

Dec. 4, 1945.

R. B. JOHNSON

2,390,439

OPTICAL RECORD INTERPRETER

Filed Feb. 2, 1943

4 Sheets-Sheet 1

FIG. 1.

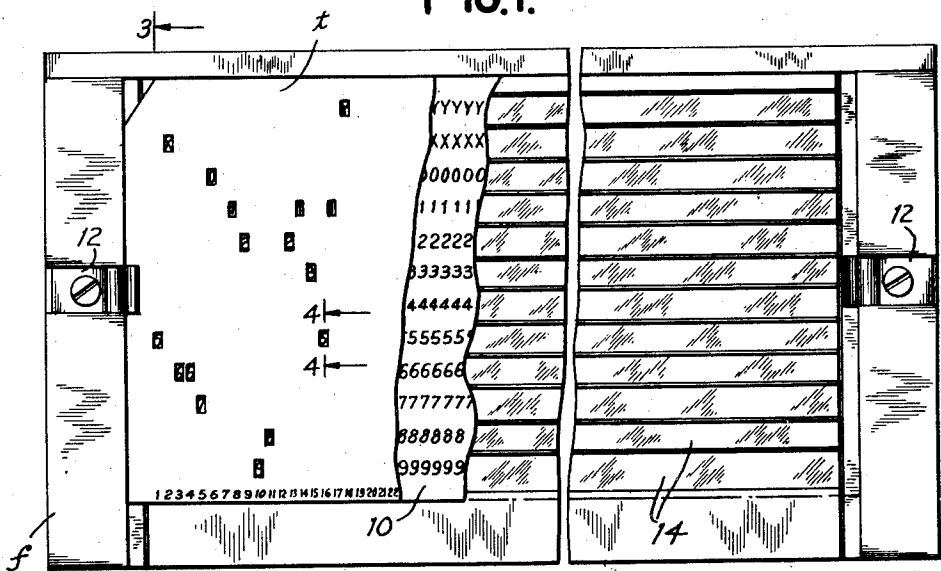


FIG. 2.

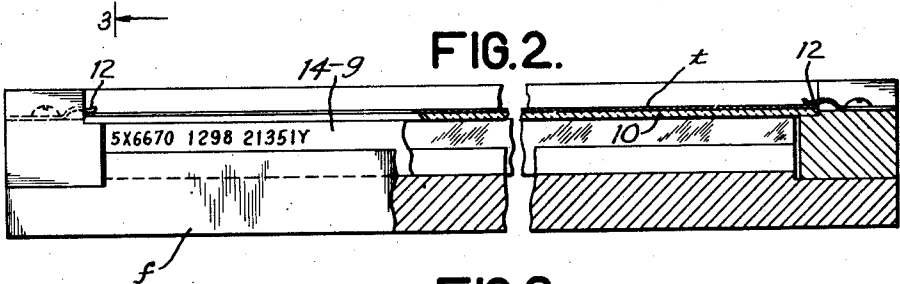


FIG. 3.

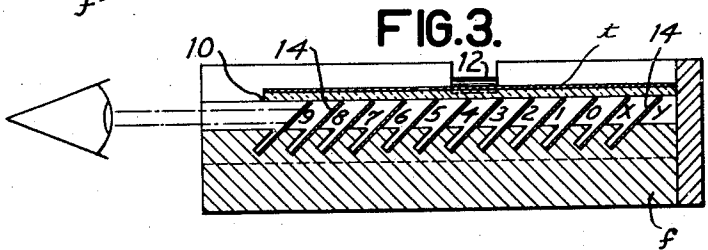
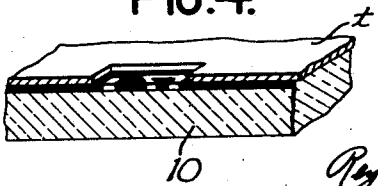


FIG. 4.



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4 Sheets-Sheet 2

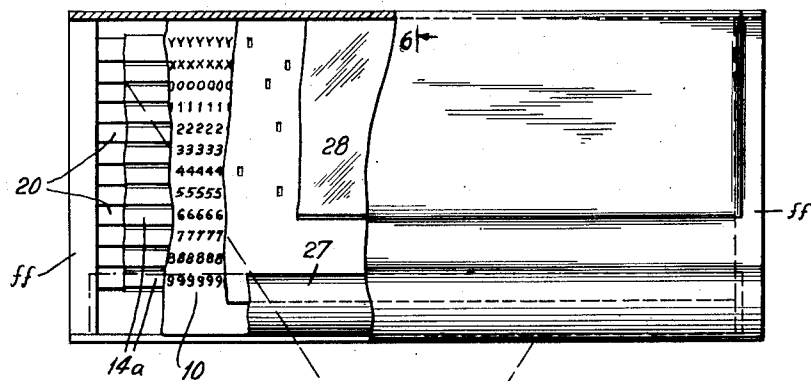


FIG. 5.

