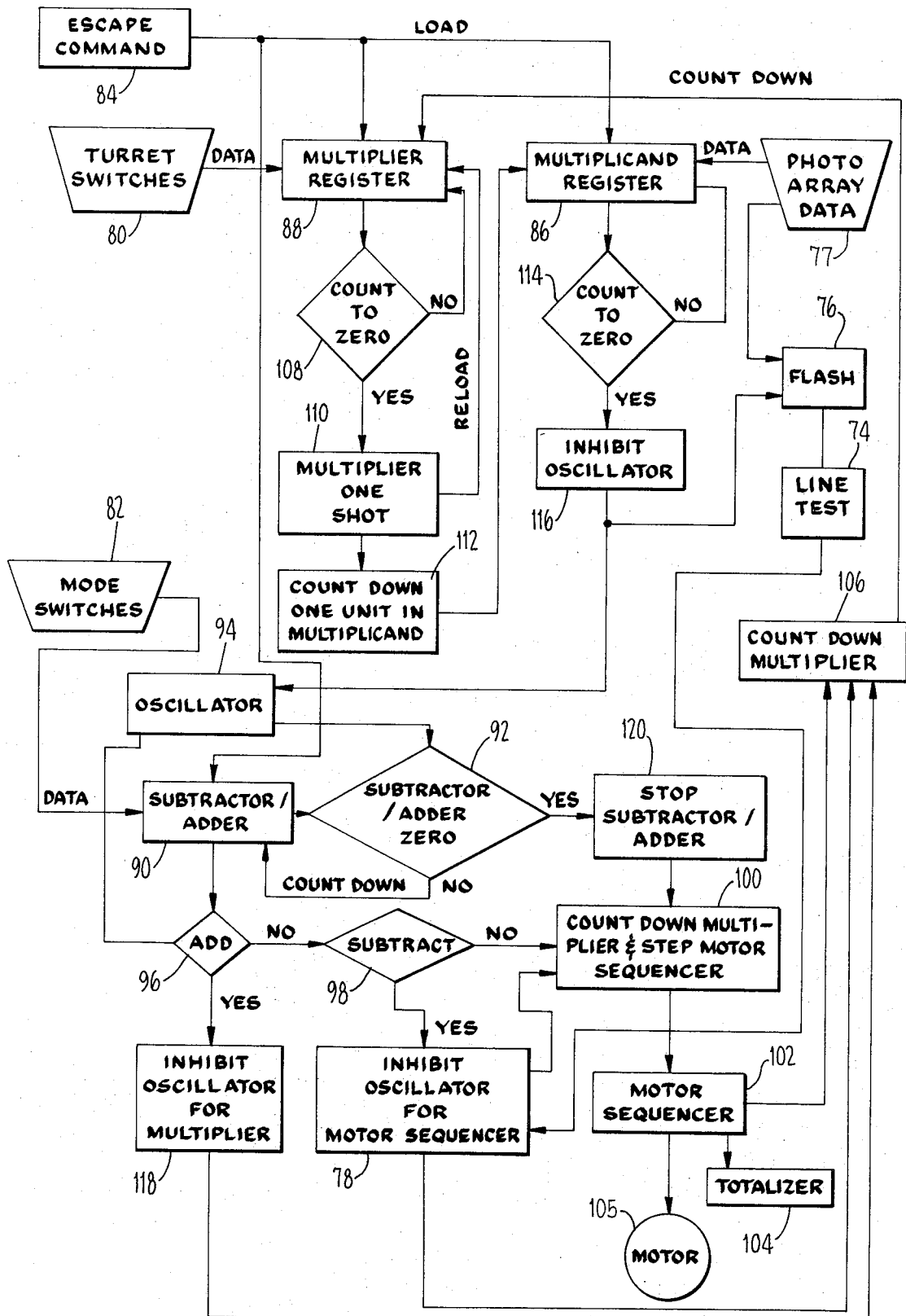


Fig. 14

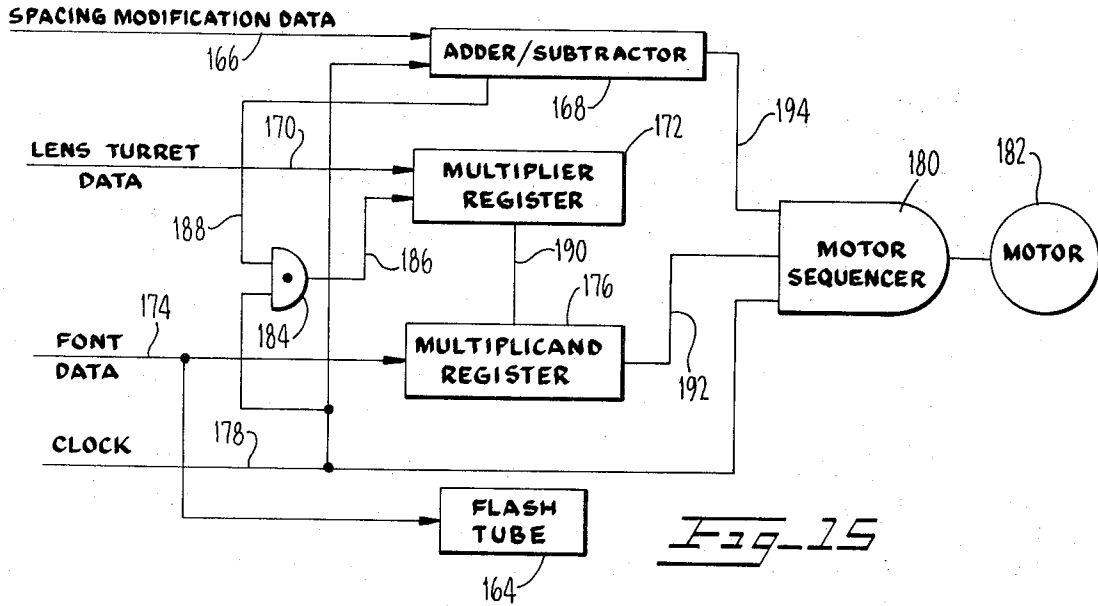


Fig. 15

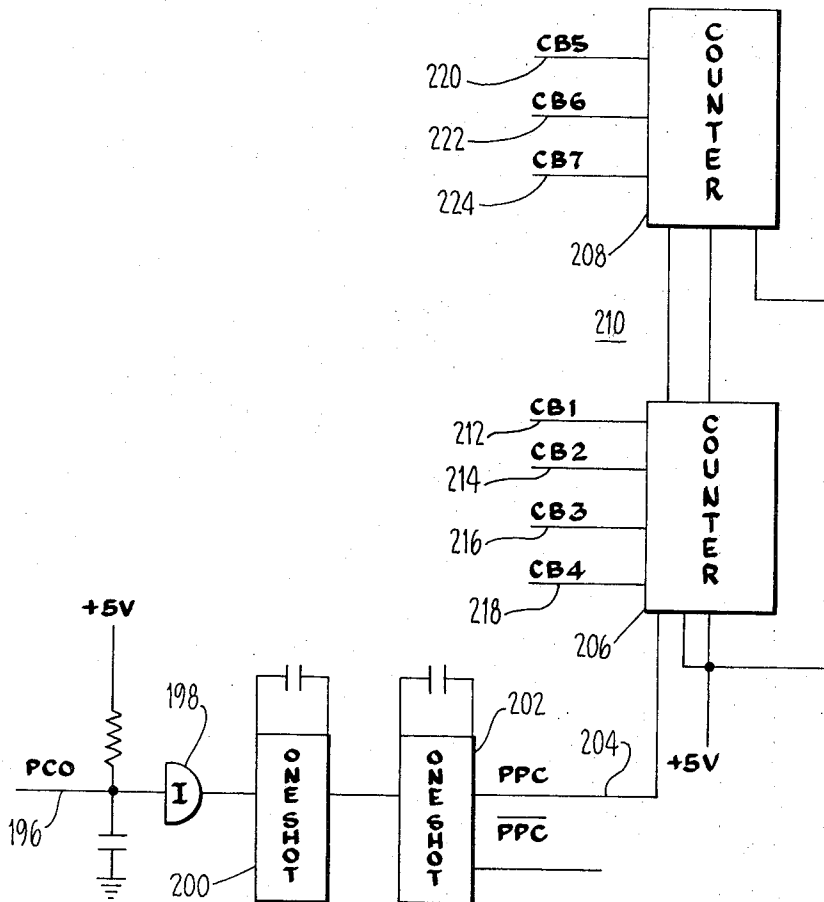
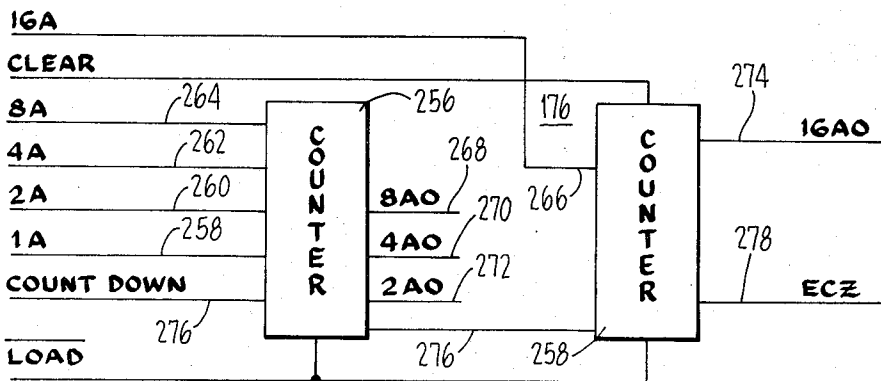
