June 6, 1967 R. C. O'BRIEN 3,323,918

METHOD OF MANUFACTURING CHARACTER MATRIX DISCS FOR PHOTOGRAPHIC TYPESETTING APPARATUS

Original Filed June 10, 1963 4 Sheets-Sheet 1

FIG-1

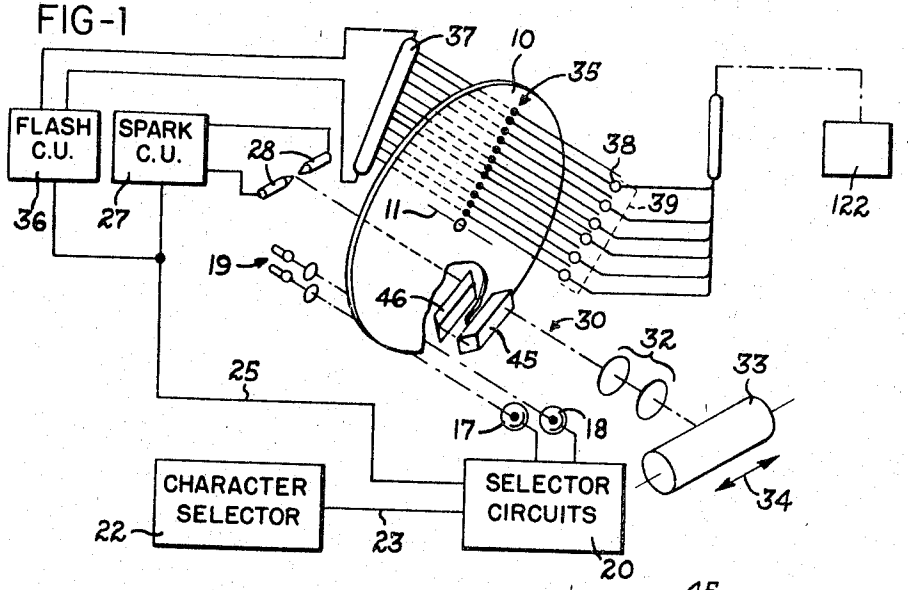


FIG-2

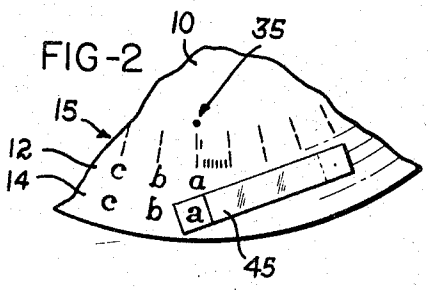


FIG-3

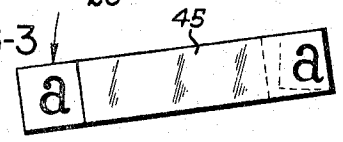


FIG-4

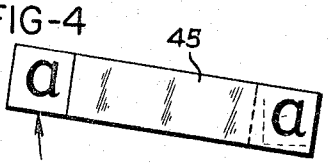


FIG-5

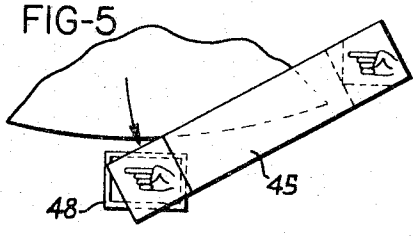
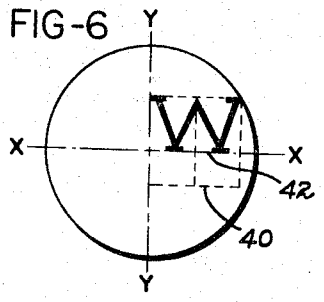


