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June 28, 1960 E. W. BECHTOLD 2,942,538
CHARACTER PRESENTATION SCHEME FOR
PHOTOTYPOGRAPHICAL MACHINE
Filed July 17, 1958

X2587

Fig:1.

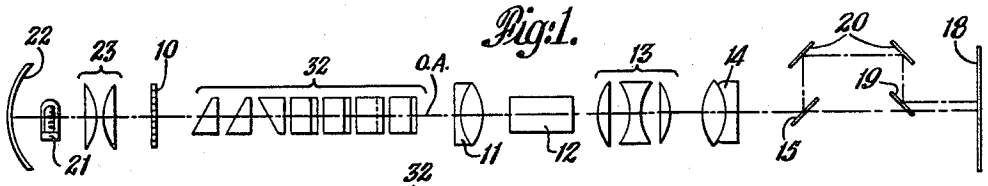


Fig:2.



Fig:3.

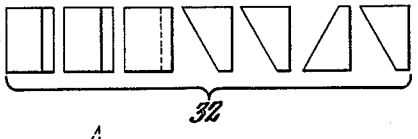


Fig:4.

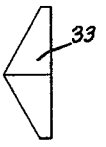


Fig:5.

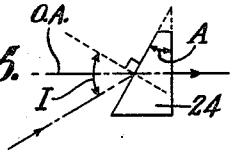


Fig:6.

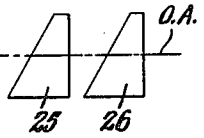


Fig:7.

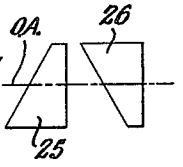


Fig:8.

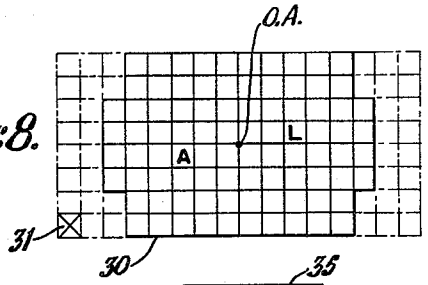


Fig:9.

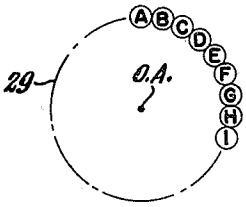


Fig:10.

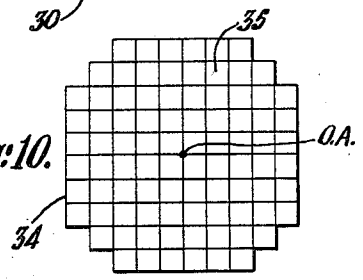
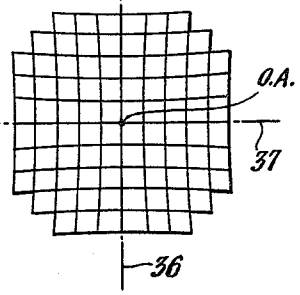


Fig:11.



NUMBER OF DIFFERENT POSITIONS

NUMBER OF WEDGES	1	2	3	4	5	6	7	8	9	10
1	1	2	3	4	5	6	7	8	9	10
2	1	4	9	16	25	36	49	64	81	100
3	1	8	27	64	125	216	343	512	729	1000
4	1	16	81	256	625					
5	1	32	243	1024						
6	1	64	729							
7	1	128								
8	1	256								

Fig:12.

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United States Patent Office 2,942,538
Patented June 28, 1960

2,942,538

CHARACTER PRESENTATION SCHEME FOR PHOTOTYPOGRAPHICAL MACHINE

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Filed July 17, 1958, Ser. No. 749,228

13 Claims. (Cl. 95—4.5)

This invention relates to an improved optical system for selecting and presenting individual graphic symbols from an illuminated array of such symbols. More particularly, it relates to the employment of the novel system in combination with a photocomposing machine.

In machines of that type, it is customary to employ character grids or font plates having either an array of opaque characters on a translucent background or an array of translucent characters on an opaque background. In view of the wide variety of characters necessarily employed in the composition of type for printing, one of the difficulties encountered in the design of such machines is that of projecting any desired character in the array onto the photographic film, along the common optical axis of the system, in order that each character composed will be aligned with respect to all other characters in sequence. The difficulty arises since initially, the light rays forming any particular character on the character grid will be displaced from the optical axis a distance equal to the remoteness of that character from the optical axis.