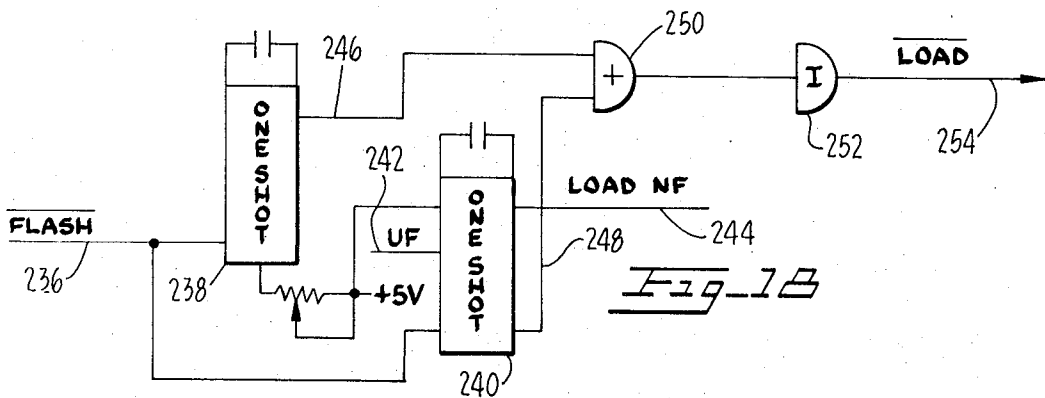
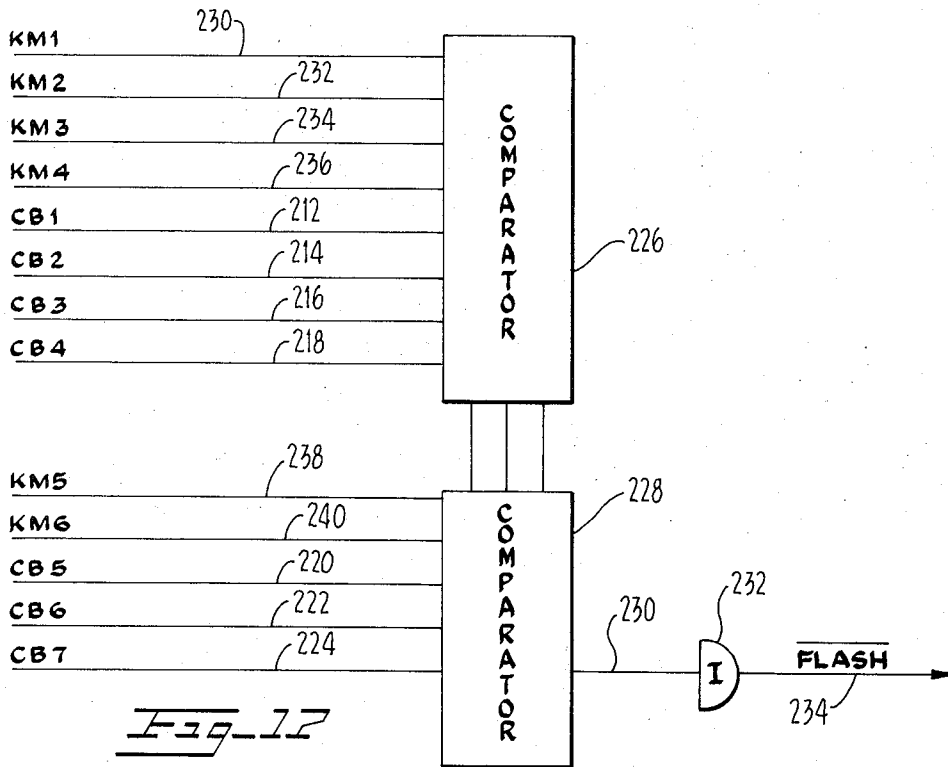
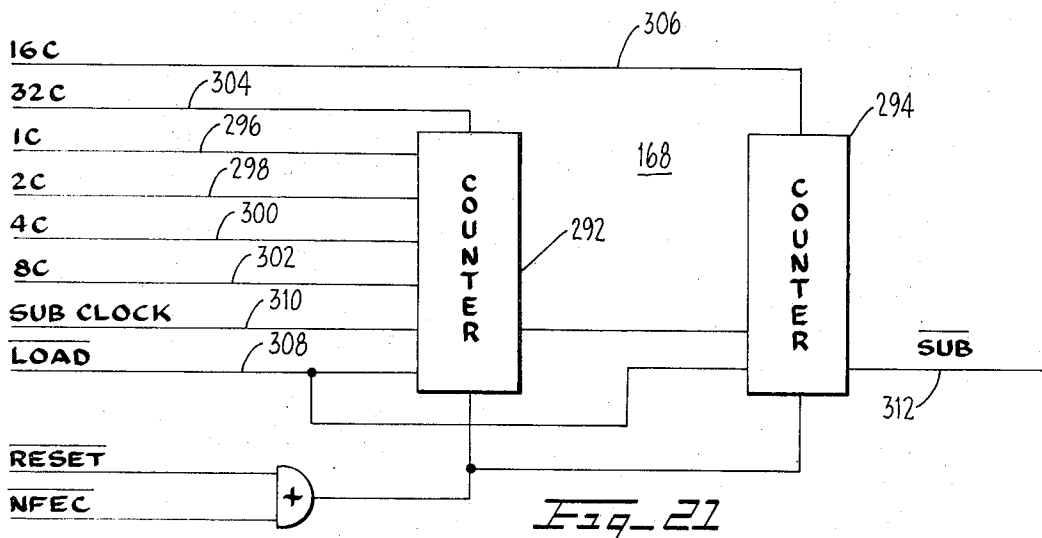
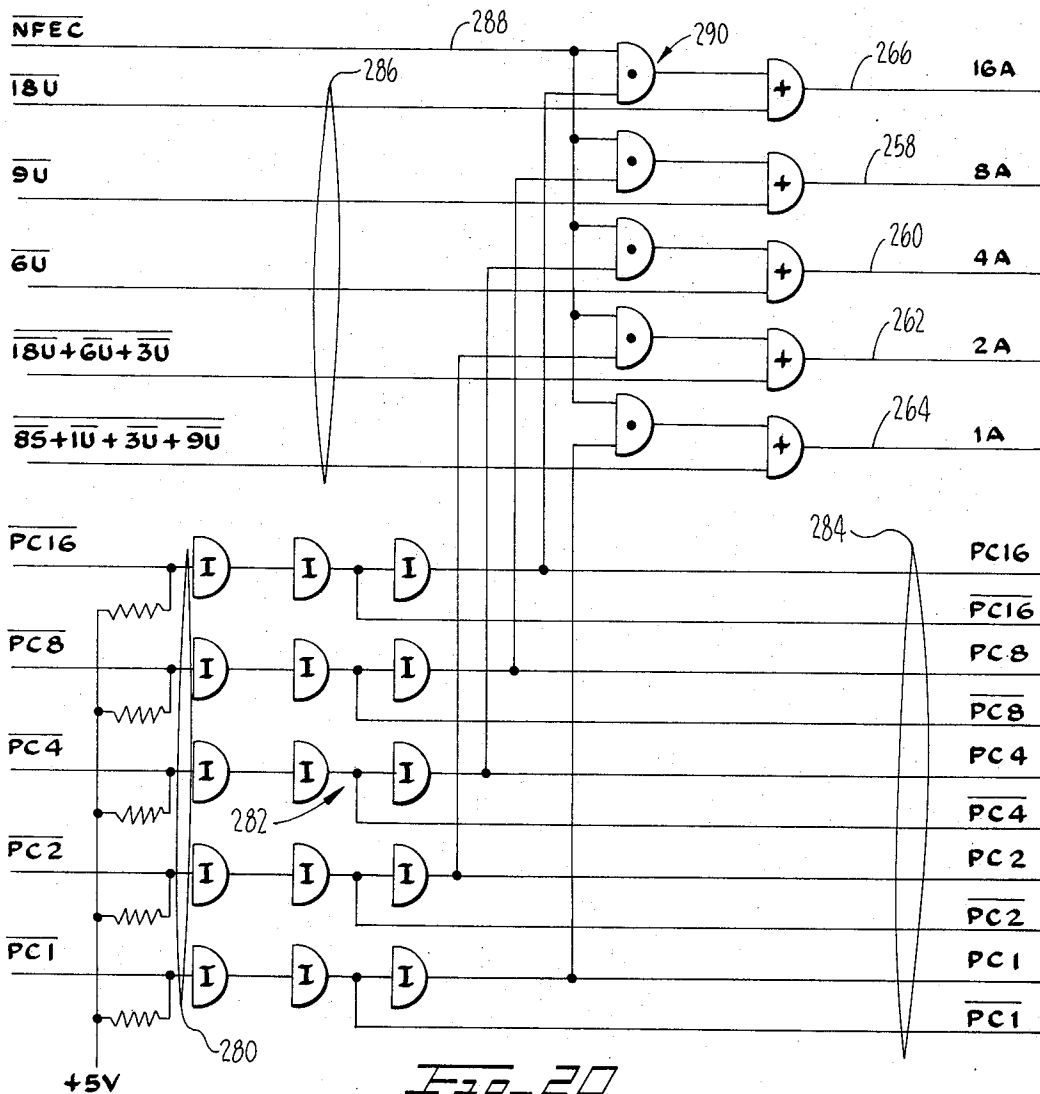


