350-6.3 SR

OR 3,591,249

United St T3022 T

[11] **3,591,249**

[72] Inventor Er
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[54] **OPTICAL SCANNING DISPOSITION**
8 Claims, 20 Drawing Figs.

[52] **U.S. Cl.** **350/6,** 250/236
[51] **Int. Cl.** **G02b 17/00**
[50] **Field of Search** ..... 350/6, 7, 285, 273—275; 250/219, 235, 236; 178/7.6; 356/23—26; 73/5, 6; 352/84, 114—118; 95/4.5; 340/146.3

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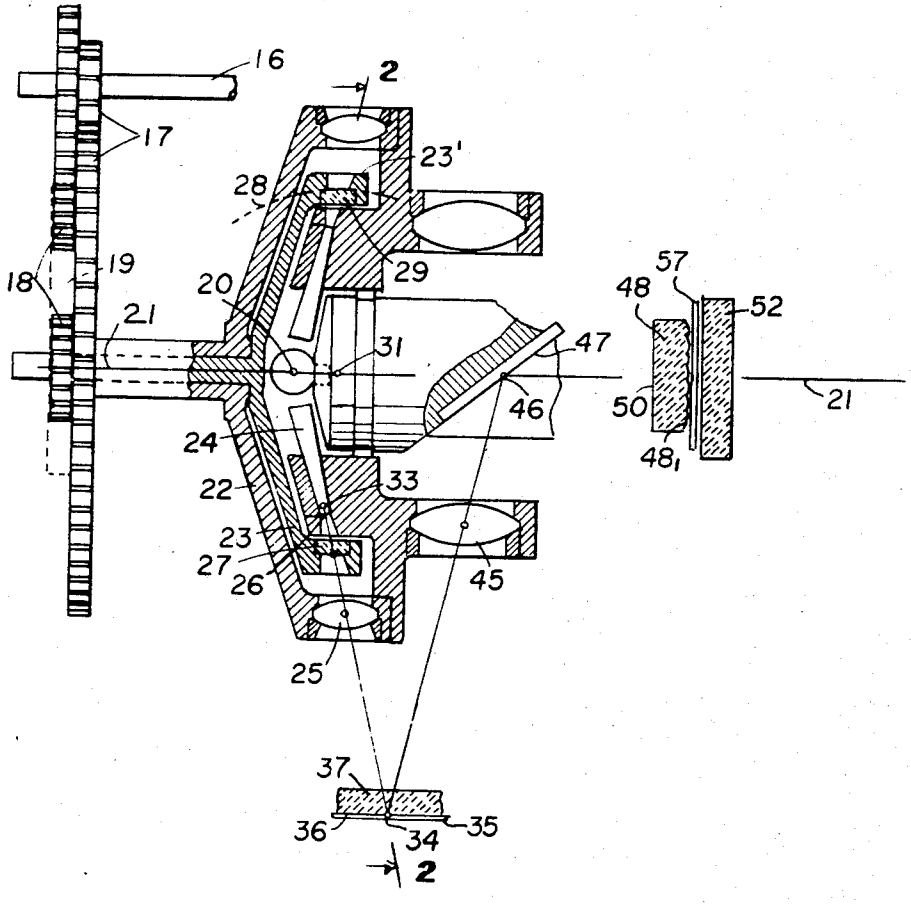
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Primary Examiner—David Schonberg
Assistant Examiner—Michael J. Tokar
Attorney—Ernest Wildhaber

ABSTRACT: This optical scanning disposition for scanning different characters, that are uniformly spaced in a line, lights the entire area of a single character simultaneously and displaces the lighted area along a line in a way that avoids simultaneous illumination of two adjacent characters. A lighted character is then compared with all the characters used.

Scanning is done either stepwise, the lighted area stopping for an instant at each character; or sufficient space is provided between adjacent characters that the lighted area does not reach two characters simultaneously as it moves uniformly along said line.