FIG-6

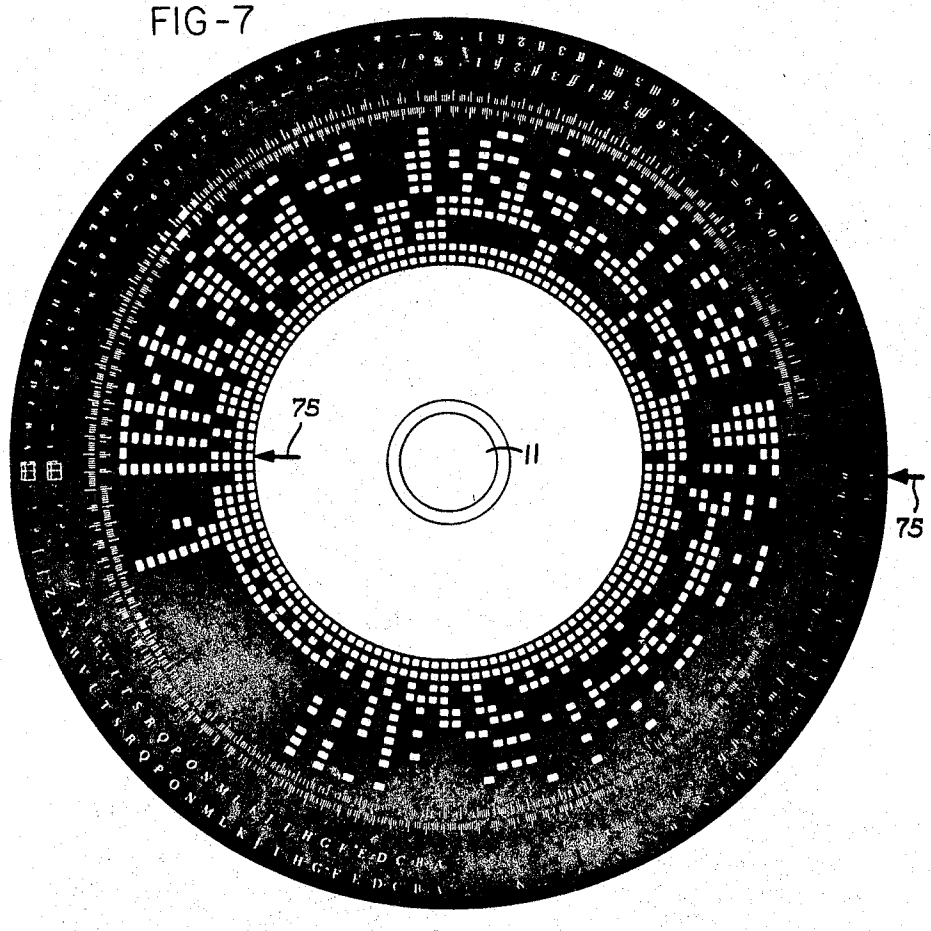


INVENTOR
RICHARD C. O'BRIEN

BY

Marechal, Biebel, French & Bugg
ATTORNEYS

FIG-7



INVENTOR
RICHARD C. O'BRIEN
BY
Marechal, Bubel, Frenchen Bugg
ATTORNEYS

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FIG-8

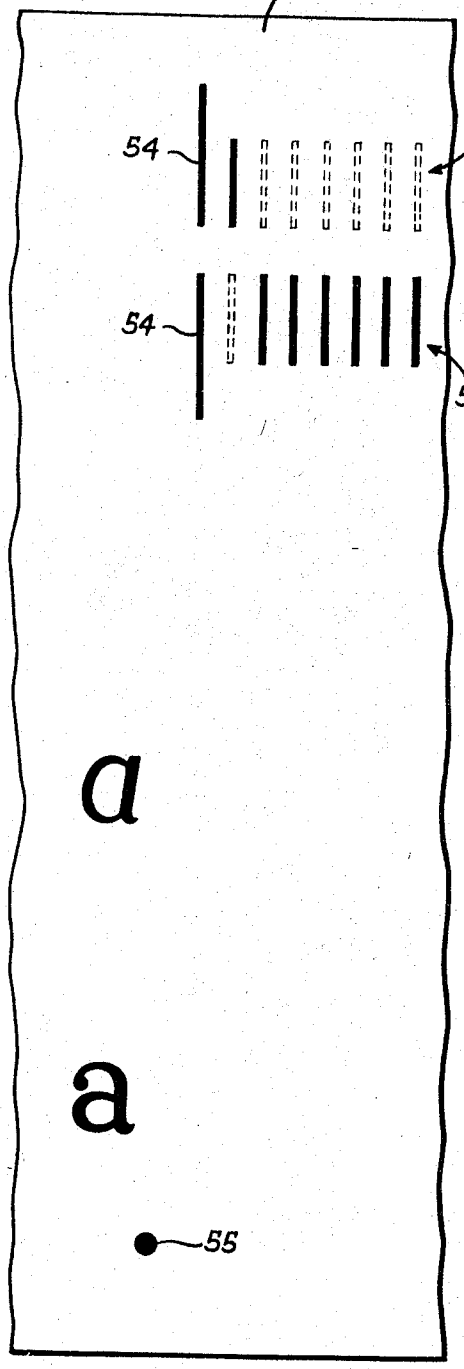


FIG-9