Fig. 16





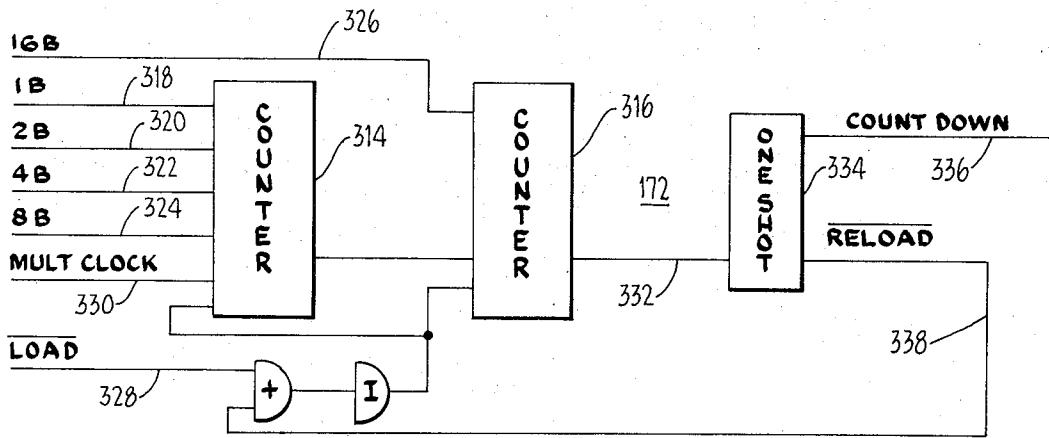


Fig. 22

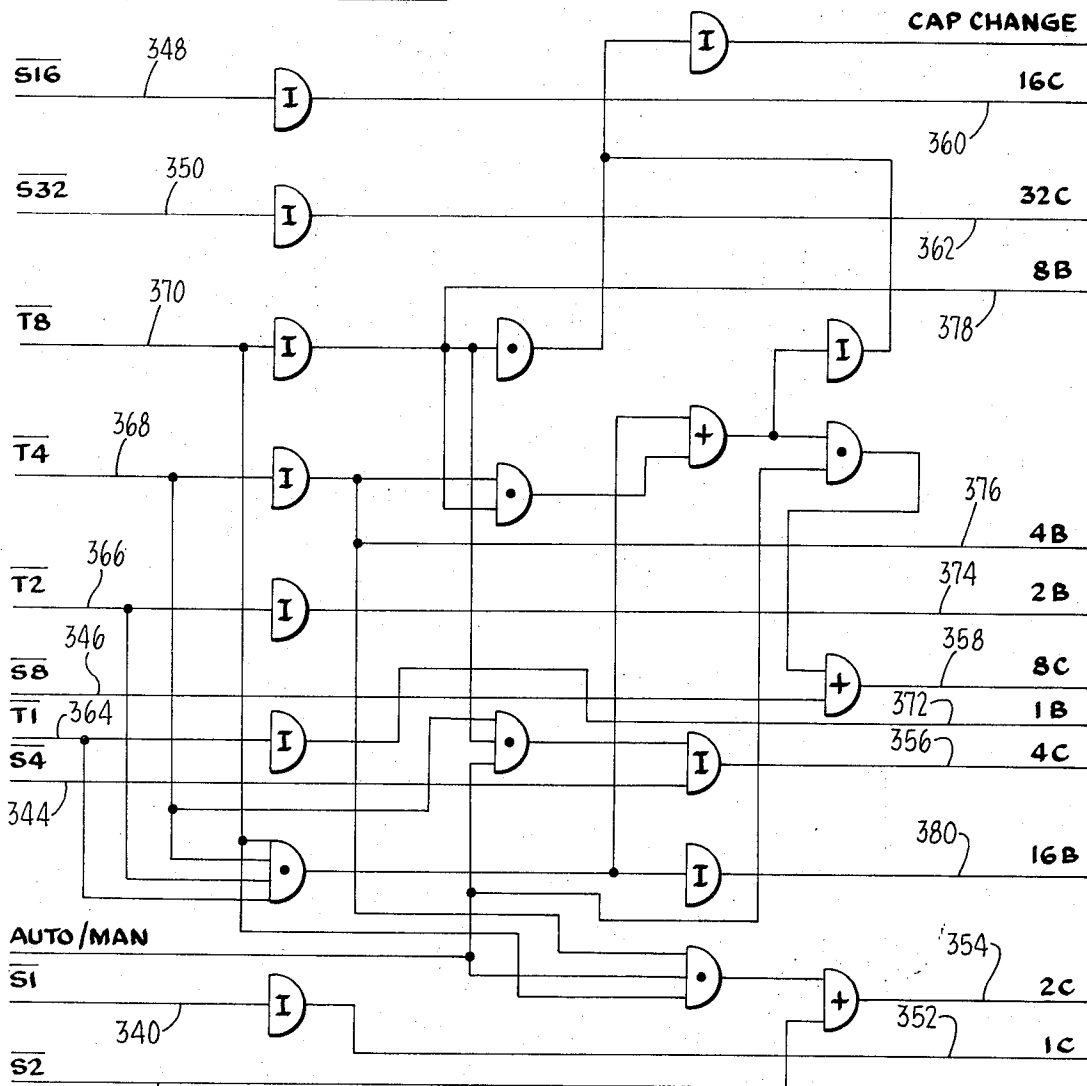


Fig. 23

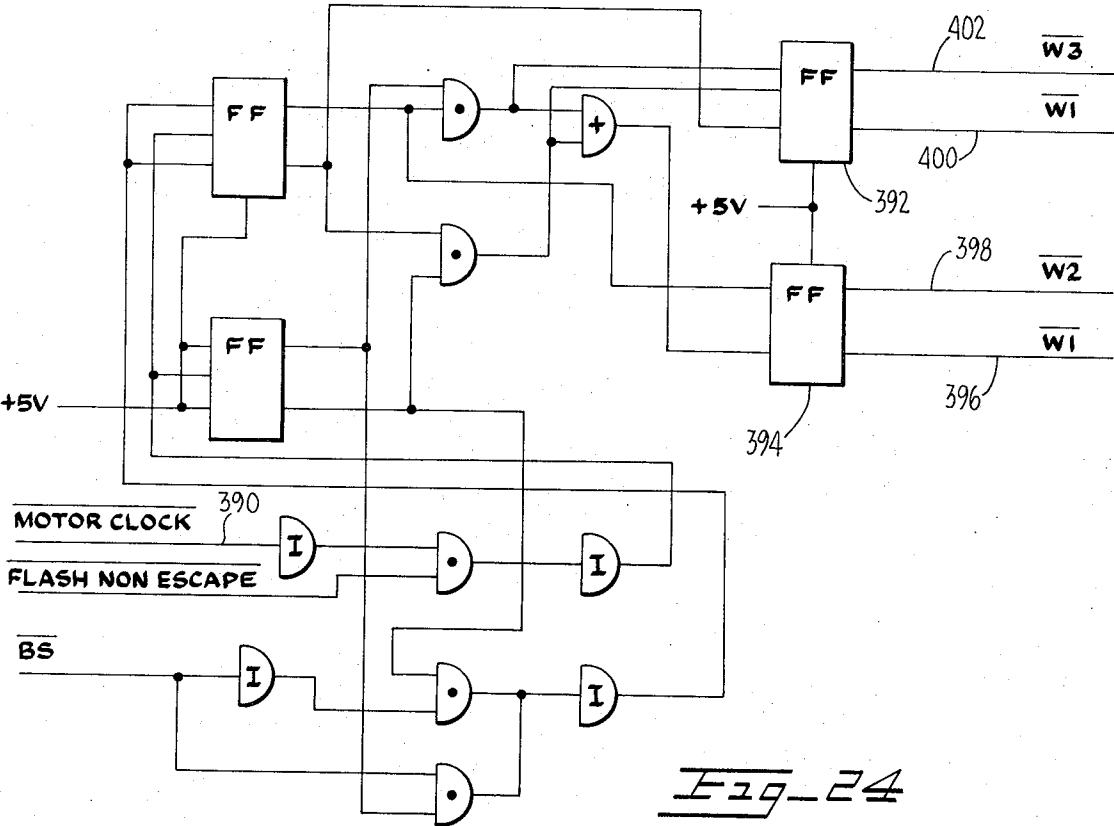


Fig. 24

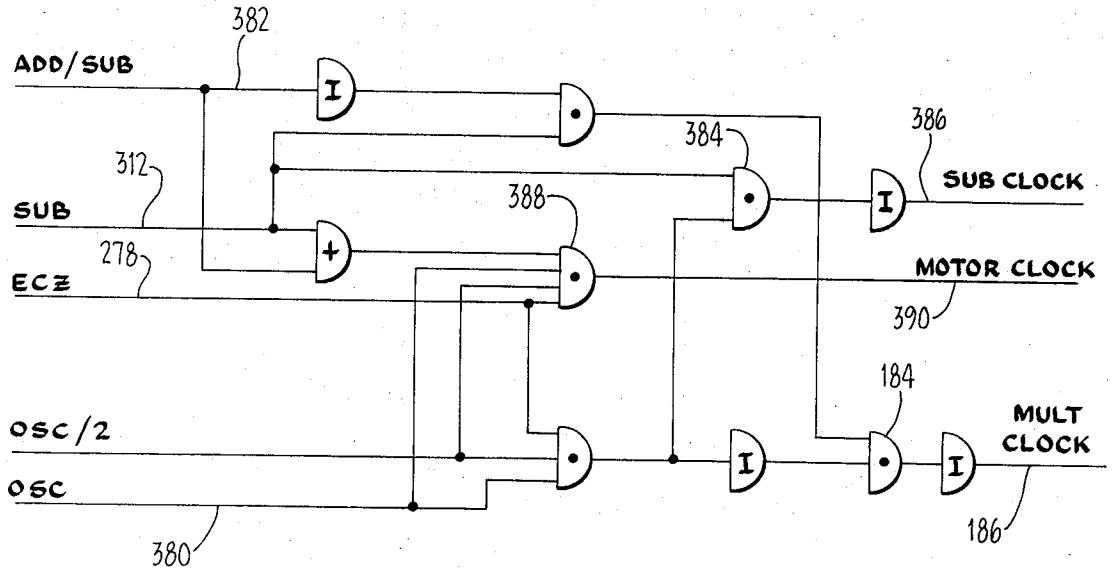


Fig. 25

METHOD AND SYSTEM FOR INTER-CHARACTER SPACE MODIFICATION TO ADJUST THE LENGTH OF A LINE OF COPY TO FIT AN ALLOTTED LINE LENGTH

BACKGROUND OF THE INVENTION

This invention relates to an improvement in the graphic arts, and more particularly but not by way of limitation to a method and system for adjusting the line length of copy to fit the line length allotted for such copy by inter-character spacing modification of the words in the copy.

In the field of graphic arts it is becoming increasingly common to use phototypesetting machines to produce mechanically completed film negatives and positives in a wide range of letter styles and sizes. By eliminating proofing and camera operations as such and providing composition of high quality, phototypesetting makes a major contribution to all printing methods employing photographic techniques. In the use of phototypesetting machines or other typesetting machines it is desirable to provide copy which is pleasing to the eye by providing correct point size and spacing for the characters in the copy.

It is known to justify text matter by expanding inter-word spacing so as to maintain even right-hand margins for the text. In other applications in graphic arts, such as producing headlines, advertisements, title pages and other display or special copy, it is desirable for the copy line to precisely fit the line length allotted for it. Although an experienced operator using the various typesetting machines heretofore available can produce acceptable copy, the present invention is concerned with quickly and automatically adjusting the length of the line of copy to precisely fit the allotted line length. The invention thus gives precise or fine control of the line length of copy when a coarse control has been provided by appropriate selection of the point size of the characters to be used, the allotted line length, and the copy line length. Thus, it is necessary for the practice of this invention that the operator has not chosen a length of copy which differs from the allotted line length by an amount which cannot be adjusted by inter-character spacing of the words in the copy nor has chosen a point size for the type which is grossly too large for the copy.

In typewriters and other impact printing devices, the amount of space allotted to each character is identical. However, in fine typography it is customary to provide better looking copy by varying the horizontal or linear space which is allotted to each character. Thus, more horizontal space is allotted to a wide character, such as a capital M, than to a more narrow character, such as a capital I. Thus, when a word is composed of characters having variable spacing a more pleasing word appears. The horizontal space allotted character also includes a predetermined white space extending from the right edge of the character to the edge of the space allotted to that character so that when characters are set from left to right in a word, the inter-character spacing is appropriate.

In what is known as "letter spacing" in the graphic arts the space between letters set in capitals will vary due to the design of the type and it is the typographer's aim to even out the uneven space to the eye in a line through letter or character spacing. Thus, the space between certain characters in a word, such as TAVERN, is expanded so that the word will appear pleasing to the

eye. The spacing of the characters is changed by expanding the space between certain characters, such as the space between the last three characters ERN of TAVERN, if possible. If, due to restrictions of measure, it is not possible to expand the length of the word by adding space to certain character spaces, it is then desirable to mortise certain offending characters as by bringing the three characters TAV closer together so that the word will appear even to the eye.