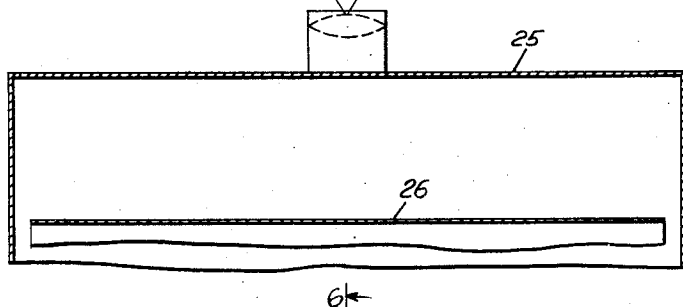
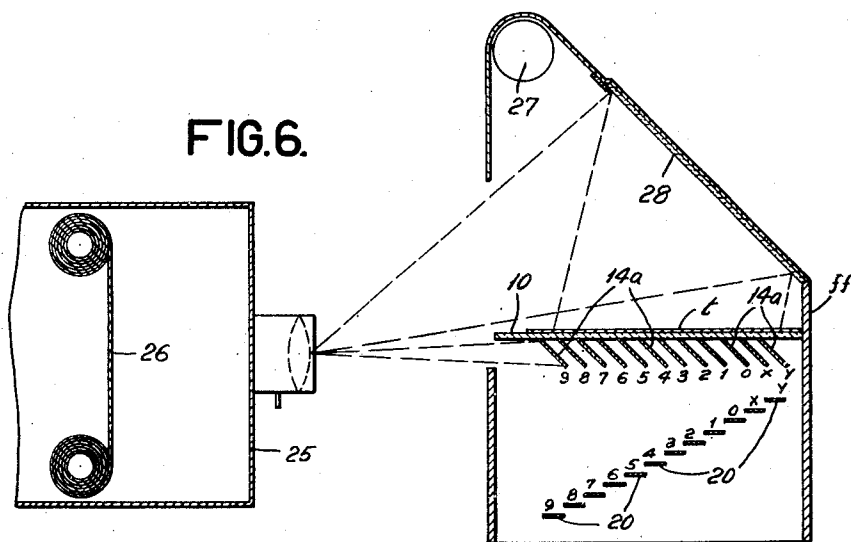


FIG. 6.



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4 Sheets-Sheet 3

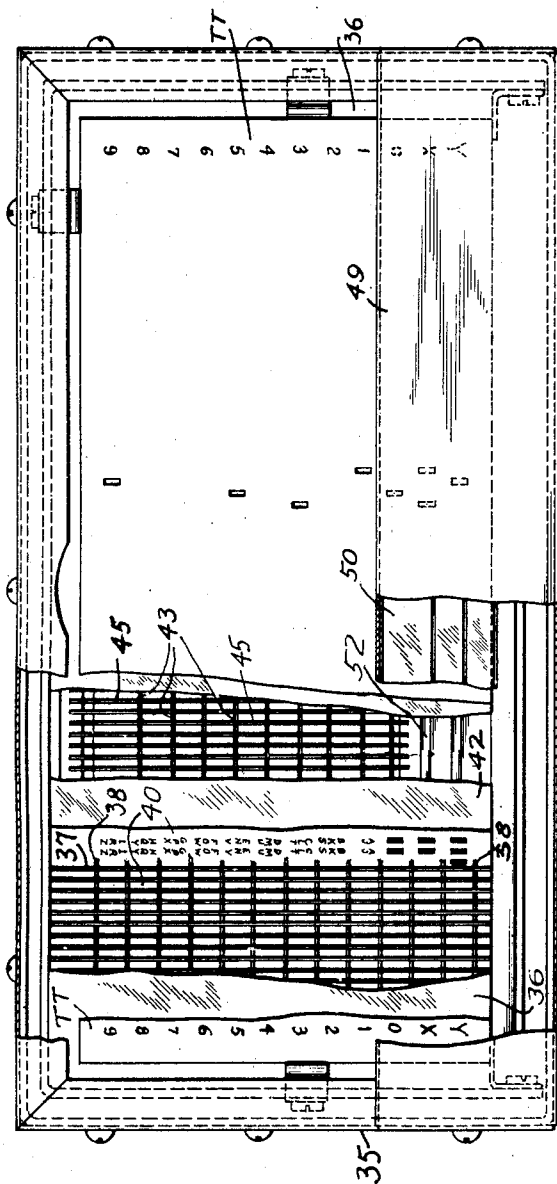


FIG. 7.

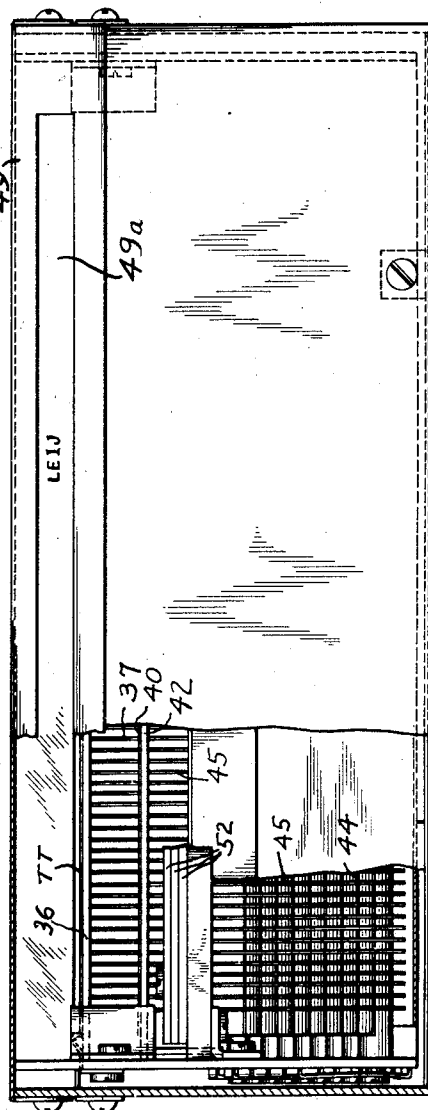


FIG. 8.