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SHEET 1 OF 2

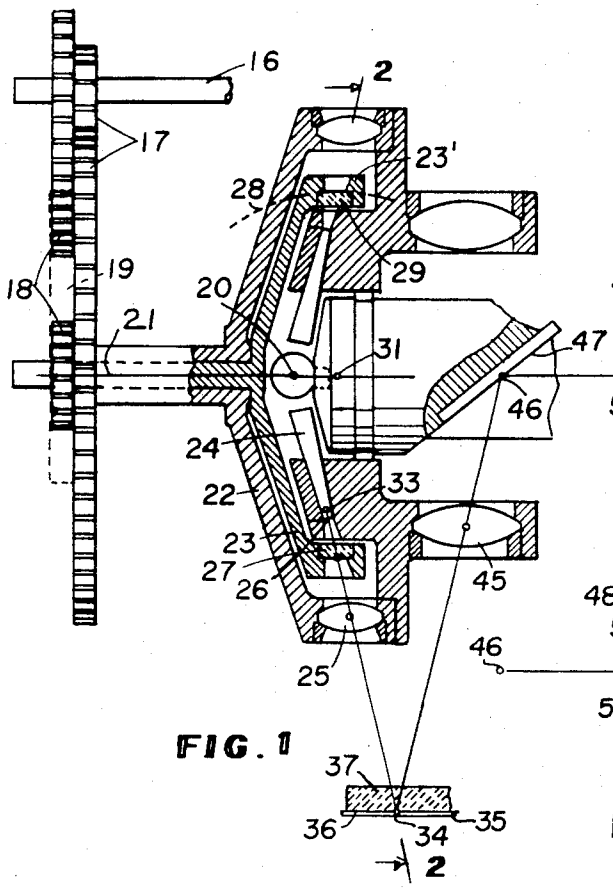


FIG. 1

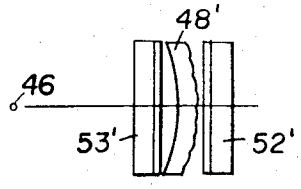
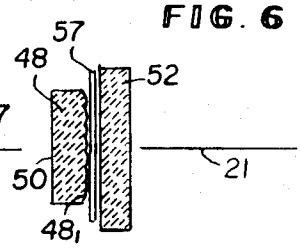
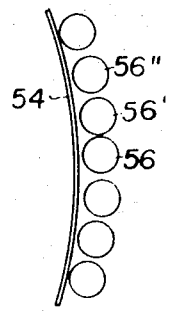


FIG. 6





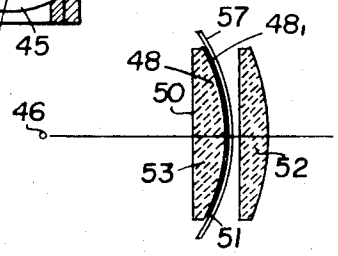


FIG. 4

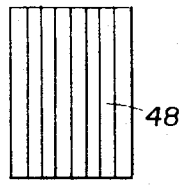
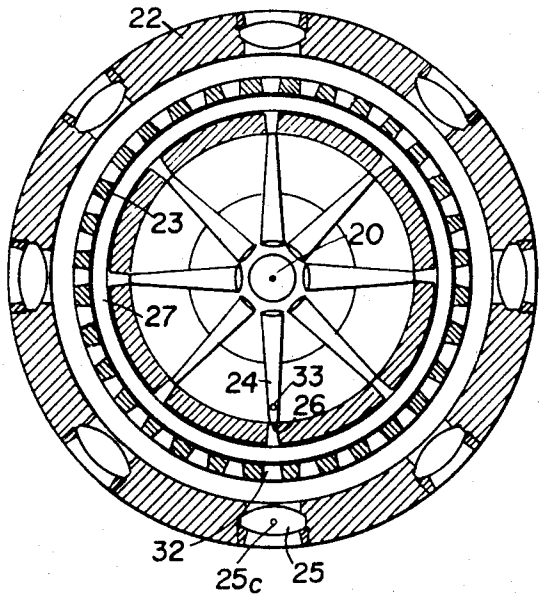