In phototypesetting, a predetermined character is exposed on a photosensitive medium and the medium is then advanced or escaped from a film transport by means, such as a stepping motor, a predetermined linear distance allotted to that character. The next character is then chosen and exposed and the process continues for the remainder of the word. The operator of the phototypesetter then inserts space between words by allowing the film to escape a predetermined distance prior to exposure of the first character of the following word. It will be understood that operation of a phototypesetter may be direct keyboard entry of characters or according to instructions prepared on a separate device, such as a tape punch, which perforates a paper tape in accordance with the instructions to be read by the phototypesetter.

When an operator desires to set copy utilizing the present invention, he will be able to exercise a precise or fine control of the length of copy in one setting of the copy on the photosensitive medium. Prior to the present invention a cut and try method of setting the characters on the photosensitive medium in several copy settings was required until the copy precisely fit the allotted length with the attendant waste of time and photographic materials. The operator first provides a coarse control of the copy line by providing approximate harmony of the point size of the characters, the copy length and the allotted line length. When this coarse control has been established, the operator then uses the teachings of the invention as set forth below to provide fine control of the copy length.

SUMMARY OF THE INVENTION

In summary, the present invention provides a novel method and apparatus particularly adapted for use in a phototypesetter to modify inter-character spacing of a line of headline, display or other special copy to precisely fit the line of copy to the line length allotted for the receipt of such copy when an initial approximation has been achieved by the judicious selection of character point size, copy line length, and allotted line length.

The linear distance or total character width allotted to each character on the photosensitive medium is determined from data relating to the point size of the characters exposed on the medium and to each character of the specific type font being used so that a variable linear distance or proportional character space is provided for each character of the font.

The difference in length between the line of copy and the allotted line length is determined by inhibiting the flash means and the film advancement means of the phototypesetter while the characters making up the copy are selected by the operator of the phototypesetter in a dry run of setting the copy on the photosensitive medium. The linear space allotted in the font to each character is summed as the characters are selected to give the total linear distance required for the characters comprising the copy using normal inter-character spacing. The difference in length is converted into instruc-

tions to either subtract a predetermined linear space from the space allotted each character in the copy or to add a predetermined linear space to the space allotted for each character with the exception of the last character of the copy, such inter-character spacing modification occurring after exposure of a first character and prior to exposure of a second character.

The length of copy is then set on the photosensitive medium by illuminating selected characters in a rotating type font and in response to the aforementioned instructions intercharacter spacing modification is provided for such space between characters to either contract or expand the line of copy so that it precisely fits the line length allotted for it in an operation which conserves the operator's time and photograph materials.

A particular font arrangement may be advantageously utilized which provides indicia that relates to the particular linear distance allotted on the medium for each character in the font.

The features and advantages of the invention will become apparent to those skilled in the art as the disclosure is made in the following detailed description of a preferred embodiment of the invention as illustrated in the accompanying sheets of drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a simplified block diagram for a phototypesetter embodying the invention.

FIG. 2 is a pictorial representation of a character illustrating the linear distance allotted to a particular character.

FIG. 3 is a pictorial representation illustrating the linear distance allotted to another character.

FIG. 4 is a fragmentary perspective view illustrating a simplified arrangement for exposing a chosen character.

FIG. 5 is a perspective view illustrating the attachment of a plurality of fonts to a rotating drive means.

FIG. 6 is a fragmentary elevation of a specific font arrangement used in a preferred embodiment for the invention.

FIG. 7 is an elevation of a portion of a keyboard of an illustrative embodiment of the invention.

FIG. 8 is an elevation of another portion of the keyboard of an illustrative embodiment of the invention.

FIG. 9 is a simplified flow chart illustrating one aspect of the invention.

FIG. 10 is a schematic logic diagram implementing the flow chart of FIG. 9.

FIG. 11 is a flow chart illustrating determining the length of a line of a copy using an embodiment of the invention.

FIG. 12 is a simplified block diagram implementing the flow chart of FIG. 11.

FIG. 13 is a schematic logic diagram implementing the block diagram of FIG. 12.

FIG. 14 is a flow chart illustrating operation of a preferred embodiment of the invention.

FIG. 15 is a schematic block diagram illustrating a preferred embodiment of the invention and implementing the flow chart of FIG. 14.

FIG. 16 is a schematic logic diagram illustrating the use of data read from the rotating font relating to characters in the font.

FIG. 17 is a schematic logic diagram illustrating the comparison of the data read from the rotating font with

the data identifying a selected character to generate a command to illuminate that character.

FIG. 18 is a schematic logic diagram illustrating the generation of a command to load data into the Adder/Subtractor, Multiplier Register and Multiplicand Register in response to a flash command.

FIG. 19 is a schematic logic diagram illustrating the Multiplicand Register of FIG. 15.

FIG. 20 is a schematic logic diagram illustrating how data is read from the rotating font for individual characters and data generated by the keyboard provides a data input for the Multiplicand Register shown in FIG. 19.

FIG. 21 is a schematic logic diagram illustrating the Adder/Subtractor shown in FIG. 15.

FIG. 22 is a schematic block diagram illustrating the Multiplier Register shown in FIG. 15.

FIG. 23 is a schematic logic diagram illustrating the decoding of the data generated by the keyboard and the lens turret to provide a data input to the Adder/Subtractor and the Multiplier Register.

FIG. 24 is a schematic logic diagram illustrating the motor sequencer in FIG. 15.

FIG. 25 is a schematic logic diagram illustrating control logic for the motor sequencer shown in FIG. 24.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings in detail and particularly to FIG. 1, reference character 10 generally designates a phototypesetter constructed according to the invention. The phototypesetter 10 includes a rotating font wheel 12 carrying a plurality of characters which are selectively chosen for illumination by a strobe lamp 14 for exposure on a photosensitive medium carried by a film transport 16. A means is provided to control the choosing of the particular character from the font wheel for exposure. In the illustrated embodiment of the invention, a keyboard 18 cooperates with control logic 20 to determine the character selected for exposure. A lens turret 22 is provided with a plurality of lenses having different magnifications and arranged so that a predetermined lens may be interposed between the font wheel and the photosensitive medium so that the character illuminated by the strobe lamp 14 is magnified to provide a character exposed on the photosensitive medium of the film transport 16 having a predetermined point size. A power supply 24 provides the requisite electrical power for operating and controlling the phototypesetter 10.

Referring now to FIGS. 2 and 3 it will be seen how the individual linear space allotted to each letter or character of a type font varies. In a phototypesetter a particular type font will have a maximum character width of a predetermined linear distance which is represented by the distance A in FIG. 2. A wide character, such as a capital M, will have a shorter width of a_1 which extends from the left-hand edge of the character to a point a predetermined distance from the right-hand edge of the character so as to provide an inter-character spacing or "white space" between the right edge of that character and the next adjacent character. As seen in FIG. 3, a relatively narrow character, such as a capital I, will have a proportionately smaller linear space a_2 allotted to it since the width of the capital I, together with the white space allotted to it, will be smaller in a system using proportional spacing for characters.

In FIG. 4 means are shown for selectively illuminating a character selected from a constantly rotating type font for exposure on a photosensitive medium. In an illustrated embodiment of the invention, this means takes the form of a character carrying member 26 provided with translucent apertures in the form of characters which are arranged in rows or type fonts as will be explained in greater detail by reference to FIG. 6. The font member 26 is secured to an annular constantly rotating drive member 30 which is shown only partially. The means of rotating the drive member 30 at constant speed are well-known to persons skilled in the art and will not be described. A flash means, such as a high-speed flash tube 31, is selectively excited or strobed to illuminate a selected character by focusing a beam of light through a predetermined character aperture 28 in the font member 26. Upon passing through the character aperture, the beam of light is then formed as a character image according to the character aperture and is magnified by a suitable lens 32 to expose the character at a character position 34 on a photosensitive medium or film 36. A KODAK EKTAMATIC photomechanical paper, type 1931, Specification 177, is used as the medium 36 in a preferred embodiment of this invention.

It is to be understood that the lens 32 is one of a plurality of lenses, one of which is positioned between the font member 26 and the photosensitive medium 36 to magnify character images through a predetermined point size. Details of the particular lens turret 22 are not shown and are well-known in the art. It is to be understood that the positioning of a particular lens 32 of the lens turret 22 in the light path of the character image generates data indicating which lens is presently in use, as will be made more clear hereinafter.

An appropriate light source 38 focuses a beam of light toward the lower portion of the font member 26 which is further provided with a plurality of apertures 40 which form timing marks and are used to determine which character 28 in the font member 26 is presently appearing in the flash position. The font member 26 is further provided with a plurality of apertures 42 to provide data relating to the amount of advancement or escapement which will be provided to the photosensitive medium 36 after exposure of a character 34. A photo array or array of photo cells 44 generate electrical signals upon receiving light from the lamp means 38 through the apertures 40 and 42 and provide necessary data for control of the flash means 31 and the film transport 16 by means of electronic circuitry which will be described hereinafter.

It will be seen, however, that upon receiving a command generated by electronic means responsive to the data generated by the timing marks 40, the lamp 31 is strobed to pass an intermittent light beam or flash of light through the character aperture to expose the character in the position 34 of the photosensitive medium 36. If the character 34 were the capital M of FIG. 2, the medium 36 would be advanced a distance of a_1 and the next character, such as the capital I of FIG. 3, would be exposed. The medium 36 would then be advanced a distance of a_2 . Similarly, the remaining letters or characters in a word would be exposed with appropriate inter-word spacing being provided by advancement of the medium to form the desired copy.

Referring now to FIG. 5, it will be seen that three font members 26 may be secured to the drive member 30 at positions 26A, 26B, and 26C by appropriate latching means 38. A plurality of font members 26 is provided

in order to allow flexibility in the selection of characters by an operator of the phototypesetter 10. Since each font member 26 may be provided with an upper and lower font of characters, it is customary to refer to the font members 26A, 26B and 26C as Pair 1, Pair 2 and Pair 3. It will be understood that the drive member is rotated at a constant speed, which in the present invention is 720 r.p.m., during use of the phototypesetter 10. The space, indicated by reference character 40, between the font members 26 permit the photo array 44 to transmit data permitting the identification of each font member 26.