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FIG.10.

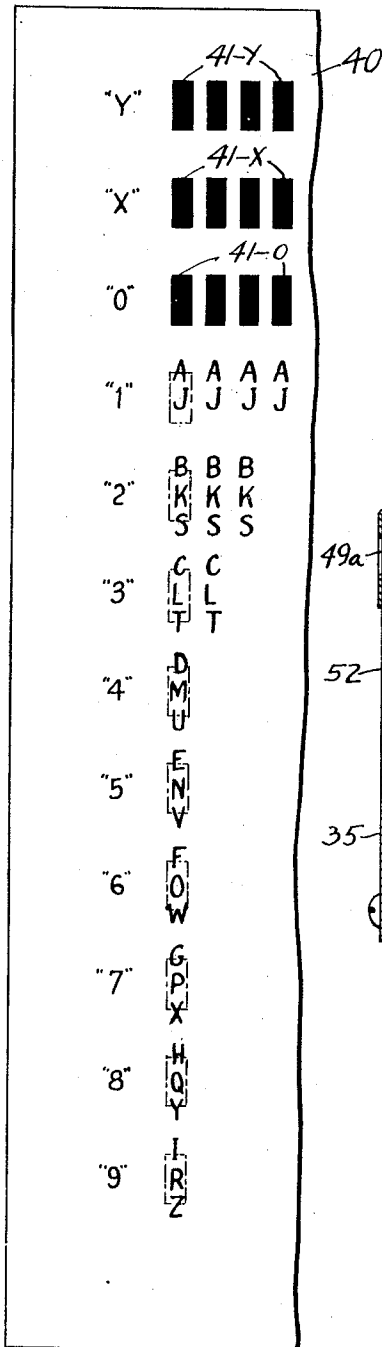
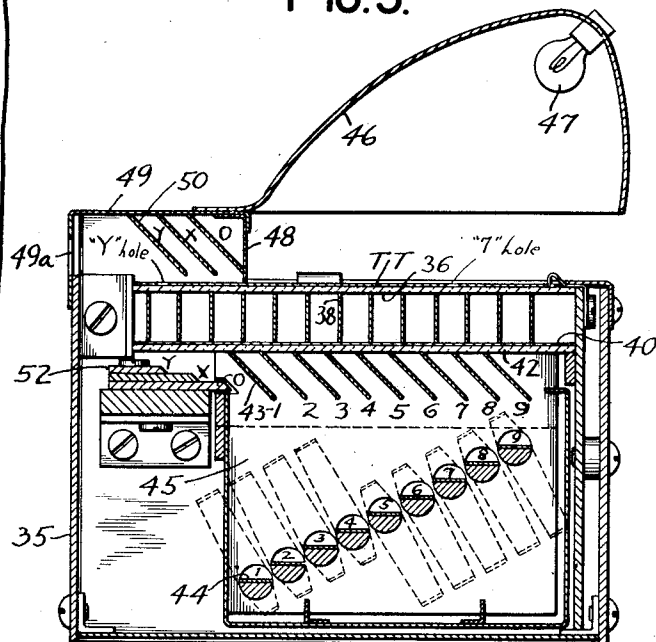


FIG. 9.



UNITED STATES PATENT OFFICE

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OPTICAL RECORD INTERPRETER

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Application February 2, 1943, Serial No. 474,441

9 Claims. (Cl. 88—14)

This invention concerns optical reading, record-
ing, or interpreting means for records.

Such records bear coded designations of data. Each record has columns of differential index or designation positions selectively perforated to designate data by a suitable code. Numeric data are here designated by the Hollerith single-point code; i. e. a single perforation in a column designates a digit. Alphabetic data are designated here by the combinational two-point code; i. e., a combination of two perforations in a column designates a letter. According to present practice, there are twelve positions in a column of a record. These are termed here the positions 9, 8, 7—1, 0, X, and Y. Thus, digits 9 to 0 are represented by a perforation in one of the 9 to 0 positions, respectively. The X and Y perforations may be perforated to provide control designations. Alphabetic items are designated by perforations in one of the 9 to 1 positions of columns combined with perforations in one of the 0, X, and Y positions. Obviously, other designation codes may be used, the record columns may have more or less index positions, and numbers as well as other characters than alphabetic characters may be designated in a combinational hole code. Further, it is evident that graphic points instead of perforations may be used as code marks. The essential thing as far as this invention is concerned is that the code marks and the unmarked surface of the record have contrasting light-affecting properties.

The conventional significance of code marks on a record is not apparent. Even a trained operator cannot immediately understand the conventional significance of the code marks. Accordingly, heretofore, a printed interpretation of the code marks has often been placed on the record. Further, the code marks on records have been used to control the printing of the represented characters on a remote sheet, for accounting purposes. In either case, whether the characters be recorded on the record itself or on a remote sheet, such recording may be referred to as an interpretation of the coded data.