Character selection, that is, the transmission of the light rays forming a selected character of a font along the optical axis, is the central problem of photocomposing, since unless this can be done, the proper alignment and spacing of characters in a sequence, necessary for high quality composition, cannot be achieved. In the past, character selection has usually involved relative movement between the character array and the optical system, either to bring the selected character onto the optical axis of the optical system, or to bring the optical axis to the selected character. Costly and elaborate mechanism is required to supply these movements, especially in view of the degree of accuracy demanded; furthermore, shifting of the character font or the optical system before each character is photographed makes for needlessly slow composition.

It is the object of the present invention to obviate the need for relative movement between the character grid and the optical system by offering a highly satisfactory and relatively inexpensive solution to the problem. According to the invention, the characters of the font are rapidly projected on the photographic film in any desired order without movement of the font plate or the optical system. In addition, the usual means for maintaining the characters in proper focus, for placing the characters on the film in proper position, and for varying the point size of the characters produced by a single font plate, are provided.

The invention will now be more fully described with reference to the accompanying drawings, in which:

Figure 1 is a schematic elevational view of an optical system showing the prism arrangement of the present invention in one operative position;

Figure 2 is an enlarged showing of the prisms in Figure 1;

Figure 3 is a plan view of the prism arrangement in Figure 2;

Figure 4 shows two reversely disposed prisms, arranged base to base;

Figure 5 is an elevational view of a single prism showing its effect on a particular beam of light;

Figures 6 and 7 are elevational views showing some relative positions of prisms with respect to one another;

Figure 8 represents a possible font plate arrangement for use with the present invention;

Figure 9 represents a font plate of circular design;

Figures 10 and 11 represent additional font plate arrangements; and

Figure 12 is a table whose significance is mentioned in the following description.

The apparatus illustrated in the drawings is, as usual, enclosed in a suitable dark chamber (not shown). Referring to Figure 1, the font plate **10**, which preferably comprises a plurality of translucent characters on an opaque background, is illuminated, resulting in the projection of a plurality of character forming beams of light therefrom, the selected beam of which is bent to coincide with the optical axis O.A. of the system, and is thereafter projected by a first image lens **11** through a mask **12** which cuts out extraneous light, allowing only the substantially parallel light which forms the character image to pass through. The beam then passes through an arrangement of point-size changing lenses **13**, thus enabling various point size type to be composed from a single font plate, and a second image lens **14**, for focusing the final character image on a stationary mirror **15** which is part of the mirror system used for translating the final image across the film **18**. The mirror **19** is displaced by an amount equal to the width of each character to be composed, and the pair of mirrors **20** are displaced in the same direction by half that amount in order to equalize the optical distance from the lens **14** to the film, thus maintaining the characters in sharp focus.

The font plate **10** is illuminated by a source of field light **21** which is intensified and directed toward the array of characters by a reflector **22** and a condensing lens **23**, thereby making for relatively even distribution over the entire area of the character array. The light source **21** may be either of the flash lamp type or it may be a standard projection lamp, in which latter case, a single shutter will be placed in the system, possibly in conjunction with the mask **12**.

In the present system, the characters are individually selected for composition by one or more wedge-shaped optical prisms, and therefore, the arrangement of the characters in the array will depend upon the particular system of prisms employed. It is a well known principle of optics that when a beam of light is passed through a triangular prism, it will be refracted or bent at one or both surfaces of the prism; thus producing a deviation of the beam from its initial path (see Figure 5). The magnitude of this deviation depends upon four factors: the angle A of the prism **24**, the refractive index of the prism, the angle of incidence I of the initial beam entering the prism, and the wave length of the light. It may easily be shown, however, that for small prism angles A (i.e. about 6° or less), variations of the angle I affect the magnitude of the beam deviation about one-tenth of one percent or less, which effect is practically negligible. In addition, if monochromatic light is used as the source of illumination or if an achromatic prism is used, the effect of different wavelengths of light on magnitude of deviation may be ignored. Therefore, the angle through which a beam of light is deviated by a prism may be made substantially dependent upon the first two parameters mentioned, the angle of the prism, and the refractive index thereof, both of which, of course, are constants for any particular prism chosen.