In FIG. 6, a portion of a unique font member 26 is shown which is particularly adapted for use with this invention. As previously noted in the discussion of FIG. 4, the font member 26 is provided with character apertures 28 which are arranged in upper and lower fonts 28A and 28B extending horizontally along the length of the font member 26. The font member 26 is provided with appropriate apertures 42B to permit precise locating on the drive member 30 by engagement with appropriate up-raised portion 44U of the drive member 30 seen in FIG. 5. The plurality of apertures 40 or timing marks which are spaced along the length of the font member 26 are spaced a predetermined distance apart and permit electronic means responsive to the photo array 44 to make identification of the characters 28. The apertures 42 provided in the lower portion of the font member 26 provide manifestations of data relating to the amount of linear distance allotted to each character in the upper and lower fonts of the font member 26. The apertures 42 are arranged to provide data relating to the particular amount of linear distance allotted to a particular character. The data provided by apertures in the font member 26 is data relating to a particular character and requires a means responsive to this data as well as to data related to the particular point size provided by a lens 32 of the lens turret 22 to provide the specific linear distance which is allotted to a character after exposure on the photosensitive medium 36.

In the particular font member 26 illustrated in FIG. 4, the apertures 42 manifest data in binary code. An aperture arranged in the upper row 42A (FIG. 6) has a value of one unit where correspondingly the apertures arranged in the downwardly extending rows provide values of "2," "4," "8" and "16" units. If a line 28a is drawn through the center of the characters in the upper and lower fonts transversely (in FIG. 6) to the length of the font member 26, it will be seen that apertures 42 lie to the immediate left and right of the line. The apertures of interest are determined by the two timing mark apertures 40A and 40B lying also to the immediate left and to the immediate right of such line. The apertures 42, appearing to the left of the line 28a and associated with the particular upper and lower characters in the upper and lower fonts as determined by the two timing marks 40A and 40B, relate to the linear distance or escapement allotted to the character in the lower font 28B. Similarly, the apertures 42 appearing to the right of the line 28a and associated with those particular characters relate to the escapement for the character appearing in the upper font 28A. As an example, the character F appearing in the lower font 28A has an escapement value of "9" provided by apertures 42 while the F appearing in the upper font has an escapement value of "19." As noted, the data represented by apertures 42 is utilized by the electronic control logic 20 of the phototypesetting machine 10 embodying the inven-

tion together with the data representing the point size of a lens 32 of lens turret 22 to determine the specific linear distance allotted to that character.

In FIGS. 7 and 8 will be seen the two control portions of the keyboard 18. The keys 46 provide means for an operator of the phototypesetter 10 to determine which of the three pairs of type fonts he wishes to utilize, whether the character is in the upper or lower font, and to choose the particular character which will be exposed on the photosensitive medium 36. In addition, the keys also provide for other characters to be selected in addition to alpha numeric characters and provide for the amount of linear distance to be interposed between words. A "unit" appearing on a key 46 provides one unit of escapement of the medium 36 and is equal to 0.046 inch in the preferred embodiment of the invention. This "unit" represents the distance a stepping motor of the film transport 16 will advance the film 36 in one step.

The control panel of the keyboard 18 shows in FIG. 7 how various lights will indicate to an operator of the phototypesetter 10 information concerning the operation of the machine. A display 48 will indicate by an appropriate number the particular point size provided by a lens 32 of the lens turret 22 which is in an operative position with respect to the strobe lamp 32 and the font member 26. A display 50 indicates the number of picas and points in a line of copy either to be set by the machine or that has been set by the machine. Typesetting measurements are picas and points rather than inches. There are 12 points to 1 pica, 6 picas to 1 inch and 72 points to 1 inch. The display 50 uses a seven segment light emitting diode matrix with arbitrary symbols being assigned to the numbers 10 and 11 in the point display. The control switch 52 determines the mode in which the machine is operated. When the control switch is set to LINE TEST, the flash lamp means 14 and film trans-

port 16 (of FIG. 1) are disabled while the line length of the copy to be set is determined by the operator typing of the line of copy upon the keys 46 using normal inter-word and inter-character spacing. The length of the copy will then appear on the display 50 in picas and points. This data is utilized to determine the amount of inter-character space which is to be added to each character in the line of copy or to be subtracted from each character in the line of copy to provide a precise fit for the line of copy within the allotted line length. The display 50 and the control logic 20 is then cleared by moving the control switch 52 to the RESET mode position.

The difference in picas and points between the length of the intended copy and the allotted line length is then determined. The operator then refers to the chart partially shown below to determine the amount of linear space which is to be subtracted or to be added to each character in the line of copy. The difference in length between the allotted line length and the length of copy is divided by the number of characters in the line less one to determine the amount of inter-character spacing modification. The divisor is the number of characters less one since the length of the copy is determined by the distance from the left-hand edge of the leftmost character to the right-hand edge of the rightmost character and the number of inter-character spaces accordingly does not include space appearing to the right of the last character. In the illustrated embodiment of the invention, the data relating to the amount of inter-character spacing modification results in instructions to a stepping motor for the film transport 16 but it is to be understood that these instructions will be used to control whatever driving means is used for the film transport 16.

An illustrative chart for a maximum of 20 and a minimum of five characters follows:

		Number of characters																	
Pica	Pt.	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0		
0	2	2	1	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
0	3	1	0	0	0	1	1	1	2	2	-2	-2	-2	-2	-2	-2	-2		
0	4	0	0	1	-1	0	0	0	1	1	1	1	2	2	2	3	3		
0	5	0	-1	0	2	2	1	1	1	1	1	1	1	1	1	1	1		
0	6	4	3	3	2	2	2	-1	0	0	1	1	1	1	1	1	1		
0	7	0	0	1	0	0	1	2	-1	-1	1	1	0	0	1	1	1		
0	8	5	4	3	3	2	2	2	2	2	1	1	1	1	1	1	1		
0	9	1	1	0	1	-1	0	1	1	2	-2	-1	-1	-1	0	0	0		
0	10	5	4	4	3	3	2	2	2	2	2	2	2	1	1	1	1		
0	11	0	0	1	0	1	-1	0	0	1	2	2	-2	-2	-1	-1	-1		
1	0	6	5	4	3	3	3	2	2	2	2	2	2	2	2	1	1		
1	1	0	0	0	-1	0	1	-1	-1	0	1	1	2	3	-2	-2	-2		
1	2	7	5	5	4	3	3	3	2	2	2	2	2	2	2	2	1		
1	3	0	-1	1	0	-1	0	1	-2	-1	0	0	1	2	2	3	-3		
1	4	8	6	5	4	4	3	3	3	3	2	2	2	2	2	2	2		
1	5	1	0	0	-1	1	-1	0	1	2	-1	0	1	2	2	2	3		
1	6	8	7	6	5	4	4	3	3	3	3	2	2	2	2	2	2		
1	7	0	0	1	1	0	-1	0	2	-1	0	1	2	-2	-1	0	1		
		0	0	1	1	0	-1	0	2	-1	0	1	2	-2	-2	-1	0		
		11	8	7	6	5	5	4	4	4	3	3	3	3	3	2	2		
		1	-1	0	0	-1	1	-1	1	2	-1	0	3	3	2	2	2		
		9	8	6	6	5	5	4	4	4	3	3	3	3	3	3	2		
		0	0	1	-1	1	0	2	0	1	-2	-1	0	1	2	3	-2		
		12	10	8	7	6	5	5	4	4	4	3	3	3	3	3	3		
		0	1	0	0	0	-1	1	-1	0	1	-2	-1	0	1	2	3		
		13	10	9	7	6	6	5	5	4	4	4	3	3	3	3	3		
		0	0	1	-1	-1	1	0	1	-1	0	2	-2	-1	0	1	2		
		14	11	9	8	7	6	5	5	5	4	4	4	3	3	3	3		
		1	0	0	1	1	0	-1	0	2	-1	1	2	-2	-1	0	1		
		14	11	10	8	7	6	6	5	5	4	4	4	4	3	3	3		
		0	-1	1	0	0	-1	1	-1	1	-2	0	1	2	-2	-1	0		

		Number of characters																	
Pica	Pt.	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
1	8	15	12	10	9	8	7	6	5	5	5	4	4	4	4	3	3		
		0	0	0	1	1	1	0	-2	0	2	-1	0	1	3	-2	-1		
1	9	16	13	11	9	8	7	6	6	5	5	5	4	4	4	4	3		
		0	1	1	0	0	0	-1	1	-1	1	2	-1	0	2	3	-2		
1	10	17	13	11	9	8	7	6	6	6	5	5	4	4	4	4	3		
		1	0	0	-1	-1	-1	1	0	2	0	1	-2	-1	1	2	-3		
1	11	17	14	12	10	9	8	7	6	6	5	5	5	4	4	4	4		
		0	0	1	0	1	1	0	-1	4	-1	0	2	-2	0	1	2		
2	0	18	14	12	10	9	8	7	7	6	6	5	5	5	4	4	4		
		0	-1	0	-1	0	0	-1	2	0	2	-1	1	3	-1	0	1		

It is to be understood that a chart in practice will be much more extensive. The operator determines in the chart the instruction of the difference in picas and points between the copy line length and the allotted line length. This intersection determines the amount of inter-character modification in machine units and the lower figure at the intersection indicates in points how far the new copy line length will differ from the allotted line length. After the operator determines from the above chart the amount of inter-character spacing modification, he then sets the value in machine units into the switches 54 in binary code. Although a plurality of switches 54 are shown which enable the value to be represented in a binary code, it is understood that any appropriate switching means could be used.

The phototypesetter 10 is further instructed by means of switch 56 whether the inter-character spacing modification will be to subtract space between the characters in each word of the copy or to add space between the characters of each word of the copy. It will be appreciated that since the point size of the characters, the allotted line length, and the line of copy are in approximate harmony, the amount of inter-character spacing modification will be small to provide a precise fit for the copy. The switch 58 is also depressed to operate the phototypesetter in the automatic or AUTO mode to indicate to the machine that the data represented by the setting of the switches 54 represents space which is to be subtracted or to be added to each character of each word of the copy line. The control switch 58 also provides for operation of the phototypesetter 10 in a MANUAL mode whereby the setting of the switches 54 determines the amount of space between individual characters when only selected inter-character space is to be modified between characters in a word as described hereinabove in the description of letter-spacing.

A flow chart for operation of the phototypesetter 10 when the control switch 52 is set in the LINE TEST mode, is shown in FIG. 9. When the phototypesetter 10 is in the LINE TEST mode, it will be seen that the strobe lamp 14 is inhibited from flashing and the film transport 16 is inhibited from advancing film in response to depression of key levers 46. A schematic diagram logic for implementing the flow chart of FIG. 9 is shown in FIG. 10. There it will be seen that the LINE TEST signal appearing on input lead 60 or OR-gate 62 provides an output signal on lead 64 which inhibits the advance of the film. The input lead 60 is connected via lead 66 to an AND-gate 68. Thus, with the LINE TEST signal appearing on lead 60, the appearance of a flash signal on lead 70 precludes the AND-gate 68 from being enabled and permitting a strobe signal on the output lead 72 of the AND-gate 68.