With this explanation in mind, the purport of the following objects will be clear.

An object of the invention is to provide an optical interpretation of the code marks on a record, whereby such interpretation will be visually displayed to an observer.

Another object of the invention is to provide improved optical means for providing a graphic interpretation of code marks on a record.

Another object is to provide improved optical

reading and interpreting means for code marks on a record.

Another object is to provide improved optical means for affording a single-line interpretation of code marks which are scattered among different rows or lines and columns of a record.

Another object is to provide a single-line interpretation without parallax error.

Another object is to prevent parallax error by bringing images of characters, codally designated on a record, into a common focal plane. Not only will this avoid parallax, but it will also eliminate eye fatigue if the interpretation is to be viewed by the eye and will also enable a camera to be sharply focused on all images, and will further, enable the images to be filmed with equal sharpness.

A main object of the invention is to provide means for optically interpreting combinational designations on a record. Such designations may represent alphabetic or other data.

An incidental object is to provide means for optically displaying the face of a record together with the optical interpretation of code marks on the record.

Specifically, it is an object to provide an optical interpreting system in which parallel reflecting elements display character images selected by code marks in different rows of a record, with at least those elements in front of any other being partially transparent to enable images behind the front element to be viewed.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of example, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

Three embodiments of the invention will be described. The first embodiment is a simple, novel form of numerical data interpreter. The second embodiment is the preferred form of numerical data interpreter which provides for elimination of parallax. The third embodiment is an optical interpreter for combinational code marks, specifically, an alphabetic interpreter. The second embodiment contains the inventive features of the first embodiment, and the third embodiment contains the inventive features of the first and second embodiments.

In the drawings:

Fig. 1 is a plan view, with parts broken away, of the first embodiment.

Fig. 2 is a front, partly sectioned, view of the first embodiment.

Fig. 3 is a section on lines 3—3 of Fig. 1.

Fig. 4 is a section, on a larger scale, taken along lines 4—4 of Fig. 1.

Fig. 5 is a plan view of the second embodiment, some of the parts being shown as broken away.

Fig. 6 is a section on lines 6—6 of Fig. 5.

Fig. 7 is a plan view, with some parts broken away, of the third embodiment.

Fig. 8 is a front view, also with parts broken away, of the third embodiment.

Fig. 9 is a vertical side section through the third embodiment, and

Fig. 10 shows a fragment of a pattern plate used in the third embodiment, the dot and dash lines forming no part of the pattern plate but indicating the relation of perforations in a card column to a column of the pattern plate.

Hereinafter, it is to be understood that in referring to the optical means as displaying or bringing characters into view, it is meant that such display is to the eye of an observer or to the objective of a camera or to some other image-perceiving means which may, itself be an optical element for modifying the direction of the image. The term objective is to be taken broadly as applying either to the objective of a camera, the eye of an observer, or another optical element.

The first embodiment (Figs. 1 to 3 and 4)

The card *t* has singly perforated columns. When such card is to be interpreted, it is inserted in position on a frame *f*. In this position, the card is superimposed on a flat member 10 suitably mounted on the frame *f* in fixed position. The member 10 which may be a film or a glass plate is provided with columns and rows of character pattern-bearing areas. Preferably, the character patterns are transparent or translucent and the surface of the member 10 is otherwise opaque, so that light may pass through the character patterns only. For simplicity of illustration, the character patterns are shown in all figures, except Fig. 4, as opaque against a seemingly transparent background, but it is to be understood that in this case, the reverse is actually true; that is, the background is opaque and the characters are transparent. The character patterns are arranged in columns and rows similarly to the arrangement of index positions of the record. Each column of character patterns is similar to the other columns and includes characters 9, 8—0, X, and Y, and the like patterns of the several columns are aligned in a common row perpendicular to the disposition of the columns. When the record card is superimposed on the member 10, each index position of the card registers with a character pattern on the member. Thus, each column of index positions on the card registers with a column of character patterns.

The card *t* which it is desired to interpret is inserted in frame *f* and there rests upon pattern plate 10. In practice, a diffusing sheet may be superimposed on the upper surface of the plate 10 or the character patterns themselves may be translucent to prevent visibility therethrough of objects above the card. When the card is properly located, it fits closely between the sides of the frame and abuts the back wall of the frame. Means such as clips 12 may be provided to hold the inserted card firmly against the top surface of plate 10.

Twelve mirrors generally designated 14 are fixed in the frame. Each mirror is below a row of character patterns on plate 10 and has an effective length equal to the length of the row.

Each mirror 14 may further be identified by appending the symbol of its related pattern row to the common designation 14; e. g., mirror 14—2 underlies the "2" pattern row on plate 10. The mirrors 14 are disposed parallel to each other and lie at an angle of 45 degrees to plate 10. The mirrors 14 are so constructed as to be partially light transmitting and partially light reflecting in various degrees depending on their positions with respect to the eye in front of the frame. Thus, the rear or right hand mirror 14 (as viewed in Fig. 3) may be completely light reflecting and its light transmitting characteristic may be substantially zero. The next mirror will be a light transmitting as well as light reflecting mirror. The third mirror from the right will have a greater light transmitting potentiality and so on to the first or front mirror 14 which will have maximum light transmitting and less light reflecting potentiality.