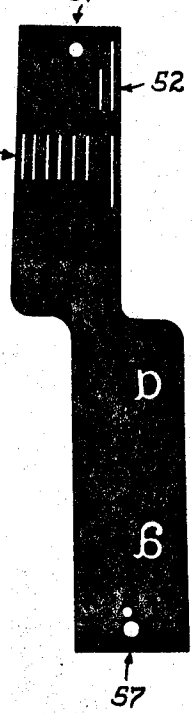
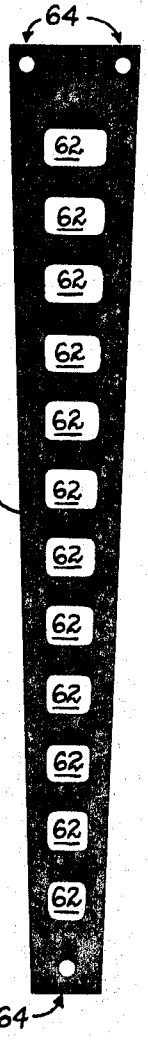


FIG-10



INVENTOR
RICHARD C. O'BRIEN

BY
Marechal, Biebel, French & Bugg
ATTORNEYS

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FIG-11

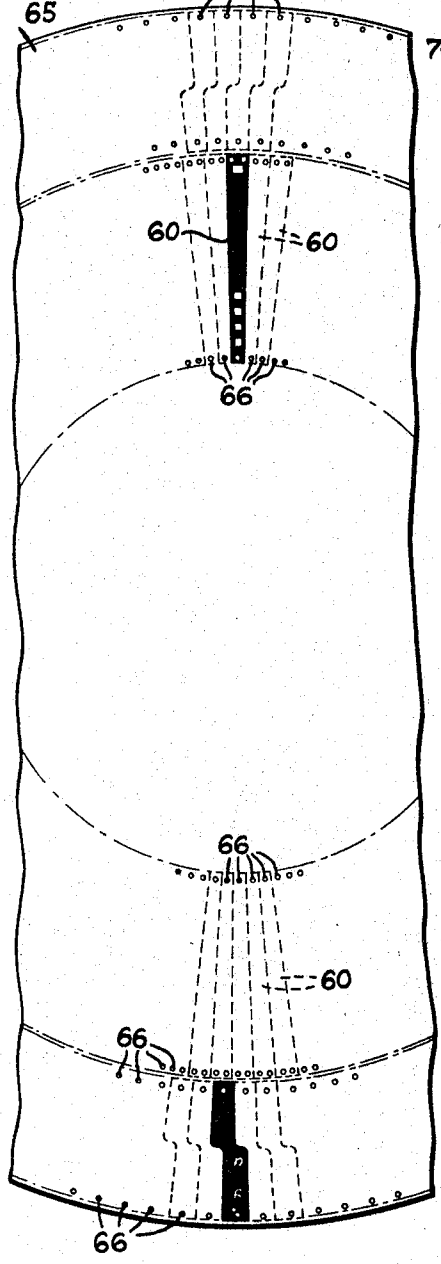
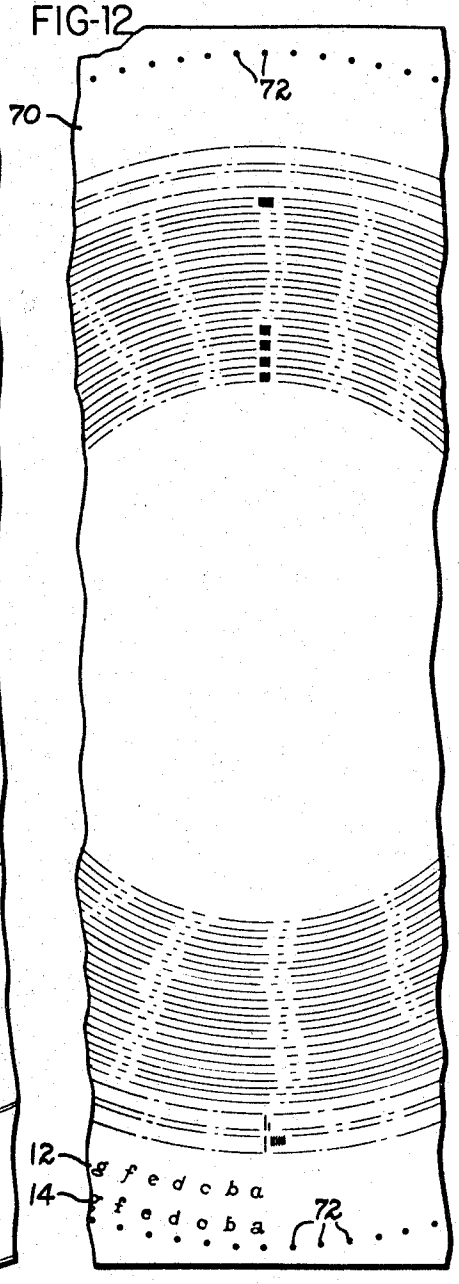