A simplified flow chart for determining the length of copy to be set by the phototypesetter 10 is shown in FIG. 11. This flow chart illustrates the operation of the

phototypesetter 10 in totalizing or counting the number of points in the copy. It will be seen that a source of clock pulses to the stepping motor of the film transport 16 is selectively enabled to commence a count in an appropriate summing means which can take the form of a counter or register. Since the machine operates in response to digital pulses, the clock pulses which would cause the motor to advance the film are converted by an appropriate translator into points. These points are summed in an appropriate counting means and displayed as seen in FIG. 7 by a display 50. As the phototypesetter 10 is continued to be operated by an operator, the points summing means upon exceeding a count of "12" returns to "0" and adds "one" to a summing means for picas. Similarly, upon the summing means for picas exceeding "10," the pica summing means is set to "0" and the second pica summing means is incremented one count. Thus, the display 50, upon completion of the operation of the keyboard 46 by an operator of the phototypesetter 10, contains the line length of the copy in picas and points, the system of measure commonly used in the printing industry.

A schematic block diagram implementing the flow chart of FIG. 11 is shown in FIG. 12. A schematic logic diagram is shown in FIG. 13 which similarly illustrates the implementation of the block diagram of FIG. 12. A detailed description of the block diagram and the logic diagram for the line length counter will appear hereinafter.

Since the major components of a preferred embodiment of the phototypesetter 10 and its operation have been described, and it has been shown how the phototypesetter 10 is operated to determine the line length of copy, reference will now be made to the flow chart of FIG. 14 to illustrate how the phototypesetter 10 is operated to practice the invention by modifying the intercharacter spacing of each character of the words in a line of copy. For ease of understanding, reference characters will be applied to the flow chart but it should be understood that the reference character may refer to a step or a condition as well as to particular structure.

In the flow chart of FIG. 14 the setting of the control switch 52 to the LINE TEST mode causes the line test block 74 to inhibit the flashing of the strobe lamp 76 and to direct the inhibiting of the oscillator or clock for the motor sequencer in block 78. When the phototypesetter 10 is set to the LINE TEST mode, there is to be no inter-character spacing added or subtracted to the spacing between the characters in the line of copy. Thus, upon the operator commencing to determine the line length by depression of the first key 46 for the first character of the first word, first data is sensed by the photo array 77 relating to the particular escapement allotted that selected character. Second data, relating to the point size of the character to be exposed, is determined by the setting of the switches of the lens turret

block 80. Since there is to be no inter-character modification, the modification control switches at 82 represent data having "zero" value. The depression of a key lever 46 causes an escape command 84 to be generated and cause the loading of the first data from the photo array 78 into a Multiplicand Register 86, the loading of the second data from the turret switches block 80 into the Multiplier Register 88 and the loading of inter-character spacing modification data from the MOD switches block 82 into a Subtractor/Adder 90. The value of the data loaded into the Subtractor/Adder 90 in this instance is zero with the Subtractor/Adder 90 tested by block 92 to determine whether the value contained therein is "0" or not. Since the value is "0," due to no inter-character spacing modification, and since there is no add (ADD) command 96 nor subtract (SUB) command 98, the clock 94 can generate a pulse at block 100 to normally cause the motor sequencer 102 to step the motor 105 one unit and advance the film. However, since the line test block 74 had caused the command 78 to be generated to inhibit the clock 94 from sequencing the motor, the command relating to stepping the motor sequencer is inhibited. However, a command to count down the multiplier one count is received by the line length counter 104 and a count of "1" appears in the display 50 of FIG. 7.

The pulse which sequences the line length counter 104 also passes through a count down multiplier block 106 to decrement the Multiplier Register 88 one count. The oscillator 94 would continue to supply pulses through this path to the Multiplier Register 88 until there is a sensing by block 108 that the Multiplier Register has reached "0." In this event the block 108 issues command to block 110 providing for a one-shot to reload the data from the lens turret switches block 90 into the Multiplier Register block 82 and to cause block 112 to issue a command to the Multiplicand Register block 86 to decrement one count. The oscillator 94 continues to supply pulses to the line length counter block 104 and to the Multiplier Register 88 and the Multiplicand Register 86 until the count reaches "0" in both the Multiplier Register 88 and the Multiplicand Register 86. When the Multiplier Register 88 and the Multiplicand Register 86 reach this state, as determined by block 108 and block 114, a command is issued by block 116 to oscillator 94 inhibiting further generation of clock pulses.

Thus, the line length counter 104, by means of display 50 in FIG. 7, would indicate the total points for the first character selected from the keyboard. The selection of characters making up a line of copy continues by an operator operating the keyboard 18 of the phototypesetter 10 until the line of copy has been typed into the machine in a "dry run" which displays the total line length in display 50 while conserving photographic materials and the operator's time by inhibiting the flash and the film advance.

At this point the display 50 contains the line length of the copy in picas and points. By reference to the table shown hereinabove, the operator determines the number of units of escapement that are to be subtracted or to be added to the inter-character spacing for the line of copy. The operator then sets the control switches 56, 58 and 54 in FIG. 7 to indicate the machine is to operate in the automatic mode, is to add or to subtract inter-character modification spacing, and the specific amount of inter-character spacing modification to be employed. The control switch 52 in FIG. 7 is moved to the reset position to reset the display and

to clear the machine and it is then set to the print position. In the print position the line test block 74 is disabled so that the flash block 76 and the motor sequencer 102 in FIG. 14 may operate according to command.

The operation of the phototypesetter 10 is then commenced as before. Upon depression of a key lever 46 indicating entry of the first character, a load command is generated by escape command block 84 to load first data into the Multiplicand Register 86 from the photo array 77, to load second data from the lens turret switches 80 into Multiplier Register 88, and to load the inter-character spacing modification data into the Adder/Subtractor 90. Upon the data being loaded into the Multiplicand Register 86, the block 114 determines if the count in that register 86 is not "0" and block 116 releases the oscillator 94 to start issuing pulses. The block 92 determines that the value in the Subtractor/Adder 90 is not "0" and permits the pulses from the oscillator 94 to commence counting down the Subtractor/Adder 90. Presuming initially that the inter-character spacing modification involves addition of space between all the characters in all of the words of the line copy ADD block 96 would determine that an add instruction had been set into switch 56 in FIG. 7.

The photo array data 77 is used to determine when the selected character is in a print position and at such time the flash means 76 is strobed to expose the selected character on the photosensitive medium 36. Immediately subsequent to the flashing of the character on the medium 36, the escape command block 84 issues a load command to the Multiplicand Register 86, the Multiplier Register 88 and the Subtractor/Adder 90. Block 96 then instructs the block 118 to inhibit the block 106 from permitting clock pulses from the oscillator 94 from being applied to the Multiplier Register 88. Accordingly, block 92 permits clock pulses to be applied to the motor sequencer 102 to cause the motor 105 to be stepped and thereby advance the photosensitive medium a predetermined distance. The stepping of the motor 105 continues until the block 92 senses that the count in the Adder/Subtractor 90 has reached "0," thereupon the block 92 issues a command to block 120 to stop pulses from being applied to the motor sequencer 102. Thus, the film photosensitive medium 36 has been advanced a predetermined linear distance following the exposure of the character.

The oscillator 94 continues to generate clock pulses after the Adder/Subtractor 90 has reached "0" and the ADD block 96 indicates that an add instruction is no longer present, so the block 188 no longer inhibits pulses from being applied to the Multiplier Register 88. Thus, the pulses which are generated by the oscillator 94 are applied to the Multiplier Register 88 and to the Multiplicand Register 86, as previously described, and the motor 105 is stepped a predetermined distance corresponding to the data received from the photo array data 77 and the lens turret switches 80 as previously set forth herein. When the Multiplier Register 88 and the Multiplicand Register 86 have both reached "0," the block 116 inhibits the oscillator 94 from generating further clock pulses for application to the motor 105 and the film is stopped, ready for exposure of another character by the flash 76 in response to photo array data 77 generated by depression of a key lever 46. The selection of the other characters forming the words in a line of copy continues until the line of copy has been entirely set on the photosensitive medium. This results in

inter-character modification which adds space between all the characters in all words of the copy, thereby expanding the copy a predetermined amount so that it precisely fits the allotted line length.

On the other hand, if the operator of the phototypesetter 10 determines the length of the copy to be greater than the allotted line length thereby requiring inter-character spacing modification which subtracts space between characters in the words of the copy, the control switch 56 would then be set in the SUB mode and the binary switches 54 would be set according to the amount of inter-character modification required, as determined by reference to the chart included hereinabove. As noted, the operator would then reset the phototypesetter 10 and move the control switch 52 to the print position. Upon selection of the first character, by depression of the appropriate key lever 46, photo array data 77 would cause the flash 76 to expose the chosen character on the photosensitive medium 36. Thereupon, the escape command block 84 would load the Multiplicand Register 86, the Multiplier Register 88 and the Subtractor/Adder 90 as before. Since the block 92 determines that the count in the Subtractor/Adder is not "0," the pulses generated by oscillator 94 would be applied to block 100. However, block 96 would indicate that an add instruction was not present and block 98 would sense that a subtract instruction was present and would cause block 78 to inhibit the clock pulses from being applied to the motor 105. Thus, the clock pulses generated by the oscillator 94 would simultaneously count down the Subtractor/Adder 90 and the Multiplier Register 88 and the Multiplicand Register 86, as described hereinbefore. This state continues until the block 92 determines that the state of the Subtractor/Adder is "0," thereupon a command is issued to block 100 to ignore the signal supplied from block 78 to inhibit the motor clock pulses from the motor sequencer 102, thereby permitting the clock pulses to step the motor 105 until the Multiplier Register 88 and the Multiplicand Register 86 have gone to "0" and the oscillator 94 is disabled by block 116 as described. Thus, the pulses which would normally have stepped or advanced the film 36 according to the linear distance allotted to the particular character which had been exposed is inhibited according to the instructions set by the control switches 54 and the result is inter-character spacing modification by subtraction of spacing. The operator would continue to type the remainder of the characters in the words of the line of copy as described above until the line of copy has been completely set in the film 36. Since a predetermined amount of inter-character spacing modification has been performed by subtraction of spacing between all of the characters in the words making up the line of copy, the line of copy precisely fits the allotted line length.