When a card *t* is superimposed on pattern plate 10, the code holes on the card expose the character patterns underneath to light. The other character patterns, not lying underneath holes in the card, are masked and concealed by the card. The image of the illuminated, exposed character pattern will be received by the particular mirror 14 underneath and be reflected by the mirror towards an objective or the eye. The images of all such character patterns exposed to light through code holes in a plurality of columns of the card will be visible, from in front of mirrors 14, in alignment along a single row. Thus, the first column of the card has a perforation in the "5" index position, designating digit 5. This perforation exposes the "5" character pattern on the first column of plate 10. The image of this character pattern "5" appears in mirror 14—5 which reflects the image forwardly. Since mirrors 14—6, 7, 8 and 9 are partially transparent, the image will be in view from in front of mirror 14—9. In card column 2, the "X" index position is perforated, exposing the "X" character pattern in the second column of plate 10. The image of this "X" pattern is received by mirror 14—X which reflects the image through the mirrors 14—0 to 14—9, so that the image of the "X" pattern is visible from in front of mirror 14—9 alongside the image of character pattern "5" derived from the first card column. Similarly, images of the character patterns of the other columns and rows upon plate 10 which are exposed through code perforations in the card are displayed alongside one another to an objective in front of mirror 14—9. Thus, Fig. 2 shows the row of displayed character images derived from the exposed character patterns underlying the perforations in columns 1 to 18. It should be noted that columns 7 and 12 of the card are unpunched, accounting for the spaces between the groups of displayed images shown in Fig. 2. It may be understood now why it is preferred to progressively increase the light transmitting characteristics of the mirrors in accordance with their distance from the rear of the frame. No light need be transmitted through mirror 14—Y. Images derived only from one row, the "Y" row, need be seen through mirror 14—X, images from two rows, the "X" and "Y" rows, must be seen through mirror 14—0, and so on. Conversely, mirrors, 14—Y to 14—9 have progressively decreasing light reflecting potentialities. In this manner, by graduating the light reflecting and light transmitting potentialities of the mirrors 14, the brilliance of the images displayed to an

objective in front of mirror 14-9 and derived from different pattern rows is substantially equalized. The characters thus displayed on mirrors 14 comprise an optical interpretation of the coded designations perforated in the card *t*. Such interpretation may be viewed by the eye or photographed on a film.

In the simple form of optical interpreter described above, the different mirrors display images at differential distances from an objective. The effort of the eye to view such images concurrently may result in eye fatigue. Further, parallax errors may arise unless the sighting position is substantially directly in front of the group of character pattern columns from different points of which the images are derived. If the sighting position is too far to one side of the correct sighting position, some of the images, displayed by the different mirrors, may appear superimposed or in reverse order; that is, parallax error will result. The basic reason why such parallax errors may arise in connection with the device shown in Figs. 1 to 3 is that the images are displayed at different distances from a sighting point; that is, at different focal points. Such parallax errors, as well as eye fatigue, are eliminated by the second form of the invention which will now be described.

The second embodiment (Figs. 4, 5, and 6)

In general, the second embodiment provides for display of images, derived from different rows of character patterns, within a common focal plane. Such common plane will extend parallel to the direction of a pattern row and be perpendicular to the plane of the pattern plate. With all the images, even though derived from character patterns at different distances from an objective, brought to positions within a common focal plane, it follows that the images will be displayed in their correct order, that eye strain will be avoided, and that a camera may be properly focused on the images and film the images with equal sharpness and in correct order.

An incidental feature of the second embodiment comprises means to display to an objective the face of the record at the same time that the optical interpretation of data on the record is displayed to the objective. Thus, the face of the record and its interpretation may be photographed in juxtaposition on a film, providing a check against the interpretation and providing a photographed record of other data, than the coded data, which may be present on the record.

In detail, referring to Figs. 5 and 6, a card *t* to be interpreted is placed, as in the first form, in position within a frame *f* and rests on the character pattern plate 10 which is the same as the character pattern plate of the embodiment shown in Figs. 1 to 4. Below each row of character patterns and extending along the full length of the row is one of a set of twelve mirrors 14*a*. Mirrors 14*a* are disposed parallel to one another at an inclination of 45° to pattern plate 10, but it will be noted that such inclination is opposite to the inclination of the mirrors 14 of the device shown in Figs. 1 to 3. Moreover, all the mirrors 14*a*, including the right hand one, are partially light transmitting as well as partially light reflecting mirrors. Below each of the twelve mirrors 14*a*, frame *ff* carries a companion mirror 20, of a set of twelve horizontal mirrors 20, which is of the same length as the mirror 14*a*. The mirrors 20 may be simple light reflecting mirrors. Each of the mirrors 14*a* and 20 may be identified by appending to their common reference num-

bers the indication of the row of character patterns below which they are positioned; e. g., mirror 14*a*-X relates to the row of character patterns "X" and the mirror 20-X relates to the same row of character patterns.

When a character pattern is exposed, light passes therethrough and through the translucent mirror 14*a* underneath the pattern. The light thus passed through forms an image of the pattern in the companion mirror 20. This image is reflected by the mirror 20 upwardly to the front of the companion mirror 14*a* which, in turn, reflects the image forwardly. Since all the mirrors 14*a* are partially transparent, such image displayed by a mirror 14*a* will be exposed to a viewing device which is here shown as the objective of a camera 25. For example, if a pattern Y is exposed, the light passing therethrough and through mirror 14*a*-Y causes an image to form in mirror 20-Y. Mirror 20-Y reflects the image to the front of mirror 14*a*-Y and the latter mirror reflects the image to the objective of the camera.