The effect of more than one of such prisms on a single

beam of light will be additive, if the prisms are arranged as shown in Figure 6, i.e. with their vertices (or more correctly, the truncated portions thereof) pointing in the same direction. For example, if the prism **25** has a deviation power of 2° and the prism **26** has a deviation power of 1°, the combination will deviate a single beam 3°. On the other hand, if the prism **26** is reversed (rotated 180°) as shown in Figure 7, the effect will be a subtractive one, and a beam of light passing through the combination will be deviated only 1° (2°—1°). Furthermore, the deviations produced by these prisms, whether completely additive or additive and subtractive, will be in a meridian plane, i.e. a plane perpendicular to the front and rear faces of the prism, meaning that the prisms shown in Figures 5, 6 and 7 will deviate beams of light in a vertical plane only. It follows, then, that if any of these prisms were rotated about the optical axis, say 90°, the deviation in the beam passing through such a prism would no longer be in a vertical meridian plane, but would lie instead in a horizontal meridian plane.

Now then, applying these principles to a photocomposing machine, wherein the entire font plate is illuminated and the problem is to select the beam of light passing through the one character which is to be composed, and bring that beam, and no other, on to the optical axis of the system, it may readily be seen that with a font plate having a circular arrangement of characters, such as that indicated in Figure 9, and by employing one prism rotatable about the optical axis, the light from any one of characters of the font plate **29** may be deviated on to the optical axis by merely rotating the prism to the proper position. The spacing of the characters from the optical axis O.A., the deviating power of the prism chosen, and the distance between the prism and the font plate are the parameters important for successful operation of the system, fixing of any two of which will automatically fix the third. Furthermore, the prism should have as many positions in its plane of rotation as there are characters on the font plate; the number of possible positions, of course, being infinite.

A set-up such as that just described is certainly operable, however as a practical matter, it would be rather difficult and expensive to put into practice due to the large number of positions which the single prism must assume (it being contemplated that the usual eighty-eight character font will be used), and the means which would be necessary to accurately adjust the prism in all its positions. In addition, the arrangement of characters in a circle is not a particularly economical one.

Instead, it is apparent that if a plurality of prisms are utilized, each prism need assume only a small number of positions in order to yield enough combinations, through use of the optical addition and subtraction mentioned above, to cover the selection of at least an eighty-eight character font. Determining the maximum number of different combinations obtainable from a plurality of prisms, each prism having a number of different positions, may be done merely by solving the general equation $N=p^n$, where "N" is the maximum number of different combinations obtainable, "*p*" is the number of different positions for each prism, and "*n*" is the number of prisms. This equation has been solved for various values of "*p*" and "*n*" and the results are tabulated in Figure 12. The circled combinations are the smallest in their respective groups which will suffice to select eighty-eight different characters.

In preferred form, the present invention contemplates the use of seven prisms, each having two positions, which as may be seen in Figure 12, are capable of providing a maximum of 128 different combinations, although only eighty-eight will be employed. This particular set-up was chosen only because it is relatively easy to accurately adjust a prism which has just two positions of adjustment, and also because it permits use of a more or less economical arrangement of characters (see Figure 8).

The prisms are not all disposed in the same direction (e.g. vertically) inasmuch as such an arrangement would only allow characters disposed in a single line to be selected. Instead, in order to allow selection of characters arranged substantially along Cartesian coordinates, some of the prisms are positioned vertically and others horizontally, or in other words, some of the prisms are positioned either with their vertices pointing up or pointing down, while the other prisms are positioned either with their vertices pointing to the right or pointing to the left. Therefore, in order to change the position of any particular prism, it must be reversed, i.e. rotated 180°, about either the optical axis or a line parallel to both the front and rear faces of the prism. In fact, actual rotation of the prism is not necessary as will be explained hereinafter.

It should here be noted that the slight variance in the deviating power of a prism due to differences in angles of incidence, which was mentioned above, should be considered when preparing a character array. In order to compensate for the variation, the array, instead of being arranged in straight rows and columns (as shown in Figures 8 and 10), is arranged in slightly bowed or arcuate rows and columns (see Figure 11 in which the curvatures are greatly exaggerated for clarity) such that the further a character is disposed from the vertical center line **36** of the array, the further it is disposed from the horizontal center line **37**.