FIG. 5



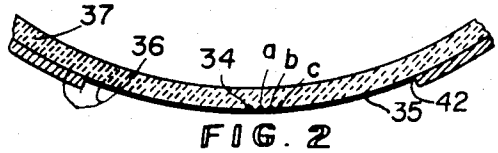


FIG. 2

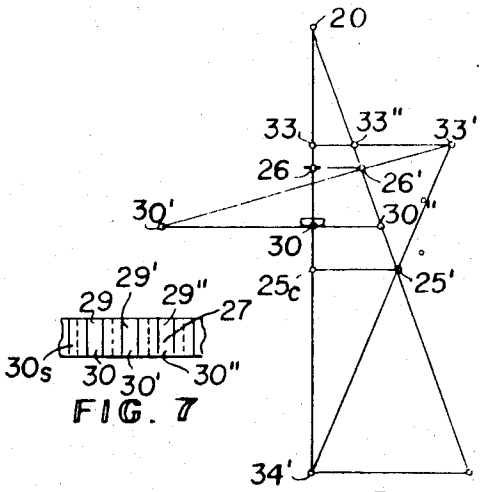


FIG. 7

FIG. 3

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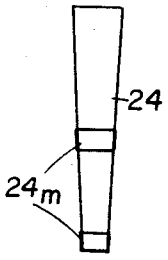