As shown in Fig. 6, mirrors 20-9 to 20-Y are at differential distances from companion mirrors 14*a*. The differential distances of the mirrors 20 from companion mirrors 14*a* are inversely proportional to the differential distances of the character rows from the objective. Thus, mirrors 14*a*-Y and 20-Y are spaced apart the least while mirrors 14*a*-9 and 20-9 are spaced apart the most. By such differential spacing of companion mirrors, the optical paths of exposed characters, in different rows of the pattern plate, to an objective are equalized. Stated differently, the optical illusion is given that all character images are in a common plane. Regardless of the laterally offset position of columns of the pattern plate with respect to the objective, the differential optical system displays the images of characters from these columns in one common plane. Since virtual images will be formed, such plane will be behind the farthest mirror 14*a*-Y. Further, the disposition of the mirrors 14*a* and 20 is such that the common image plane will be perpendicular to the pattern plate and parallel to the direction in which a character pattern row extends. It follows, since all the images are in a common plane, that there is no possibility of parallax error and the images will be shown in the same, correct order in a single line along said plane as the order of appearance of the columns which contain the optically interpreted code marks. Further, since all the images are displayed in a common plane, eye fatigue, when visual observation is to be made, is avoided. Still further, with all the character images in one plane, a camera may be sharply focused thereon and all the images filmed with equal brilliance.

The foregoing has described the second embodiment which is the preferred form of numerical interpreter.

A camera 25 is diagrammatically shown in Figs. 5 and 6 to photograph the displayed images, so that film 26 when developed will show an interpretation of the code marks found on the record card.

The device shown in Figs. 5 and 6 also provides for photographing the face of the card being interpreted as well as photographing the optical interpretation of the coded designations. Thus, the film, after development, will show the card and its interpretation adjacent to each other. In Figs. 5 and 6, an elongated lamp 27 serves as the source of light. The lamp may be provided with a suit-

able glazed or translucent front surface to cast an even and dispersed light upon the card. The frame *ff* is provided with a mirror 28 which mirrors the lighted face of the card and reflects the image thereof towards the camera. Thus, the camera will photograph the face of the card and its optical interpretation upon adjacent portions of the film.

Suitable known means may be provided to feed the film and trip the shutter of the camera.

The third embodiment (Figs. 7 to 10)

The third embodiment of the invention affords means whereby items designated by a combination of markings on a record may be optically interpreted. Such combinationally designated items may be alphabetic characters. In the example shown here, the alphabetic characters are designated by a combination of two perforations. Each letter is designated by two perforations in a card column. One perforation of the combination pair is in one of the 0, X, and Y index positions. The other perforation of the combination pair is in one of the positions 1 to 9. The 0, X, and Y index positions may be considered as one zone of index positions, and positions 1 to 9 may be regarded as the other zone of index positions. It will be understood that the principle of the invention is applicable to other code combinations and to other characters than letters. According to the selected code, as will be understood from Figs. 7 to 10, characters A to I are respectively represented by a common Y hole combined with individual holes 1 to 9. Characters J to R are respectively designated by an X hole combined individually with holes 1 to 9. Characters S to Z are designated by a 0 hole plus one of the holes 2 to 9, respectively.

The alphabetic optical interpreting device comprises a suitable frame and casing generally designated 35. The card *TT* to be interpreted is placed on top of a plate 36 of translucent material. This plate is suitably confined in the frame and rests on top of a honeycomb structure. The honeycomb comprises eighty-one strips 37 extending in the direction of the card columns and spaced apart similarly to the spacing of the card columns. Crossing the strips 37, at right angles thereto, are thirteen strips 38, spaced apart similarly to the spacing of the rows of index positions of the card. The honeycomb structure comprised of strips 37 and 38 is suitably confined in the frame. Underlying the honeycomb structure is a character pattern plate or film 40. Film 40 is opaque except where the characters and the exposing spots 41—0, X, and Y appear. The film 40 lies flat on top of a glass plate 42. Underneath the glass plate 42, the frame supports nine mirrors 43 disposed at angles of forty five degrees. The mirrors 43 are similar to mirrors 14a of Fig. 6, being partially transparent and partially reflecting. Each mirror 43 underlies one of the index positions 1 to 9 of a card when the card is in position to be interpreted. For convenience, the mirrors 43 may be distinguished by designating them with the index positions to which they relate. Below mirrors 43, the frame supports nine horizontal mirrors 44 similar to mirrors 20 of Fig. 6. Mirrors 44 also may be designated with reference to index positions 1 to 9 to which they relate. The companion mirrors 43 and 44 related to the same index position are differentially distant from each other in the same manner as the mirrors 14a and 20 of Fig. 6. Vertical baffle plates 45 are mounted inside the de-

vice. These baffle plates are spaced apart similarly to the spacing of strips 37 of the honeycomb. Suitably attached to the device is a light reflector 46 carrying a lamp 47. The portion of the card having index positions 1 to 9 is illuminated by the lamp. The remainder of the card is concealed from the lamp by a partition plate 48 fastened to a casing 49 provided with a sight window 49a. Carried by the frame and inside casing 49 are three mirrors 50 lying at an angle of forty five degrees to the card. The rear mirror 50—0 is above the 0 index position row, mirror 50—X is above the X index position row, and mirror 50—Y is above the Y index position row. Mirror 50—0 may be completely light reflecting; mirrors 50—X and 50—Y are partially reflecting and partially transparent. Carried by the frame below the pattern plate 40 are three reflectors 52. Each reflector has a reflecting face at an angle of forty five degrees, and each reflecting face is vertically below one of the mirrors 50. Thus, the faces of reflectors 52—0, X, and Y are below mirrors 50—0, X, and Y, respectively.