As to the selection of the deviating power of each prism, it has been found that three vertical prisms having deviating powers of 1°, 2° and 4° respectively, and four horizontal prisms having deviating powers of 1°, 2°, 4° and 8° will yield the 128 combinations shown in Figure 8. Now, as an example of how these prisms operate to produce the desired effect, assume for the sake of ease of explanation that a beam of light is being transmitted, along the optical axis, from the film **18** toward the font plate **10** (rather, than as is normal during composition, from the font plate to the film), and it is desired to deviate this beam so that it strikes the font plate **30** of Figure 8, at the center of the square **31**. In such a case, all the vertical prisms are positioned upwardly (vertices pointing up), and all the horizontal prisms are positioned rightwardly (vertices pointing toward the right), whereupon the beam is bent downwardly 7° (1°+2°+4°) by the vertical prisms, and leftwardly 15° (1°+2°+4°+8°) by the horizontal prisms, thereby bringing the beam to the center of the square **31** (assuming each square has a "width" of 2°). In actual operation then, with the set-up just described, a beam of light passing through a character disposed in square **31** would be deviated on to the optical axis of the system, and flashed on the film **18**.

Since, as mentioned before, only eighty-eight of the maximum possible 128 combinations available will be used, an array such as that outlined in heavy lines in Figure 8 might be employed whereby the combinations for transmitting light from the extreme left hand and right hand positions of the original array will not be used. In addition, it should be remembered that it is desirable in any selection system to employ prisms of as low deviating power as possible in order to minimize the small effect which the variation in the angle of incidence produces on the deviation of a beam of light by a prism. For this reason, and since all 128 combinations obtainable with the above described system will not be used, it is desirable to replace the 8° horizontal prism mentioned above with a 6° prism, thus cutting down the number of possible combinations to 112, which is, of course, acceptable since a surplus of combinations still exists.

Now, as an added example, suppose the letter "L" is to be composed on the film **18**; the beam of light passing through that letter must be deviated on to the optical axis O.A. To do this, the prisms **32** are positioned exactly as shown in Figures 1 and 3, i.e. the 1° and 2° vertical prisms are positioned upwardly, the 4° vertical prism is positioned downwardly, the 1°, 2° and 6° horizontal

prisms are positioned rightwardly, and the 4° horizontal prism is positioned leftwardly. The vertical prisms, therefore, bend the beam upwardly 1° (1°+2°−4°), and the horizontal prisms bend the beam rightwardly 5° (1°+2°+6°−4°), thus bringing the beam on to the optical axis.

If it were desired next to compose the letter "A," for example, it may be seen that the positions of the prisms just described would have to be reversed (rotated 180°). Rather than actually having to rotate each prism, its position may be reversed much more quickly, easily and inexpensively by employing "double" prisms **33** such as the one shown in Figure 4, which allow an effective 180° reversal of the prism merely by shifting it back and forth along a linear path. Thus a simple solenoid control mechanism will be all that is required to change the positions of the prisms. In addition it should be noted that with this type of arrangement, composition may take place even before the prisms come to rest in their new positions since slight movement of the prism, due to rebound or otherwise, will not affect the angle which the beam of light makes with the individual prisms, thus allowing extremely rapid composition of characters.

The character array shown in Figure 8 is, of course, not the most spacially economic one obtainable since it is not completely symmetrical about the optical axis. In order to permit use of a more economical array, such as that indicated on the font plate **34** of Figure 10, all that need be done is to add another vertical prism to the system just described, which will, of course, provide for many more combinations than it is contemplated will be needed. However, it should be noted that there is no requirement that only eight-eight characters be placed on a font plate and as a matter of fact, with the present system, composition would be just as rapid and economical if two or three fonts of characters were put on the same font plate.