FIG. 8

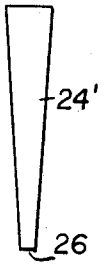


FIG. 10

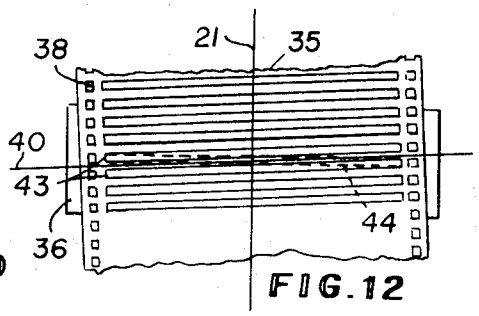


FIG. 12

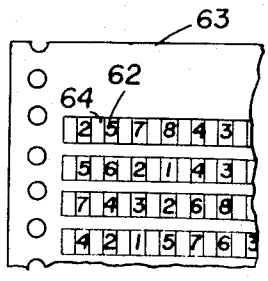


FIG. 16

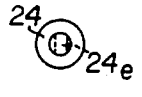


FIG. 9

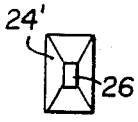


FIG. 11

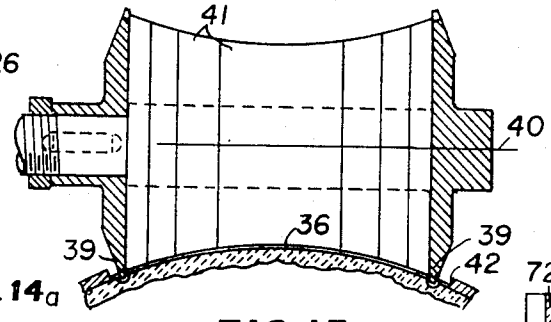


FIG. 13



FIG. 14a



FIG. 14b

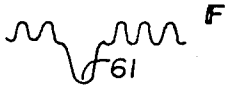


FIG. 14c

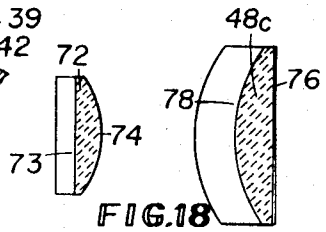


FIG. 18

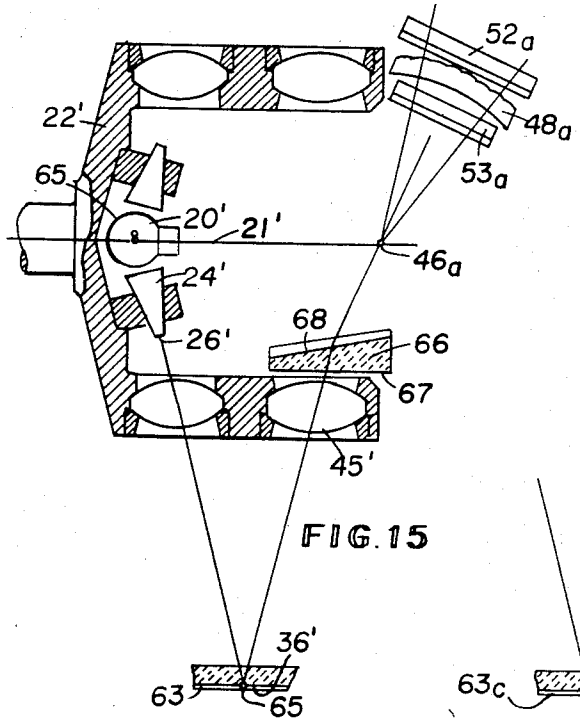


FIG. 15

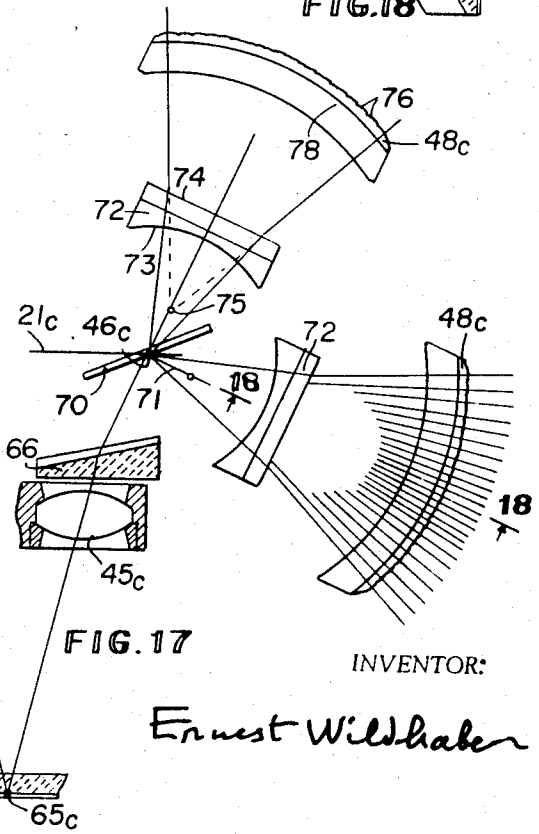


FIG. 17

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OPTICAL SCANNING DISPOSITION

Objects of the present invention are increased speed of operation and diminishing the bulk of the records. A further aim is to light all the characters of a line equally and at the same angle of incidence, thereby to increase reliability. Further aims will appear in the course of the specification and in the recital of the appended claims.

The information to be transmitted may be put down on sheets or a roll by different characters, such as symbols, numbers or letters, uniformly spaced in straight lines. According to the invention, each entire character is scanned in totality at the same moment and without infringing on other characters. The scanning beam moves across a line to be scanned without ever lighting two characters simultaneously. In one embodiment it moves stepwise and jumps from one character to the next, stopping instantaneously at each character. During the jumps light passage is blocked. The record is advanced continuously at uniform speed. In another embodiment sufficient space is provided between characters to avoid ever lighting two characters simultaneously.

The first-described embodiment of the invention contains a pair of coaxial rotary members and a source of light placed on the axis of said members.

FIG. 1 is a somewhat diagrammatic axial section of this embodiment.

FIG. 2 is an axial view thereof and a section taken along lines 2–2 of FIG. 1.

FIG. 3 is a diagram explanatory of stepwise scanning.

FIG. 4 is a section of lens-member 48 of FIG. 1 and of an associated cylindrical lens, taken along line 21 of FIG. 1.

FIG. 5 is a front view of lens-member 48.

FIG. 6 is a view of a modified lens-member and of associated lenses, taken in the same direction as FIG. 1.

FIG. 7 is a fragmentary radial view of refractory ring 27 of FIGS. 1 and 2, looking out from the inside.

FIGS. 8 and 9 are a side view and a front view of light-pipe 24 of FIGS. 1 and 2, at an enlarged scale.

FIGS. 10 and 11 are similar views of a modification thereof.

FIG. 12 is a front view of a record fed at a slight angle to the direction of the rotor axis (21).

FIG. 13 is a section taken along axis 40 of FIG. 12, and partly a view at right angles thereto.

FIGS. 14*a*, 14*b*, 14*c* are diagrams of electric current fluctuations received.

FIG. 15 is a fragmentary axial section of a modification.

FIG. 16 is a front view of a record used in this modification.

FIG. 17 is a fragmentary axial section of a further modification adapted to an increased number of different characters.

FIG. 18 is a section taken along lines 18–18 of FIG. 17.

In FIGS. 1 and 2 numeral 20 denotes a source of light or broadly of radiant energy. It lies on the axis 21 of a pair of coaxial rotors 22, 23. A plurality of tapered light-pipes 24 are equally spaced about axis 21, to conduct light outwardly from source 20. Their taper intensifies the light at the small outer end. They are secured to the outer rotor 22 and are moderately inclined to planes perpendicular to axis 21. Rotor 22 contains a lens 25, or lens system, in front of each light-pipe, at a distance therefrom.