FIG-12



INVENTOR

RICHARD C. O'BRIEN

BY

Marechal, Biebel, French & Bugg

ATTORNEYS

United States Patent Office 3,323,918 Patented June 6, 1967

3,323,918

METHOD OF MANUFACTURING CHARACTER MATRIX DISCS FOR PHOTOGRAPHIC TYPESETTING APPARATUS

Richard C. O'Brien, Huntington, N.Y., assignor to Harris-Intertype Corporation, Cleveland, Ohio, a corporation of Delaware

Original application June 10, 1963, Ser. No. 286,859, now Patent No. 3,223,017, dated Dec. 14, 1965. Divided and this application July 26, 1965, Ser. No. 474,763

2 Claims. (Cl. 96—41)

This application is a division of application Ser. No. 286,859 filed June 10, 1963 now Patent No. 3,223,017, which is in turn a continuation-in-part of application Ser. No. 39,859 filed June 30, 1960, now Patent No. 3,099,945.

This invention relates to phototypesetting apparatus, and particularly to a novel font arrangement which is adaptable to accommodate high speed operation, including changes from one font to another.

The present invention is particularly adapted for font discs for phototypesetting machines which employ high speed photography of individual characters from a rotating character matrix or stencil on which more than one font of master characters is carried in a predetermined order. The characters usually are of different relative widths in accordance with the font design, and a flashing light source is mounted adjacent the character carrier to direct a beam of light through a single selected character to produce a character image-bearing light beam, with the image being focused upon photographic or like material for recording. The beam usually is directed through an optical system by means of which the size of the character image may be altered in relation to the size of the master character on the carrier, to obtain different point size from the same master characters.

The character disc in use is rotating continuously at high speed, for example 3600 r.p.m. or higher, and the recording of characters likewise proceeds at a proportionately high rate of for example 50 to 60 characters a second. It is desirable to change fonts as quickly as possible in order to avoid delays in the composing operation when, for example, the composer uses a few characters from a different font such as in the case of inserting a word in italics. All the characters of one font are located at a common radius or row on a disc, and rotated past the light source, and separate fonts are arranged in different such rows, concentric with the axis of rotation.

Thus different fonts of characters are on the same rotating carrier, but at different radii from the axis of rotation. Assuming that the master characters in each font are of the same relative size, then the same optical length must be provided between the master character or "object" of the optical system and the photographic recording material, otherwise changing between fonts may result in loss of focus or an unwanted change in image size. It is possible to overcome or alleviate this situation by displacing the carrier with respect to the light source, but this involves a requirement for movement of the relatively heavy mounting bearings, etc., for the carrier which must be positioned accurately to maintain the correct alignment between the carrier and the light source. Furthermore, while the character carrier may not be excessively heavy, nevertheless since it is rotating at high speed sufficient force must be provided to move the carrier accurately under such circumstances while overcoming the gyroscopic forces resulting from such high speed rotation.

Another important aspect of this invention involves the ability to select and photograph as quickly as possible a desired master character on the matrix disc. In order to provide optimum selection speed it is desirable to use a discrete address type of selection code, of the type disclosed in U.S. Patent No. 3,059,219, but in the interests of having more than one font on the disc it is desirable to limit the space occupied by the address code, and a feature of the invention provides a novel matrix disc arrangement, and the method of producing the disc, whereby a single code is used in selecting the corresponding character in any of the fonts carried on the disc.

Similarly, it is desirable to have character width codes directly on the disc, such that when different discs are used in the phototypesetting machine, automatically the corresponding relative width code is supplied, and when any character is selected its width code is made available at the same time. Such an arrangement eliminates the necessity of separate encoding devices or elements which otherwise would have to be incorporated or attached independently to the phototypesetting machine in accordance with the fonts being used. Even as between the different fonts on the disc, in order to achieve versatility of spacing, it is desirable to have separate width codes available for each character in each font, and to this end the present invention provides a master character disc wherein a plurality of fonts are provided in separate font segments, and for each character in each font there is a corresponding unique character width designation in the form of a multiple digit binary code.