The array of Figure 10 could also be used if another selection system, say four prism, each having four positions, were employed. In such a case, two 1° prisms, a 3° prism, and a 4° prism, each positionable in the 45th, 135th, 225th, and 315th meridians, would suffice. Thus, if it is desired to select the character disposed in square **35**, the 3° prism is placed in the 45th meridian and one of the 1° prisms is placed in the 225th meridian, thereby deviating the beam toward the 45° meridian by 2° (3°−1°), and the 4° prism and the other 1° prism are placed in the 135th meridian, thereby deviating the beam toward that meridian by 5° (4°+1°). Now, if the diagonal "distance" across each square is 2°, then counting from the optical axis, the beam is moved upwardly and to the left across one square, and upwardly and to the right across two and one-half squares, thus bringing it to the selected square **35**.

Summarizing, the entire character array **10** is illuminated thereby producing a beam of light through each character in the array. These beams fall upon and are deviated by an arrangement of optical prisms **32** which may be so positioned that only the beam from the character selected for composition will be deviated on to the optical axis of the system. This beam will thereupon be projected on the film **18** for composition, through the conventional arrangement of image lenses **11** and **14**, and point size changing lenses **13**.

The present invention, therefore, provides a compact, rapid and inexpensive mechanism for selecting individual characters from a large array and presenting those characters for further optical projection.

The invention has been shown and described in preferred form only and by way of example, but many variations and modifications may be made therein and in its mode of application which will still be comprised within its spirit. It is understood, therefore, that the invention is not limited to any specific form or embodiment, except in so far as such limitations are specified in the appended claims.

What is claimed is:

1. In an apparatus having an array of graphic symbols, and a light source for illuminating the entire array to concurrently project a number of symbol representative beams of light therefrom, means for selectively presenting any desired one of said beams to a predetermined photographic station, said means comprising an optical prism through which all the projected beams pass and by which they are all deviated, means for positioning the prism as desired in a plurality of positions with respect to the array, whereby any selected beam may be deviated to a predetermined path, and means for forming an image of the symbol represented by the selected beam.

2. In an apparatus having an array of graphic symbols, and a light source for illuminating the entire array to concurrently project a number of symbol representative beams of light, means for selectively presenting any desired one of said beams to a predetermined station, said means comprising a plurality of optical prisms aligned with the array through each of which all of said beams pass and by which they are all deviated, means for positioning each of the prisms in any chosen one of a plurality of positions, whereby by selectively positioning each prism a selected beam of light may be deviated to a predetermined path, and means for forming an image of the symbol represented by the selected beam.

3. In an apparatus having an array of graphic symbols, and a light source for illuminating the entire array to concurrently project a number of symbol representative beams of light, means for selectively presenting any desired one of said beams to a predetermined station, said means comprising, a plurality of optical prisms aligned with the array through each of which all of said beams pass and by which they are all deviated, and means for positioning each of the prisms in either of two positions, whereby by selectively positioning each prism a selected beam of light may be deviated to a predetermined path.

4. In a photocomposing machine having an array of graphic symbols, and a light source for illuminating the entire array to concurrently project a number of symbol representative beams of light therefrom, means for selectively presenting any deisred one of said beams to a predetermined photographic station, said means comprising, a plurality of optical prisms aligned with the array through each of which all of the projected beams pass and by which they are all deviated, and means associated with each of said prisms for transferring the prism between either of two operative positions, one position being the reverse of the other, whereby by selective actuation of said transferring means the light beam representative of a single desired symbol may be deviated to a predetermined path.

5. In a photocomposing machine, the combination of an array of graphic symbols, a light source for illuminating the entire array to project a number of symbol representative beams of light therefrom, a plurality of optical prisms aligned with the array and through each of which all of the projected beams pass and by which they are all deviated, said prisms all having the same meridian plane and said prisms being spaced along an optical axis parallel to or contained in said plane, and means associated with each of said prisms for transferring the prism between either of two operative positions, one of the positions being the reverse of the other, whereby by selective actuation of said transferring means the light beam representative of a single desired symbol may be deviated to a predetermined path.

6. In a photocomposing machine, the combination of an array of graphic symbols arranged substantially along Cartesian coordinates, a light source for illuminating the entire array to project a number of symbol representative beams therefrom, a plurality of optical prisms through each of which all of the projected beams pass and by which they are all deviated, some of said prisms having the same meridian plane, the remainder of said prisms

having another meridian plane perpendicular to the first meridian plane, and all of said prisms being spaced along an optical axis parallel to or contained in both of said planes, and means associated with each of said prisms for transferring the prism between either of two operative positions, one position being the reverse of the other, whereby by selective actuation of said transferring means the light beam representative of a single desired symbol may be deviated to a predetermined path.