FIGS. 8 and 9 further show light-pipe 24 at a larger scale. It is a conical solid rod of glass or other refractory material, whose small end is partly covered up by the holder, so that it presents a generally rectangular free end 24_e bounded laterally by parallel straight lines. This free end is similar to the area to be lighted simultaneously, wherein a character is inscribed. The light-pipe preferably contains a mirror layer 24_m at the places where it is held on rotor 22. The mirror surface faces inwardly towards the centerline of the light-pipe.

The modified embodiment shown in FIGS. 10 and 11 is a light-pipe 24′ of rectangular cross section. Its side surfaces are planes that form the desired rectangular area 26 at the small end. It may be used in place of light-pipe 24.

The inner rotor 23 encloses a ring 27 of refractory material. Ring 27 has a spherical outside surface 28 supported by rotor 23 and an inside surface 29 that has a large number of plane facets 29′, 29″ etc. extending parallel to axis 21. They do not show up in FIG. 2 but are shown in FIG. 7. Spherical surface 28 has its center 31 on axis 21. Ring 27 is held in place axially by a ring-shaped top 23′ secured to rotor 23.

Ring 27 is equivalent to a large number of lenses 30, each having a plane inner surface and a spherical outer surface that is part of surface 28. The individual lenses 30 thus formed are separated by opaque layers 30_o. Suitable light openings 32 (FIG. 2) are formed in the supporting rotor 23.

When in alignment with a light-pipe 24 a lens 30 of ring 27 forms a virtual image of the strongly lighted free end 24_e or 26 of the light-pipe. It is centered at point 33. And lens 25 of rotor 22 projects this image as a further image 34 to the record sheet or band 35 that is pressed against the cylindrical outside surface 36 of refractory segment 37. Surface 36 is coaxial with the rotors 22, 23.

If the rotors 22, 23 were locked to each other and would uniformly rotate together, the brightly lighted area 34 would uniformly sweep a circular path that is part of the circular cross section of cylinder 36. Different rotational speeds of the rotors 22, 23 however modify the position of the lighted area along said circular path. By suitable proportions of speed the image 34 can be maintained in a fixed position for a brief interval, as will be further explained with diagram FIG. 3, until light is momentarily shut off by the portions between the light openings 32. Thereafter the adjacent lens opening 32 and its lens 30 move into alignment with light-pipe 24, forming briefly an adjacent stationary lighted area. And so on. This continues while light-pipe 24 turns through one pitch, which in the instance illustrated in FIG. 2 amounts to one-eighth of a full turn. By then an entire line of characters has been swept, the lighted area jumping from one stationary area to the next one, while light ceases during the jump itself. After the lighted area arrives at the end of a line of characters, the following light-pipe 24 takes over to sweep the next line in the same manner.

Record 35 is uniformly fed over the cylindrical surface 36 in a direction perpendicular to its lines of characters and at a moderate angle to the direction of axis 21, as shown in FIG. 12. The feed may be by means of sprockets engaging holes 38 provided on the record. Two such sprockets 39 are shown in FIG. 13. They rotate on an axis 40 perpendicular to the feed direction. Coaxial therewith are several independently rotatable and somewhat resilient discs 41 that press the record onto the cylindrical surface portion 36. The record is also guided at both ends 42.

The feed direction of the record is so inclined to the direction of axis 21 that the opposite ends of adjacent lines 43 of characters are approximately on the level of the scanning path 44, that is successively swept by the lighted area 34 (FIG. 3). 34′ is the center of this area.

The relationships to be observed will now be described in principle with diagram FIG. 3. When rotor 22 turns very slightly, infinitesimally, the center 25_c of lens 25 moves peripherally to position 25′ shown at a much exaggerated distance from 25_c. The same numerals are used in FIG. 3 as in FIGS. 1 and 2. Area 26 moves to 26′. The image center 33 should move to 33′ on extended line 34′—25′, to keep center 34′ at the same place for an instant. And the optical center of lens 30 should move to 30′ on extended line 33′—26′.