Since the operation of the phototypesetter 10 has been described carefully in detail by reference to the flow charts, it will now be indicated by reference to schematic block diagrams and to supporting schematic logic diagrams now the operations of the flow chart in FIGS. 11 and 14 are implemented. Referring now to FIG. 12, the block diagram for the line length counter includes a bidirectional counter 122 which is responsive to clock pulses on lead 124 to count up and to pulses on lead 126 to count down indicating a back space. Clock pulses will appear on lead 124 according to the width of a selected character. Each clock pulse represents an instruction to the stepping motor of the

film transport 16 to advance the film 36 by 0.0046 inch or one-third point. This advance of the stepping motor in response to pulse is constant regardless of character width or point size. Since there are three units or stepping motor pulses per point, the counter 122 is reset on the third pulse and generates a pulse on lead 128 which is applied to a Divide by "12" counter 130 which upon the application of 12 pulses, is reset and generates a pulse on lead 132 to a Divide by "10" counter 134. Upon the application of 10 pulses to the counter 134, the counter is reset to "0" and a pulse generated on output lead 136 which is applied to another Divide by "10" counter 138. The count appearing in counter 130 is decoded and the voltage levels amplified by a suitable decoder-driver 140 for application to a suitable display means 142. Similarly, the decoder-driver 144 decodes the count in the counter 134 and drives a display 146. The decoder-driver 148 decodes the count in the counter 138 and drives a display 150.

In the schematic logic diagram of FIG. 13, the particular logic used for the block diagram of FIG. 12 is illustrated. The particular logic which is shown is logic which has been used in an embodiment of the invention and it will be apparent as in other further description herein that other implementations would occur to those skilled in the art. Also, use was made of commercially obtainable integrated circuits that are purchasable as standard parts having standard specified characteristics from major manufacturers.

The counter 122 includes flip-flops 152 and 154 and appropriate gating to act as a bidirectional counter when receiving pulses on either lead 124 or lead 126. The flip-flops 152 and 154 are Series 74107 flip-flops. The output of the counter 122 is applied to the Divide by "12" counter 130 which comprises counter 156, one-shot 158, one-shot 160 and appropriate gates. The counter 156 is a Series 74193 counter. The output of the counter 130 is connected to the Divide by "10" counter 134 which is a Series 74192 counter, as is the counter 138 to which the output of counter 134 is connected. The decoder-driver 140 connected to the counter 156 is a Series 7447 decoder-driver, as is decoder-driver 144 and the decoder-driver 148. The outputs of the decoder-drivers 140, 144 and 148 drive seven segment light emitting diodes digital displays shown by reference character 50 in FIG. 7.

Referring to FIG. 15, a schematic block diagram illustrates a preferred implementation of the flow chart of FIG. 14. In this block diagram, upon choosing a character to be exposed from the font, font data is read from the rotating font and upon determination that the chosen character is in the print position, the flash tube 164 is strobed to illuminate the selected character aperture 28 and expose that character on the photosensitive medium 36. Upon the exposure of the character on the photosensitive medium 36, a load command is then generated which causes data represented by the setting of the control switches to be loaded from data bus 166 into the Adder/Subtractor 168. Similarly, data representing the setting of the turret switches of the lens turret 22 is loaded from data bus 170 into the Multiplier Register 172. Also, font data representing the particular escapement of the linear distance allotted to the selected character is loaded from data bus 174 into the Multiplicand Register 176.

After the operator of the phototypesetter 10 had completed a dry run of typing the copy and has determined from the chart shown above the amount by which the length of copy has underflowed or over-

flowed the allotted line length and the amount of inter-character modification to be made, this data has been set into the mode switches and has accordingly been inputted into the Adder/Subtractor 168 over data bus 166. Presuming initially that the inter-character modification is to involve the addition of space, the clock pulses appearing on lead 178 for application to the motor sequencer 180 to step the motor 182 are also directed to AND-gate 184 for application to the Multiplier Register 172 over lead 186. Since the inter-character modification is to involve addition, the Adder/Subtractor 168 provides a command over lead 188 to disable the AND-gate 184 and to preclude the application of clock pulses to the Multiplier Register 172. However, the clock pulses appearing on lead 178 are applied to the Adder/Subtractor 178 simultaneously with the application of the pulses to motor sequencer 180 so that the motor 182 is stepped a predetermined distance until the Adder/Subtractor is counted to "0" at which time the inhibiting command is removed from lead 188 and the AND-gate 184 is enabled to permit the application of clock pulses over lead 186 to the Multiplier Register 172. As previously described, as the Multiplier Register is counted to "0" the motor sequencer 180 steps the motor 182 to advance the photosensitive medium 36. Upon the Multiplier Register reaching a count of "0," the Multiplier Register 172 permits one pulse to issue over lead 188 to count down the Multiplicand Register 176 one count and simultaneously the initial value of the turret switches is reloaded over data bus 170 into the Multiplier Register 172. When both the Multiplier Register 172 and the Multiplicand Register 176 are counted down to "0," the Multiplicand Register issues a command over lead 192 to disable the motor sequencer 180 from further stepping of the motor 182.

When the inter-character modification involves subtraction of space from the linear space allotted to each character, the Adder/Subtractor 168 will issue a command on lead 194 to inhibit the motor sequencer 180 from stepping the motor 182 when clock pulses are applied to the sequencer 180 over lead 178 after the flash 164 has exposed a character on the photosensitive medium 36. The clock pulses applied on the lead 178 counts down the Adder/Subtractor 168 and are also applied to the Multiplier Register 172 and intermittently to the Multiplicand Register 176 since the command on lead 188 to the AND-gate 184 enables the AND-gate 184 for transmission of pulses over lead 186. Thus, the motor sequencer 180 is inhibited while the Multiplier Register 172 and the Multiplicand Register 176 are being decremented. When the value in the Adder/Subtractor 168 goes to "0," the inhibit signal is removed from lead 194 permitting the clock pulses on lead 178 to step the motor 180 simultaneously with decrementing the Multiplier Register 172 and in turn the Multiplicand Register 176. When the values in the Multiplier Register 172 and in the Multiplicand Register 176 go to "0," a command is issued over lead 192 to disable the motor sequencer 180 from further stepping of the motor 182 since the linear distance allotted to the particular character has been advanced on the photosensitive medium by stepping of the motor 182.

Referring now to FIGS. 16 and 17, the schematic logic diagrams will be seen for implementing the block 164 of FIG. 15, which exposes a predetermined character on the photosensitive medium 36 in response to font data read from the rotating font over data bus 174. The input on lead 196 represents voltage pulses resulting

from a photo cell of the photo array 44 being responsive to light passing through the timing mark apertures 40 of the rotating font member 26. The pulses are inverted by an appropriate inverter 198 and applied to consecutive monostable multivibrators or one-shots 200 and 202 to produce a pulse train on lead 204 for application to the interconnected counters 206 and 208 which form a character position counter 210. The particular one-shots 200 and 202 are Series 74121 integrated circuits and the counters 206 and 208 are Series 74193 integrated circuits purchasable from any major integrated circuit manufacturer.

The particular count held in the counter 210 at any particular time is represented by the voltage state on the leads 212, 214, 216 and 218 for the counter 206 and leads 220, 222 and 224 for the counter 208. The voltage state appearing on these leads represent the state of the flip-flops which comprise the counters 206 and 208.

The output leads of the counter 206, as seen in FIG. 17, are applied as inputs to a comparator 226. Similarly, the outputs of counter 208 are applied to the inputs of a comparator 228. The remaining three inputs of the comparator 226 are input leads 230, 232 and 234 and 236 which represent the value of the particular character associated with the key lever 47 which has been depressed by an operator of the phototypesetter 10. Similarly, the remaining two inputs 238 and 240 of the comparator 228 represent further data representing the particular character selected.

The data appearing on the input leads from the keyboard will remain relatively static while the data appearing on the leads from the character position counter 210 will be considered relatively dynamic. When there is a match between the two sources of input data, the comparator 228 will generate an output signal on lead 230 which, when inverted by inverter 232, becomes a flash command FLASH on lead 234 for strobing the flash tube 31 in FIG. 4 to illuminate character on the photosensitive medium 36. The comparators 226 and 228 are Series 7485 integrated circuits.

In FIG. 18 it will be seen how the flash command FLASH appearing on lead 234 of FIG. 17 is utilized to generate a load command to load data into the Adder/Subtractor 168, the Multiplier Register 172 and the Multiplicand Register 176 as shown in FIG. 15. A flash command appearing on lead 236 triggers either one or both of the one-shots 238 and 240. Whether one-shot 240 will be triggered is determined by whether a signal UF representing selection of a character 28 in the upper font 28A of the font member 26 appears on input lead 242 of the one-shot 240. The one-shots 238 and 235 are Series 14121 integrated circuits.

If there is an upper font command UF on 242, the one-shot 240 produces the signal Load UF on output 244 indicating that the escapement data for the upper font 28A is to be loaded. The output 246 of one-shot 238 and output 248 of one-shot 240 are applied to an OR-gate 250. The output of OR-gate 250 is inverted by a suitable inverter 252 and the load signal LOAD appears on lead 254. This load command is applied as noted to direct the loading of data into the Adder/Subtractor 168, the Multiplier Register 172 and the multiplicand Register 176.

Referring now to FIG. 19, it will be seen that the Multiplicand Register 176 comprises a first counter 256 and a second interconnected counter 258. The counter 256 has inputs 258, 260, 262 and 264 representing signals 1A, 2A, 4B and 8A, respectively. Input lead 266

to counter 258 sets signal 16A into the counter 258. The counter 256 has output leads 268, 270 and 272 upon which signals 8A0, 4A0, and 2A0 appear. Counter 258 has an output lead 274 upon which signal 16A0 appears. The application of clock pulses to input lead 276 decrements the counter 256 and in turn the counter 258 interconnected thereto by lead 276. When both counters are counted down to "0," signal ECZ appears on output lead 278 of counter 258 which is the command to inhibit the motor sequencer 180 from passing any further clock pulses to the stepping motor 182 as seen in FIG. 15. The counters 256 and 258 are Series 74193 integrated circuits.

Referring now to FIG. 20, it will be seen how the font data from the photo array 44 appears on the inputs of the counters 256 and 258 of the Multiplicand Register 176. In reviewing all of the logic diagrams, it must be remembered that while the logic may appear redundant at times, applicant is disclosing the best embodiment of the invention known to him and a physical construction of this embodiment may have been in particular instances dictated by the particular integrated circuits commercially available and the requirement to raise certain signals to desired levels. It will be seen that the voltage signals caused by the light from tube 38 passing through the apertures or in the font member 26 selectively lower resistance and caused voltage levels to change. The signals which appear on the plurality of input leads 280 represent data input from the rotating font 26. These signals, after passing through a plurality of inverting states shown generally at 282, appear on a plurality of output leads 284 and are decoded for use to indicate which pair of fonts is presently being read and other pertinent information. The extra long pulses caused by the spaces 40 between the font members 26A, 26B and 26C are used to identify the font pairs. Also, escapement information relating to inter-word spacing received from depression of key levers 46 on the keyboard is indicated on a plurality of leads 286. Data from leads 286 and the input from the photo array on leads 280 then appear on the output leads 258, 260, 262, 264 and 266 as inputs for the counters 256 and 258 in FIG. 19.