Accordingly, the primary object of the invention is to provide a novel method of manufacturing such a character matrix disc, whereby flexibility of arrangement of the desired characters and fonts is readily achieved, permitting the manufacture of unique character matrix discs to the order of a customer.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

In the drawings:

FIG. 1 is a diagrammatic view of the essential parts of of a phototypesetting apparatus, shown together with a matrix disc of the type provided by the present invention;

FIG. 2 is an enlarged view of a segment of the character matrix disc showing the position of the font selection prism with respect to the plural fonts on the disc, but with the body of the disc and the appearance of the characters and marks thereon represented diagrammatically as opaque parts on a white background, whereas the preferred construction embodies a black or apaque disc body with the master characters and marks formed as transparencies thereon;

FIGS. 3, 4 and 5 are diagrammatic views on an enlarged scale, showing the selector prism and the relative positions thereof for projecting characters from different fonts on the disc and for projecting characters not carried on the matrix disc;

FIG. 6 is a schematic representation of a lens of the optical system of the machine, showing the arrangement of the character field with respect to the optical system and selector prism as shown in FIGS. 3–5;

FIG. 7 is a view, on a scale somewhat reduced from actual size, of a typical matrix disc as provided by the invention;

FIG. 8 is a view showing the manner in which an artist constructs the original characters to be placed on the matrix disc;

FIG. 9 is a view showing the photographic negative reproduction which is made on a reduced scale from a layout as shown in FIG. 8;

FIG. 10 is a view showing one of the width code master photographic negatives which is employed in manufacturing a matrix disc;

FIG. 11 is a view showing a portion of the apparatus on which the various character negatives and code negatives, of the type shown in FIGS. 9 and 10, are assembled

in separate radial zones to make up a complete arrangement of characters for a plurality of fonts together with the width code markings and selector code markings therefore; and

FIG. 12 is a view of a segment of a positive master plate which is produced from the assembly shown in FIG. 11, and which in turn is employed for photographic reproduction in making master character discs as shown in FIG. 7.

Referring to the drawings, which illustrate a preferred embodiment of the present invention, and referring particularly to FIGS. 1–6, the apparatus receives the character matrix which is in the form of a rotating disc **10**, such that the disc rotates across the optical system. The disc preferably is an opaque member (see FIG. 7) having portions thereof suitably formed as master characters which are light transmitting parts as will be described, and which is rotated about an axis **11**. There are at least two separate font rows of such characters, designated **12** and **14** (FIG. 2). It will be noted that these rows are in separate concentric zones, of different radii in the case of a disc carrier, and that corresponding characters as between the different fonts are arranged along the same radius line.

Also arranged in accordance with the spacing of the characters are selection code address markings, indicated generally at **15**. These markings are preferably of the type disclosed in the U.S. Patent No. 3,059,219 issued to the assignee of this application. These marks are in the form of light transmitting segments or slits arranged in a predetermined pattern in one or the other of two circular rows to cooperate with one or the other of the selection code reading photocells **17** and **18**, and light passed from the corresponding bulbs **19** falls on one or the other of these photocells to produce a discrete identifying code in the form of electrical pulses transmitted to the selector circuits, indicated generally at **20**. There is a full address pattern of marks for each different character (but not each font), and the pattern is within the same radial "zone" of the disc as the characters to which it pertains.

An identifying code is set up in the apparatus from a keyboard or a control tape, or other suitable register means which will form a coded representation of selected characters in the proper sequence to make up lines of composition. For purposes of illustration this is shown as a character selector **22** which transmits through the connecting line or cable **23** the character selection code to the circuits **20**. When the identifying code on the matrix corresponds to the selection code, a control pulse is transmitted through line **25** to the spark control unit **27**. The details of this system are explained fully in said Patent No. 3,059,219. Other suitable circuits and apparatus may be used to perform the same function.

The control unit **27** is arranged to produce a substantially instantaneous, high intensity flash of light, as by causing a spark to be produced in the gap between a pair of electrodes **28**. This projects a beam of light along the optical path **30**, through the selected character on disc **10**, through a size controlling and focusing optical lens system **32**, and produces a character image of predetermined size on photosensitive material, such as a photographic film or paper, which may be mounted on a carriage shown schematically as the drum **33**. A suitable carriage construction is shown in detail in U.S. Patent No. 3,183,806. Means are provided to produce relative movement between the film and the optical path along which the images are projected to allot the necessary space from each character in accordance with its relative width (with respect to the other characters) and the optical size change produced by the lens system **32**. For example, the film **33** may be stepped in the direction of arrow **34** as projection of each character image in accordance with the necessary space for the recorded character image.