After assuming the sphere radius 20—30 of lens 30 and the distance of area 26 from 30, the location of image center 33 can be determined in a known manner. Lens or lens system 25 is determined to form an image of 33 that is centered at 34′ on the record. The turning angles of rotors 23 and 22 are then in the proportion of distances 30–30′ and 30–30″, point 30″ being on line 20—25′. The finite turning angles are in this same proportion.

It should be noted that the two rotors 22, 23 have to turn in opposite directions if convex lenses 30 are used.

When rotor **22** turns through an angle corresponding to the spacing of the characters (at *a*, *b*, *c*, FIG. **2**), rotor **23** should turn relatively to rotor **22** through one spacing of lenses **30**. The angular spacing of lenses **30** should be in the proportion of distances **30'–30''** and **30–30''** respectively to said turning angle. To obtain an integral number of uniformly spaced lenses **30** a slight change in the assumed distance **26—30** may have to be made.

The rotors **22, 23** are driven from a shaft **16** through gear pairs **17, 18**, of which pair **18** is connected through an idler **19**.

A lens **45**, or lens system, gathers the light reflected from the record area **34** to form an image thereof at and around point **46** that lies on axis **21**. This is a common point for the images of all the successively lighted areas that are spread out in an arcuate line. Lens **45** is secured to rotor **22** and lies in the same axial plane that contains lens **25** and light-pipe **24**. There is a lens **45** for each lens **25**. A plane mirror **47** directs the light bundle in a generally axial direction to a lens-member **48**.

Member **48** contains a plane surface **50** on one side and an overall cylindrical surface **51** on the opposite side. Surface **51** has its axis coinciding with point **46** in a view along the drawing plane of FIG. **1**. A plurality of individual lens surfaces 48_1 of convex profile are inscribed to overall surface **51**. These coherent surfaces constitute individual toroid lenses running peripherally of cylindrical surface **51** and tangent to it. A cylindrical lens **52** is parallel to overall cylindrical surface **51**. Its axis lies in the plane of FIG. **1**. A similar equally directed cylindrical lens **53** is constituted by plane side **50** and overall cylindrical surface **51**.

In the plane of FIG. **1** the individual toroid lenses form images of the region around point **46** on a master **54**. In a plane through axis **21** at right angles to the plane of FIG. **1** the cylindrical lenses **52, 53** are likewise dimensioned to produce an image of said region on master **54**. The combination of these crossed cylindrical and toroid lenses has the effect of spherical lenses, as known. They produce identical images of the illuminated character on master **54**, opposite the spaced phototubes or light-sensitive elements **56, 56', 56''**, etc.

Master **54** contains all the characters used in the system, one character opposite each tube **56**. Preferably the characters are transparencies. If the master is opaque, it may be cut out or perforated in the shape of the character. If transparent, it is covered up except for the character. I may use a system of eight different characters, for instance symbols so formed that in any combination of two different symbols the area of overlap is about half the total area of the symbol.

One of the characters of the master will match the transmitted image and thus identify the lighted character of the record. A minimum of light is then transmitted to the phototube back of this character. A minimum current then instantaneously passes through this phototube. Known circuitry may be used to transmit the signal.

To impart about equal light to the several phototubes I may use a screen **57** governing the lens openings of the individual toroid lenses. This screen has slots of different width, through which light may pass, but is otherwise opaque. The width of the slots increases from the center outwardly. In place of screen **57** the juncture of the individual lenses may be covered up with opaque bands of varying width.

In principle it is also possible to use spherical individual lens surfaces on lens-member **48**. However because of the strongly curved profile thereof, which would have to be retained in the cross section FIG. **4**, the height of spherical lenses would be sharply reduced in this Figure. This would require increasing the number of light channels over the shown number of eight.

While I have shown lenses **30, 25, 45** parallel to axis **21**, the lenses may be inclined thereto, if desired.

FIG. **6** illustrates a modified form **48'** of lens-member **48**. Here the individual lenses are cylindrical and arranged in a circle about center **46**. Two cylindrical lenses **52', 53'** accompany lens member **48'**.

FIG. **14***a* illustrates the fluctuations of electric current in phototubes, where the projected character does not match the adjacent character of the master. The straight line at the bottom is the zero line. The current drops down to zero when light is instantaneously blocked off by rotor **23**. FIG. **14***b* illustrates the current when characters match. The peak is then cut off in the cycle at **60**, signalling match.