Each of mirrors 43, 44, 50, and 52 spans one entire row of the index positions of a card. The illustrated card is of the 80-column type and, accordingly, pattern plate 40 has eighty columns of characters and exposing spots 41. When the card is located in interpreting position on the device, the columns of index positions of the card register with the columns of the pattern plate. As indicated in Fig. 10, the characters in each column of the pattern plate are in groups of three, except for characters A and J. Index position 9 of a card column, when perforated, exposes to light the bottom group of three characters IRZ. Index position 8, when perforated, exposes to light the characters HQY, and so on as indicated in Fig. 10. The top group of two characters A and J of a column of the pattern plate are exposed by a perforation in the index position 1 of a card column. The transparent or translucent exposing spots 41—0, X, and Y register with the index positions 0, X, and Y of the card in interpreting position.

The operation is as follows:

Assume a card column has perforations in index positions Y and 5. This combination of perforations designates letter E. Light passing through the 5 perforation in the card column illuminates the group of three characters ENV of the aligned column of the pattern plate 40. The light transmitted by this group of characters passes through partially transparent and partially reflecting mirror 43—5 and impinges on mirror 44—5. Mirror 44—5 forms an image of all three characters ENV and reflects the image to the mirror 43—5. Mirror 43—5, in turn, reflects the image forwardly, in a horizontal direction. The latter image is displayed, through the partially transparent mirrors 43—4, 3, 2, and 1, to the reflectors 52—0, X, and Y. The reflectors 52—0, X, and Y are so located vertically in relation to the image of a group of three characters reflected towards them by a mirror 43 that they respectively view the bottom third, middle third, and top third of the image. Thus, the reflector 52—0 forms an image of letter V reflected by mirror 43—5, reflector 52—X forms an image of letter N, and reflector 52—Y forms the image of letter E. The reflectors 52 reflect the character images upwardly in a vertical direction. The active faces of reflectors 52 are so spaced in a horizontal direction that the upwardly, vertically reflected character images are spread horizontally

in accordance with the spacing of index positions 0, X, and Y. Thus, the images reflected by reflectors 52—0, X, and Y are respectively directed towards the index positions 0, X, and Y passing intermediately through exposing spots 41—0, X, and Y, respectively, of the pattern plate 40. Considering the group of three characters ENV, the image of character V is reflected by reflector 52—0 through exposing spot 41—0 and to the index position 0 of the card. The images of characters N and E are reflected by reflectors 52—X and Y, respectively, through spots 41—X and Y and to index positions X and Y. The card column taken as an example has only the Y index position perforated. Hence, only the image of character E, reflected upwardly by reflector 52—Y will appear through the perforated index position Y, while view of the remaining character images will be blocked by the opaque card material. The character image E will appear in the mirror 50—Y and be displayed thereby through the sight window 49a. In this manner, the combination of perforations Y and 5 in a card column are optically interpreted and the letter E designated by this combination of perforations will be displayed to an objective. If the index position X, instead of Y, were perforated, character image N would be exposed by this perforation and shown in the mirror 50—X. The image N would be visible to the objective since the mirror 50—Y, in front of mirror 50—X, is partially transparent. If the index position 0 were perforated, character V would be displayed by mirror 50—0, mirrors 50—Y and X both being partially transparent. In the same manner, other combinationally designated characters will be optically interpreted, and their images displayed by mirrors 50.

The honeycomb structure comprised of strips 37 and 38 isolates each of the index positions of each column and row of a card and the corresponding index portions of the pattern plate from every other such position. In this way, light passing through a perforation in an index position of the card is prevented from striking any other portion of the pattern plate but the portion registering with the index position. The baffle plates 45 isolate the images reflected by each column span of mirrors 43 and 44 from every other column span, so that only images of one column of character patterns may be reflected by related column spans of mirrors 43 and 44.

The optical path of each exposed character to an objective is substantially equalized by the differential spacing of mirrors 44 from mirrors 43, in the same way as in the embodiment shown in Figs. 5 and 6. Thus, all the character images, regardless of their derivation from different parts of a column of the pattern plate will be, in effect, displayed by mirrors 50 in a substantially common focal plane.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to several embodiments, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art, without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. Apparatus for optically interpreting character designating code marks disposed in col-

umns and rows of index positions of a record, comprising a series of parallel reflecting elements, arranged one behind another, a pattern sheet bearing columns and rows of character pattern areas corresponding to the index positions of the record and selectively exposable under control of the marks in said positions, means supporting the elements in operative relation to one another and in such operative relation to the pattern sheet that each element is located to receive exposure of the areas of one said row of areas and to reflect images of such exposed areas in the same direction as images of other areas are reflected by the other elements, and at least those elements in front of the rear element being partially transparent to enable any image, including one reflected by an element behind the leading element, to be exposed to a viewing position in front of all the elements.