7. The combination of claim 6 wherein the symbols of the array are arranged in bowed or arcuate rows and columns.

8. In a photocomposing machine, the combination of an array of graphic symbols, a light source for illuminating the entire array to project a number of symbol representative beams of light therefrom, a plurality of optical prisms aligned with the array and through each of which all of the projected beams pass, said prisms having a variety of deviating powers but each of said prisms having a substantially constant deviating power for all of the projected light beams, and means associated with each prism for transferring the prism between either of two operative positions, one position being the reverse of the other, whereby by selective actuation of said transferring means the light beam representative of a single desired symbol may be deviated to a predetermined path.

9. The combination of claim 8 wherein the maximum deviating power of any prism is 6°.

10. In a photocomposing machine, the combination of an array of graphic symbols arranged substantially along Cartesian coordinates, a light source for illuminating the entire array to project a number of symbol representative beams therefrom, at least seven optical prisms through each of which all of the projected beams pass and by which they are all deviated, four of said prisms having deviating powers of 1°, 2°, 4° and 6° respectively and having the same meridian plane, the remainder of said prisms having deviating powers of 1°, 2° and 4° respectively and having another meridian plane perpendicular to the first meridian plane, and all of said prisms being spaced along an optical axis parallel to or contained in both of said planes, and means associated with each of said prisms for transferring the prism between either of two operative positions, one position being the reverse of the other, whereby by selective actuation of said transferring means the light beam representative of a single desired symbol may be deviated to a predetermined path.

11. In a photocomposing machine, the combination of an array of graphic symbols, a light source for illuminating the entire array to project a number of symbol representative beams therefrom, a plurality of primary optical prisms aligned with the array and through each of which all of the projected beams pass, each of said prisms comprising two identical reversely disposed secondary prisms arranged base-to-base, and means associated with each of said primary prisms for transferring the prism between either of two operative positions, only one of the secondary prisms of each primary prism being effectively utilized in one of the two operative positions and the other

of said secondary prisms being utilized in the second of the two positions, whereby by selective actuation of said transferring means the light beam representative of a single desired symbol may be deviated to a predetermined path.

12. In a photocomposing machine, the combination of an array of graphic symbols arranged substantially along Cartesian coordinates, a light source for illuminating the entire array to project a number of symbol representative beams therefrom, a plurality of primary optical prisms through each of which all of the projected beams pass and by which they are all deviated, each of said prisms comprising two identical reversely disposed secondary prisms arranged base-to-base, some of said primary prisms having the same meridian plane, the remainder of said primary prisms having another meridian plane perpendicular to the first meridian plane, all of said prisms being spaced along an optical axis parallel to or contained in both of said planes, and means associated with each of said prisms for shifting the prism into either one of two positions along a line perpendicular to the optical axis and parallel to the meridian plane of the prism, whereby by selective actuation of said shifting means only the selected one of the two secondary prisms of each primary prism will be effectively utilized at one time and the light beam representative of a single desired symbol may be deviated to a predetermined path.

13. In a photocomposing machine, the combination of an array of graphic symbols arranged substantially along Cartesian coordinates, a light source for illuminating the entire array to project a number of symbol representative beams therefrom, at least seven primary optical prisms through each of which all of the projected beams pass, each of said primary prisms comprising two identical reversely disposed secondary prisms arranged base-to-base, the secondary prisms of four of said primary prisms having deviating powers of 1°, 2°, 4° and 6° respectively and having the same meridian plane, the secondary prisms of the remainder of said primary prisms having deviating powers of 1°, 2° and 4° respectively and having another meridian plane perpendicular to the first meridian plane, and all of said primary prisms being spaced along an optical axis parallel to or contained in both of said planes, and means associated with each of said prisms for shifting the prism into either one of two positions along a line perpendicular to the optical axis and parallel to the meridian plane of the prism, whereby by selective actuation of said shifting means the deviating effect of one prism with respect to another prism may be made either additive or subtractive as desired.

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