The circuitry is simplified when the periodic pulses to zero, shown in FIG. **14***a*, are avoided, so that only a character match causes the lowest current. This is indicated in FIG. **14***c*, where the drop **61** signifies match. This showing is obtainable by generating an additional current approximately like that defined by FIG. **14***a* but with a phase difference of one-half cycle. This additional current is then combined with the current corresponding to FIG. **14***b*.

The emission of light from source **20** is kept uniform. If desired, however, it may be caused to pulsate and stop or cease instantaneously between characters. Also monochromatic light may be used if desired.

FURTHER EMBODIMENT

The embodiment to be described with FIGS. **15** and **16** uses a single rotor and a special record. Again light is confined to the whole area of a single character; but here this lighted area is moved uniformly along the line of characters of the record. Rectangular area **62** of record **63** (FIG. **16**) is one such area. Empty spaces **64** are provided between the areas of adjacent characters, so that the characters are separated from each other by a width (**64**) equal at least to half the pitch of the characters. For convenience the characters are shown as numbers in FIG. **16**.

The light bulb **20'** is placed on or close to the axis **21'** of rotor **22'**, which carries the tapered light pipes **24'** and lenses **25'**. The filament may be set eccentric in bulb **20'** that is partly covered with a mirror layer **65** to throw more light forward. Each lens **25'** or lens system forms an image of the outer end **26'** of its coordinated light-pipe. End **26'** may be rectangular, as shown at **26** in FIG. **11**, and is higher than wide. The said image is formed at **65** on record **36'** which is pressed against cylindrical surface **63'**. The latter is coaxial with rotor **22'**. As rotor **22'** turns it displaces this image uniformly along the line of characters. Transmission of each character lasts while the lighted area moves from the empty space **64** on one side of the character over the character to the empty space on the other side.

A lens **45'** of rotor **22'** forms images of the successively lighted characters of the record at and adjacent a common point 46_a that lies on axis **21'**. A fixed refractory sector **66** modifies the direction of the light bundle. It has a cylindrical outside surface **67** coaxial with rotor **22'** and a conical inside surface **68** coaxial therewith. Prisms of the same cross section, placed on rotor **22'**, could be substituted for sector **66**, if desired. The image formed at 46_a is multiplied into a number of equal images on a master (not shown) by a lens-member 48_a and cylindrical lenses 52_a, 53_a. These are similar to the described lens-member **48'** and lenses **52', 53'** of FIG. **6**. They could be identical therewith. The images are compared with the characters of a master, as described in connection with FIG. **1**. Similarly a photocell is placed back of each such character of the master.

FIG. **17** is similar to FIG. **15** and further shows a way to multiply the number of characters used. It may contain the same lenses **25'** carried by rotor **22'** (not shown). They form images at 65_c on record 63_c. A lens 45_c of the rotor forms images of the successively lighted areas of the record at and adjacent a common point 46_c, even though said areas are spread out in an arcuate line. Point 46_c lies on axis 21_c of the rotor. For convenience it is shifted axially somewhat by stationary refractory sector **66** that has been described. A mirror **70** is lightly coated to let half the light pass through and to reflect the other half in direction **71**. Each of the two thus resulting light bundles reaches one of two identical lenses **72**. Lens **72** has a concave cylindrical side surface **73** extending at right angles to the plane of FIG. **17**, to spread out the light bundle in this view.

The opposite side of lens 72 contains a convex cylindrical surface 74 that extends parallel to the plane of FIG. 17, as seen in FIG. 18. Lens 72 can be considered a combination of a concave cylindrical lens with a convex cylindrical lens set at right angles thereto. In the view of FIG. 17, lens 72 forms a virtual image of point 46_c at 75. In this view multiple individual convex cylindrical lenses 76 of lens-member 48_c form as many equal images of point 75 as there are lenses 76. This applies to each of the two light bundles. The number of different characters that may be used equals the sum of the number of lenses 76 in both lens-members 48_c together. The said images are formed on a master (not shown), as described with FIG. 1. The master contains the characters used and has a phototube back of each character.