2. Apparatus for optically interpreting a record perforated in index positions of a column to designate characters, comprising a column of character pattern elements selectively exposable to illumination through perforations in the record column, a series of reflecting elements arranged, in parallel, one behind another, each to receive and reflect an image of one said pattern element, when illuminated, all said reflecting elements reflecting images in the same direction to a location in front of the leading reflecting element, those reflecting elements in front of the rear reflecting element being partially transparent to enable any image, including one reflected by a reflecting element behind the leading reflecting element, to be exposed to a position in front of the leading reflecting element, and means for supporting the reflecting elements, pattern elements, and record in operative relation to one another.

3. Optical means for interpreting character representing code marks in columns and rows of index positions of a record, comprising a character pattern plate having corresponding columns and rows of light-pervious characters, means for locating the record in front of the pattern plate so that the index positions of the record will register with the light-pervious characters and will enable the characters to be trans-illuminated through the code marks, and a series of mirrors disposed in parallel, at equal angles to the pattern plate, means supporting the mirrors in operative relation to one another and in such operative relation to the pattern plate that each mirror is located behind one row of the characters on the pattern plate so as to receive images of trans-illuminated characters of the related row, all said mirrors reflecting the images, received thereby, in the same general direction to a location in front of the foremost mirror, and at least those mirrors in front of the rear mirror being partially transparent to enable the images reflected by all the mirrors to be exposed at said location.

4. Apparatus for optically interpreting combination representations of characters on a record member having a column of index positions divided into two zones and selectively perforated in a position in each zone to designate by the combination of perforations a desired one of the characters, comprising a column of groups of character patterns, means to locate the record member and pattern groups so as to optically register the groups of patterns and one zone of said index positions of the record col-

umn, thereby to expose, through the perforation in this zone of the record column, the registering group of patterns, optical means for receiving images of the patterns of the group exposed through said perforation and coacting optical means for redirecting the image of each different exposed pattern to a separate one of the index positions of the other zone of the record column, whereby the perforation in an index position of the latter zone passes only an image of the pattern delineating the character corresponding to the combinational perforations in the two zones of the record column, and means supporting the first and second named optical means in operative relationship to one another and to said groups of character patterns.

5. Apparatus to optically interpret codal representations of characters on a record, comprising a member formed with a series of patterns of the characters, means for locating the record in position for the character codal representation thereon to control exposure of the related pattern, a series of reflecting elements, one for each pattern, arranged in parallel, one behind another, each to receive exposure of a related pattern and form and reflect an image thereof in the same direction as images may be reflected by the elements related to the other patterns, at least those elements in front of the rear element being light-pervious to enable a pattern image reflected by each element, including any element behind the leading element, to be brought into display at a position in front of the leading element, and means for supporting the reflecting elements and patterns in operative relation to one another.

6. Apparatus for optically interpreting combinational hole representations of characters on a record, comprising means provided with a plurality of groups of character patterns, an optical structure including reflecting means at one side of the record to which the groups may be selectively exposed, each through a related one of the holes of the combinational representation and which reflects an image of any exposed group of patterns towards the record for selective exposure of the image of one said pattern in the exposed group through another of the holes of the combinational representation, and means for supporting the record, pattern bearing member, and optical structure in operative relation to one another.

7. Apparatus for optically interpreting combinational character representations on a record, comprising a pattern sheet bearing groups of character patterns, means to illuminate one said group under control of a portion of a rep-

resentation on the record, optical means to form images of the patterns of the illuminated group, coacting optical means to which the first named means directs said images and which re-directs said images towards the part of the record bearing the remaining portion of the character representation, image receiving means at the side of the record opposite the side at which the second named optical means is located and to which one of the images re-directed by said second named optical means is transmitted through a remaining portion of the character representation on the record, and means for supporting the record, the first and second named optical means, the image receiving means, and the pattern sheet in operative relation to one another.

8. Apparatus for optically interpreting characters represented by combinations of light passing areas in index positions of a record, comprising a pattern sheet with groups of character patterns, reflecting means at one side of the pattern sheet, means locating the record with certain of the index positions in registration with said pattern groups, whereby light transmitted through a light passing area in an index position carries an image of the registering group of patterns to the reflecting means, other reflecting means for receiving the reflection of the images of the group of patterns from the first named reflecting means and re-directing said images towards other index positions of the record, whereby a light passing area in one of said other positions transmits one of the re-directed images, and means for supporting the record, pattern sheet, and the first and second named reflecting means in operative relationship to one another.

9. Apparatus comprising columns and rows of character patterns delineating characters which may be represented by perforations in a record, means for positioning the record relative to the patterns so as to expose the character patterns selectively through the perforations in the record, an optical system for displaying images of the patterns, exposed from different rows, in a single line to a suitable objective and including reflecting means behind the record and patterns to which the patterns are selectively exposed through the perforations and which reflect the images to the objective, and another optical system supported in front of the record and comprising reflecting means confronting the face of the record for reflecting an image of the face of the record to the objective to be viewed thereby simultaneously with and in contiguity to the line of images of the character patterns displayed to the objective by the first named optical system.

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