It is necessary, of course, to vary the relative spacing movement between the optical system and the film in accordance with the different widths of the successive projected character images. Each character has a characteristic width value relative to other characters in the same font, and this relative width value may provide the multiplicand for a computing operation in which the multiplier is determined by the optical size change which is in turn dependent of the setting upon the optical system **32**. Details of such a space computing arrangement are described in detail in U.S. Patent No. 3,141,395. The product of this computation represents the actual space along the line, in the direction of composition, to be alloted to each successively projected character image.

The aforementioned relative space information for each character on the disc is most conveniently provided by width code, indicated by the general reference numeral **35**, also on the disc or character carrier. Thus, in each "radial zone" on the character disc **10** there is also a characteristic relative space code for each of the characters in different fonts in that radial zone. In a suitable form of apparatus, illustrated here, a six digit binary space code is used to designate relative width information for the characters, thus providing a range of relative space increments from one to sixty-four space units. Accordingly, there are in each radial zone twelve different positions in which space code dot information may appear, with six of these code places or positions providing the spacing information for the character in one font, and the other six providing the information for the character in the other font within that radial zone.

In a preferred arrangement, the width code is interleaved, that is, counting from the code mark closest to the center of the disc the odd numbered marks provide a code for one of the characters in its radial zone, and the even numbered marks provide the code for the other character. Such an arrangement permits the use of six pickup photocells spaced apart by a distance equal to the spacing between the first and third marks, for example, and these six photocells can be shifted along a path radially of the disc to align them with the code for the inner or outer character, depending on which font circle is selected. Obviously, if more than two font circles, another arrangement of this kind could be made for the necessary width codes.

In referring to radial zones, it will be noted that any two characters and their corresponding selection code are somewhat offset in a circumferential direction, and the reason for this is that the selection code must be completely scanned for possible coincidence before the character is flashed. As explained in said Patent No. 3,059,219, the last mark controls the actual flashing of the light source which illuminates the selected character, and then the two larger marks immediately following function as a reset to prepare the selector circuits for selection of the next character.

In order to leave sufficient room for the physical mounting of the various pickup devices, the width codes are located on the opposite side of the axis of rotation of the disc from the characters to which they pertain. This arrangement is apparent from FIGS. 7 and 12. Hence, it should be understood in referring to any given "radial zone," this terminology is intended to include some slight offset from a true radius line, and is intended also to encompass the set of width code marks which is on a radius line diammetrically across the disc from the corresponding characters.

The space code dots preferably are also formed as light transmitting openings in the disc **10**, and at the same time that the spark unit **27** is energized to illuminate a selected character, a flash control unit **36** is energized to flash an elongated lamp or flash tube **37** providing an instantaneous flash of light through the space code openings in the disc corresponding to the selected character. On the opposite side of the disc there is mounted a bank or set of six code reading photocells

38. When tube 37 flashes, the light will pass to those photocells opposite which there is an opening at the time of the flash, and the resultant output pulses from one or more of the photocells provide the space code information.

These photocells are suitably mounted in a movable carrier 39, and have connections to a cable which includes six leads from the photocells. Thus, when a given font is selected the carrier 39 will be moved appropriately to provide the corresponding relative space data for the character selected.

A lens of the optical system 32 is shown in FIG. 6, with the vertical and horizontal transverse axes of the system indicated appropriately by the *x*—*x* and *y*—*y* lines. The character field is indicated by the dotted lines 40, and it will be noted that a base line 42 across the field is coincidental with the *x*—*x* axis, so that descenders will fall below this axis. The left side line of the character field coincides with the *y*—*y* axis, and thus enlargement or reduction of the character images by the optical system, with respect to the master characters on the matrix, will not change the base and side lines in the system, and the left side or reference line of the character field will always occupy the same position in the optical system with magnification preceding away from this line.

Selection between the font zones 12 and 14 is provided by directing the flash of light to the desired character in the desired font zone, and redirecting the image-bearing light beam thus formed along the common optical axis or path 30, which is the path through the lens system 32. This is accomplished by means of reflecting means such as an elongated prism 45 which has opposite end faces parallel to each other, and preferably at 45° to the front and rear thereof. This arrangement is seen most clearly in FIG. 1. The prism is mounted such that it will rotate about the center of the optical path 30, which is also the central or longitudinal axis of the lens system 32, and this axis intersects the center of one end face of the prism, as indicated in FIGS. 3 and 4. The other face of the prism thus swings in an arc between the two fonts on the matrix, and preferably in the position where the character is vertical, as shown in FIG. 2, such that a character selected from either font will occupy the same precise vertical position.