A signal NFEC may be applied to lead 288 as a common input to an AND-gate stage generally indicated at 290 to inhibit all escape data from the photo array being applied to the input leads of the Multiplicand Register 176. Since the data being represented on leads 280 is dynamic, it is necessary to inhibit the appearance of this data from the leads of the input to Multiplicand Register 176 when it is desired to load the register 176 with escapement information relating to inter-word spacing.

In FIG. 21 is illustrated a schematic logic diagram implementing the Adder/Subtractor 468 of FIG. 15. The Adder/Subtractor 168 comprises a first counter 292 and a second interconnected counter 294. The counters 292 and 294 are Series 74193 integrated circuits. The counter 292 has inputs 296, 298, 300, 302 and 304 representing signals 1C, 2C, 4C, 8C and 32C. The counter 294 has an input 306 upon which appears signal 16C. The counters are loaded in response to a signal appearing on lead 308 and are decremented by a clock signal SUB CLOCK appearing on input 310 to the counter 292. When the value in the Adder/Subtractor 168 reaches "0" in response to a pulse train appearing on input lead 310, a signal SUB appears on an output lead 312 of counter 294. This signal is utilized to inhibit the motor sequencer 180 from stepping the

motor 182 when the inter-character modification mode is ADD.

The Multiplier Register 172 is seen in the logic diagram of FIG. 22. The Multiplier Register 172 includes a first counter 314 and a second interconnected counter 316. The counters 26 and 36 are Series 74193 integrated circuits. The first counter 314 has inputs 318, 320, 322 and 324 representing signals 1B, 2B, 4B and 8B, respectively. The counter 316 has an input lead 326 for input signal 16B. The counters 314 and 316 are loaded in response to load signal LOAD appearing on input lead 328. The counter 172 is decremented by the signal MULT CLOCK received on input 330 to counter 314. When the counter 172 has been counted to "0" by clock pulses appearing on lead 330, the signal appearing on output lead 332 of the counter 316 is applied to a one-shot 334 to generate a pulse COUNT DOWN on output lead 336 which is applied to the Multiplicand Register 176 to decrement it one count. Also a reload pulse RELOAD is generated on output lead 338 of the one-shot 334 to reload the data from the lens turret switches into the Multiplier Register 172.

In FIG. 23 is seen the logic which decodes the setting of the lens turret switches and the control switches to provide the data which is applied through data bus 166 to Adder/Subtractor 168 and through data bus 170 to the Multiplier Register 172. The signals appearing on input leads 340, 342, 344, 346, 348 and 350 represents the setting of the control switches 54 indicating inter-character modification. The signals appearing on the aforementioned input leads are then decoded to appear on output leads to the right of the diagram. These output leads are 352, 354, 356, 358, 360 and 362 upon which appear respectively signals 1C, 2C, 8C, 16C and 32C. These output leads comprise the data bus 166 to the Adder/Subtractor 168. The signals appearing on leads 364, 366, 368 and 370 represent the setting of the switches of the lens turret, thereby representing the particular point size which the chosen lens will provide for the character exposed on the photosensitive medium 36. These signals appearing on these leads are decoded and appear on leads 372, 374, 376, 378, 380 which represent the data bus 170 for the Multiplier Register 172.

In FIG. 24 is shown a schematic logic diagram for the motor sequencer 180 and in FIG. 25 is shown logic for controlling the motor sequencer 180 as well as other logic required for operation of the phototypesetter 10. Referring first to FIG. 25 it will be seen that the square wave output OSC of a suitable oscillator is applied on input lead 380 to AND-gate 184, also seen in FIG. 15. The other input to the AND-gate 184 is applied by a signal on input 382 which represents the setting of the control switch 56 in FIG. 7. The output of AND-gate 184 is signal MULT CLOCK on lead 186 which is applied to the Multiplier Register 172. It will be seen that AND-gate 384 has an input 312 upon which appears signal SUB which is ANDED with the oscillator input to produce SUB CLOCK signal on output 386. In FIG. 21 it was seen that when the Adder/Subtractor 168 has been counted to "0," the output signal on lead 312 was SUB, therefore the appearance of this signal terminates the application of the pulse signal train SUB CLOCK to the input of the counter 292 of the Adder/Subtractor 168. The oscillator clock signal appearing on input lead 380 is applied to AND-gate 388 having as an output lead 390 upon which appears the signal MOTOR CLOCK.

The inverse of the MOTOR CLOCK signal is then

seen on lead 390 in FIG. 24 as the main input signal which by application to the logic illustrated, provides output signals to the flip-flops 392 and 394 having as outputs leads 396 and 398 for flip-flop 394 and outputs 400 and 402 for flip-flop 392. The leads 396, 398, 400 and 402 are connected to the windings of a suitable stepping motor which steps the photosensitive medium 36 a predetermined linear distance. It will be seen that signal ECZ which appears on output lead 278 of the Multiplicand Register 176 appears on input lead 278 to AND-gate 388 so that the control signal on this lead controls the application of clock pulses to the motor sequencer 180 to step the motor 182.

In order to insure that the logic diagrams contained herein are meaningful, an abbreviated signal glossary is included to explain the meaning of certain signals which have not been noted in the foregoing description and which may appear in certain logic diagrams.

SIGNAL GLOSSARY

AUTO IN/MAN OUT. The AUTO IN/MAN OUT signal is normally low level and goes high when a switch is depressed. This signal is applied to three gates and to the Adder/Subtractor, causing a selected number of steps of escapement to be automatically subtracted or added from the linear distance allotted to a selected character.

BS. The Not Backspace is a normally high signal that normally goes low when the backspace key lever is operated. The photosensitive medium will be reversed one unit of escapement.

CAP CHANGE. Cap Change is normally a low level signal that goes high to energize the relay which provides a longer flash period for 60, 72 and 96 point characters.

ECZ. Not Escapement Count Zero is normally a high level signal that goes low to indicate completion of the escapement sequence.

FF. Not Film Feed is normally a high level signal that goes low when the film feed switch is depressed. Depression of this switch causes the photosensitive paper to advance.

FLASH. Not Flash is a normally high level signal that goes low to cause strobe with the bar when not inhibited by line test with the bar.

FLASH NON-ESCAPE. Not Flash Non-Escape is normally a high level pulse signal that goes low when the stop feed switch is operated. This signal prevents further operation of the stepping motor.

LF. Not Lower Font is normally a high level signal that goes low to initiate the lower font operation.

LOAD. Not Load is a normally high level signal that goes low to load the Multiplier Register, Multiplicand Register, and the Subtractor/Adder as determined by the lens turret switches, letter spacing switches, and the PC1-PC16 photocells.

MAX ESC. Not Maximum Escape is normally a low level signal that goes high to clock the font position counter and clear the character position counter.

NFEC. Non-Flash Escape Character is normally a high level signal that goes low as a result of the set condition of the NFEC encoder-decoder flip-flop. This low level signal clears the Subtractor/Adder so that the escapement modification does not occur on an NFEC character. The NFEC signal also disables the PC1 to PC16 signals.

RESET. Not Reset is a low level signal when the machine is turned on and goes high when the reset switch

is depressed on the control panel. When the reset switch is depressed, the reset line momentarily goes low to reset the various logic functions of the phototypesetter 10.

STROBE. Not Strobe is a normally high level signal which goes low to fire the strobe lamp and cause the selected character on the font to be flashed on the photosensitive medium.

UF. Not Upper Font is normally a high level signal that goes low to initiate upper font operation.

W1 to W4. Not Winding 1 to 4 are normally high level signals that go low for application to the motor driver circuits which energize the appropriate motor windings of the stepping motor.

In summary, it has been shown above how the novel method and system as described by reference to a preferred embodiment of the invention provides inter-character spacing modification to precisely fit a line of copy comprising a plurality of characters formed into words in an allotted line length.

While the invention has been particularly shown and described with reference to a preferred embodiment hereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. In a phototypesetter wherein characters in a rotating-type font are selected by selectively strobing a flash means to expose the chosen character on a photosensitive medium and where the medium is advanced a variable linear distance according to the space allotted to each character of the type font and to space between words to provide inter-character and inter-word spacing and thereby set a line of copy longitudinally along the length of the medium, the improvement comprising:

means to advance the photosensitive medium for each character a distance which changes the linear space normally allotted for each character in a line of copy to thereby change the inter-character spacing within each word of the copy which includes:

means to determine first data related to the point size of the characters to be used to set the copy on the medium,

means to determine second data relating to the amount of advancement for the photosensitive medium for each character exposed on the medium,

means responsive to the first and second data to obtain third data representing the distance the medium is to be advanced for that particular character,

means responsive to the third data to advance the photosensitive medium a linear distance represented by said data,

means to determine data representing the amount of space which is to be subtracted or added to the space for each character,

means responsive to said data to inhibit the advance of the photosensitive medium an amount corresponding to said data when space is to be subtracted from each character in a line of copy and to advance the medium an amount corresponding to said data when space is to be added to the space allotted for each character in a line

of copy prior to selection of the next character to be exposed,
and wherein the means to determine first data includes switch means which are responsive to the position of a lens turret carrying a plurality of magnifying lenses to indicate the particular lens of the turret being used to magnify the characters selected from the font for exposure on the photosensitive medium in a predetermined point size,
and wherein the means determining the second data includes the photoelectric means responsive to data manifestations carried by the rotating font.

2. The combination according to claim 1 wherein the data manifestations are first indicia carried by the font indicating the linear distance allotted on the photosensitive medium to each character in the font when each character is chosen for exposure and second indicia identifying each character in the font.

3. The combination described in claim 2 wherein the means determining data representing the amount of space which is to be subtracted or added to the space for each character includes switches which are set according to the difference between the allotted line length and the length of the intended copy with normal inter-character and inter-word spacing.

4. The combination according to claim 3 wherein the first, second and third data are determined simulta-

neously in response to a signal generated by illumination of a selected character.

5. The combination described in claim 2 wherein said font indicia are provided by an opaque font member having a plurality of apertures arranged in the member in rows parallel to the length of the member, said apertures relating to the specific linear distance allotted to each character in the font on the photosensitive medium.

6. The combination according to claim 5 wherein the plurality of apertures represent binary coded values.

7. The combination according to claim 5 wherein the opaque font member is provided with upper and lower fonts of character apertures and the first indicia carried by the member relates to the specific linear distance allotted on the photosensitive medium for both the upper and lower fonts of characters.

8. The combination according to claim 7 wherein the characters of the upper and lower fonts are arranged one directly above another and the apertures relating to one character position which appear immediately on one side of an imaginary plane extending through the center of the character positions of said fonts parallel to the axis of rotation of the font member relates to a character in one font of characters and the apertures appearing immediately on the other side of the plane relates to the other font of characters.

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