Lenses 76 are arranged in a circle and can be considered inscribed into an overall convex cylindrical surface. On the opposite side lens-member 48_c contains a toroid surface 78 of convex profile in the plane of FIG. 18. It can be considered a combination of a member similar to member 48' (FIG. 6) and a cylindrical lens 53'. The convex lens surfaces in the plane of FIG. 18 are dimensioned to produce an image of point 46_c on said master. The master thus receives sharply defined images of the area around point 46_c.

To favor equal lighting the individual lenses 76 are made increasingly wide with increasing distance from the center, to make up for the diminishing light intensity on the sides. Their working surfaces are however parts of identical cylindrical surfaces.

In all described embodiments all characters of the record are lighted equally and at the same angle of incidence.

While the invention has been described with several different embodiments thereof, further modifications can be made therein by applying the knowledge of the art and without departing from its spirit. For definition of its scope it is relied on the appended claims.

I claim:

1. Optical scanning disposition for scanning equally spaced characters arranged in a line on a record, said characters being parts of a group of different characters, said disposition comprising a source of radiant energy, means for receiving energy from said source and for directing emission from said source toward a localized portion of said record, means confining said emission so that it fills an entire constant area on said record circumscribing at any one instant a single character without illuminating other characters, means for displacing said area along said line without displacing the record along said line and while avoiding significant simultaneous illumination of two adjacent characters thereby to illuminate different characters successively, a master having a plurality of characters arranged thereon which are identical with the characters of said group, rotating means positioned in operative relation to said record and including a plurality of lenses for scanning said line, means for projecting each character of said record, as it is illuminated and scanned, through one of said lenses adjacent a point close to the axis of said rotating means to form an image of each entire character of said line successively at said point, and means for projecting the images from said point to said master for comparing each such image with the characters arranged on said master.

2. Optical scanning disposition according to claim 1, wherein the means for displacing the illuminated area is a rotor having a plurality of identical lenses arranged in a circle concentric with its axis and disposed upon rotation thereof, to cause said lenses to register successively with the characters on said record, and the means for forming images of the successively illuminated characters adjacent a common point includes light-directing means carried by said same rotor.

3. Optical scanning disposition according to claim 1, wherein stationary refractory means are provided for simultaneously forming as many images of the area adjacent said common point as there are different characters in said group, for comparison with the characters of said group.

4. An optical scanning disposition according to claim 1 having means for generating a signal when such an image is identical with a character on the master.

5. An optical scanning disposition according to claim 4 wherein said signal generating means includes a plurality of photoelectric cells, one of which is associated with each character on said master.

6. In an optical scanning disposition, a pair of coaxial rotors containing, respectively, lens sets of different numbers, the lenses of each set being arranged in a circle about the rotor axis, means for emitting light outwardly of the rotor axis from a restricted area through the lenses of both rotors to form an image of said area on a record bearing different characters, said image embracing the area of one complete character without materially illuminating adjacent characters, and means for turning said rotors at different rotational speeds in timed relation to hold said image for an instant on each character to scan each character, whereby the rotor with the larger number of lenses turns relatively to the other rotor through one spacing of its lenses per scanned character.

7. In an optical scanning disposition,

a pair of coaxial rotors mounted one within the other,

each rotor carrying a plurality of lenses arranged in a circle about the common axis of said rotors but the number of lenses on one rotor being different from the number of lenses on the other rotor,

a refractory member disposed outside said rotors but having a refractory surface coaxial therewith,

means for pressing a record containing a group of different characters arranged in a line against said refractory surface,

means for emitting light outwardly of said common axis from a restricted area through the lenses of both rotors to form an image of said area on the record,

said image embracing the area of one complete character without materially illuminating adjacent characters,

means for turning said rotors at different speeds in timed relation to hold said image for an instant on each character to scan each character,

the rotor with the larger number of lenses turning relatively to the other rotor through one spacing of its lenses per scanned character, means for feeding said record over said refractory surface in a direction perpendicular to its line of characters, and

a master having different characters identical with those on said record, and

reflecting means for gathering the rays of light from said refractory surface and record to form an image of each character, when scanned, at and around a point lying on said common axis, and for reflecting said images onto said master, said record, said scanning means, and said master being optically aligned.

8. An optical scanning disposition as claimed in claim 7, wherein

said reflecting means includes a third set of lenses mounted on the rotor, which carries the smaller number of the first-named lenses,

said third set of lenses being also arranged in a circle about said common axis and being in optical registry with said refractory surface.