The length of the light passing through the prism is the same for each position, and due to the nature of the reflecting surfaces, a character from either font appears centered and properly erect on the optical path. This is indicated by the dotted lines in FIGS. 3 and 4 which denote the reference side and bottom of the character field, and it will be seen that the character field is the same in both cases. Thus in FIG. 3 the character *a* is selected from the font sector 14, and in FIG. 4 *a* is selected from the font sector 12, and in each case the character image appears in the same line on the optical path with the image being thence transmitted through the lens system.

In order to provide a simplified and essentially uniform light source, a further prism 46, hereinafter referred to as the light directing prism, is mounted on the opposite side of matrix 10. This prism is of the same construction as prism 45, and is mounted reversely. It receives the light from the source 28, and directs this light through one or the other of the font sectors. Accordingly, the prism 46 is mounted to swing about the same axis 30 as the prism 45, and the flash of light will pass only through the desired font. Therefore, the same light source is used for all fonts, and it may be mounted stationary, considerably simplifying the construction and controls of the light source.

Also, it may be desirable to provide for pi characters which do not appear in the fonts on the disc. A third position of the prisms 45 and 46 can be provided to cooperate with a pi character plate, indicated generally at 48 in FIG. 5, which is mounted in a position beyond and aligned with the periphery of disc 10. Further details of this arrangement are described in said Patent No. 3,099,945.

The present invention also includes a novel method of manufacturing character matrix discs, and this method is best understood by reference to FIGS. 7–12. The characters are first prepared and laid out on a rather large scale by an artist who forms the characters in black upon a white background copyboard 50, as shown in FIG. 8. In a preferred arrangement there are two rows of markers indicated at 52 and 53 which can be arranged to form the selection code for the characters being prepared. In the example these characters are lower case *a* in bold and italic.

There are provisions for eight marks in each of the positions 52 and 53, the first seven of these marks, counting from the right, being smaller, and being the actual marks constituting the selection code, while the final marks 54 are the reset marks and appear in the same position for each character. As an example, the code for lower case *a* has been indicated as six dark lines in the first six positions in row 53, and a line in the seventh position in row 52. The other possible positions, not used in the example, are shown in dotted outline.

These marks may be formed by fastening strips of black paper to the white background, or they may be formed as permanent parts of the copyboard which can be covered selectively with shutters, whereby the desired code pattern can be set up by manipulation of the shutters. The last or seventh position marks in each of the rows are precisely arranged with respect to the characters, since the marks in this position on the ultimate matrix disc control the flashing of the light source to photograph the character. Also, at the bottom of the board there is a black dot 55 which is an alignment mark, for purposes to be described.

The characters are carefully laid out on the copyboard, for example by drawing them in black, or by cutting them from strips of black paper and fastening them to the copyboard. In practice this is done on a rather large scale, with the size of the characters being in the range of three to four inches square. This layout on the copyboard 50 is then photographed, and substantially reduced photographically, to produce the resultant photographic negative which is shown in FIG. 9.

This negative is usually formed on photographic paper such that the background is opaque, preferably black, and the characters and selection code marks are white. The locating mark 55 likewise appears as a white dot.

This negative is then placed in a suitable jig and precisely located, then cut to the configuration shown in FIG. 9, at the same time forming reference or index holes 57 at the top and bottom of the negative strip. The foregoing operation is followed for each pair of characters in the two font circles to be placed on the matrix disc.

Similarly, a long and somewhat tapered width code negative 60 is formed as shown in FIG. 10 with a black background and twelve white marks 62 formed thereon. A number of these are prepared in the same amount as there are characters in a font circle, and it will be recalled that the width code for the two corresponding characters will be constructed as an interleaved code from the twelve possible mark positions 62. A simple operation for this purpose involves the preparation of all of the code mark strips 60 in the same fashion, whereupon the codes are then formed by using a suitable dark ink or opaquing material to cover up those white mark areas in which a code mark should not appear. Similarly, index holes or perforations 64 are formed in each of the space code strips as shown in FIG. 10.

Next, the character and selection code strips and the width code strips are fastened to a relatively large easel

65 or copy table, having a carefully constructed flat surface, and being provided with appropriate locating pins 66. There are rows of these pins as shown in FIG. 11 arranged to fit the index perforations 57 and 64. The negatives are thus mounted on a plane surface as shown in FIG. 11, with the width code negative strip on the opposite part of the radial zone from the character and selection code negative. The positioning of additional negative strips is shown in dotted lines. It will be understood that the actual size of the easel 65 is substantially greater than that shown in FIG. 11, since FIGS. 9 and 10 show approximately the full size of negatives actually used.

Once all of the negatives are assembled on the easel, this assembly is photographed at a substantial reduction, and a positive glassmaster plate 70 is produced as shown in FIG. 12. Only a portion of the width and selection codes and a few of the characters are shown. It will be understood however that the actual master plate 70 is a complete one, and includes the dots 72 which are used in alignment procedures later on.

The plate 70 is preferably the same size as desired for the character matrix discs, and these discs are formed by using glass plates provided with a photographic emulsion, and making a contact exposure on such plates from the master plate 70, the development resulting in a matrix disc which is a negative as shown in FIG. 7. For reference purposes, the arrows 75 indicate on the matrix disc shown in FIG. 7 the lower case *a* characters and their width codes, which were used in the examples in FIGS. 8–12. The matrix plate therefore has an opaque background and the characters in the font circles, as well as the selection code marks and the width code marks, are formed as transparent areas through which beams of light can be transmitted. The matrix disc shown in FIG. 7 is an actual reproduction of a matrix disc made in accordance with the invention, reduced in scale by about one-third in order to fit within the required sheet dimensions.

After the plate has been developed it is ready for mounting in a hub, and this operation requires that the center of the font circles be established so that the axis of rotation is precisely located. For this purpose the reproduction of the dots 72 on the plate will cause small alignment dots (not shown) to appear clearly on the print made from the master plate. These alignment dots are used to locate the center of the font circles, and at this position a hub is mounted whereby the font circles will rotate true past the optical apparatus of the phototypesetting margin. Once the hub is properly mounted, then the matrix plate can be cut to a suitable diameter if desired so that it is balanced and rotates with minimum vibration at the required speeds. For example one form of apparatus using these matrix discs employs a disc rotation speed of about 2400 r.p.m.

While the method herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise method, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

I claim:

1. The method of manufacturing a character matrix disc for use in a phototypesetting machine comprising the steps of preparing a plurality of large scale character and selection code layouts, each layout incorporating like characters in different fonts and selection code marks common to said like characters formed on the layout with one of such marks being precisely located with respect to each of the like characters, photographing each of said layouts at a substantial reduction to reproduce the layouts in an intermediate form, mounting said intermediate form layouts in side by side relation as segments of a circular band and in the predetermined desired succession of appearance of characters on an indexed easel member to assemble all of the characters for each of the plural fonts in a common font circle and their associated selection code marks in another circle, all of said circles being concentric and in a common plane, and photographically producing from such assemblage of intermediate layout forms at least one character matrix disc wherein the matrix disc is formed with an opaque background and the characters and selection code marks are formed as transparent portions of the matrix disc.

2. The method of manufacturing a character matrix disc for use in a phototypesetting machine comprising the steps of preparing a plurality of large scale layouts, each layout incorporating like characters in different fonts and discrete address selection code marks formed on the layout with one of such marks being precisely located with respect to each of the like characters in that layout, photographing each of said layouts at a substantial reduction to reproduce the layouts in an intermediate form, shaping such intermediate form reproductions to a common configuration which is a predetermined segment of a circular band encompassing the desired font circles and corresponding selection code marks, mounting said intermediate form layouts in side by side relation and in the predetermined desired succession of appearance of characters on an indexed easel member to assemble all of the characters for each font in a separate circle and their associated selection code marks in another circle, all of said circles being concentric and in a common plane, photographing such assemblage of intermediate layout forms with a further optical reduction to produce a master character plate incorporating all of the desired characters in the fonts, and then reproducing from said master character plate at least one character matrix disc as a negative reproduction thereof whereby the matrix plate is formed with an opaque background and the characters and selection code marks are formed as transparent portions of the matrix disc.

References Cited

UNITED STATES PATENTS

2,714,841	8/1955	Demer et al.	95—4.5
2,715,862	8/1955	Moyroud et al.	95—4.5
3,204,520	9/1965	Grube	96—46

NORMAN G. TORCHIN, *Primary Examiner.*

R. H. SMITH, *Assistant Examiner.*