

Sept. 16, 1969

D. M. STERN ET AL
IMAGE DISSECTOR SCANNER

3,467,775

Filed Jan. 3, 1967

3 Sheets-Sheet 1

Fig. 1

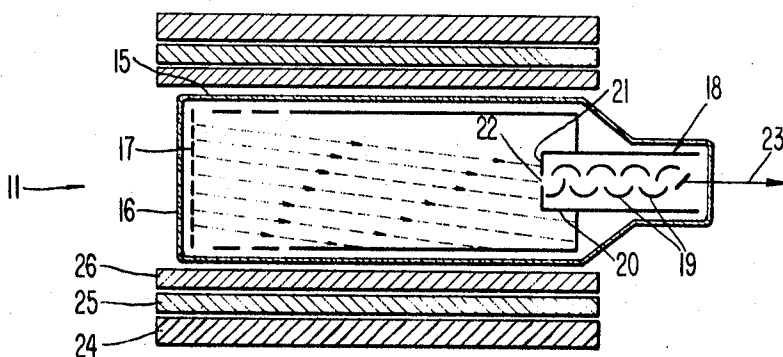
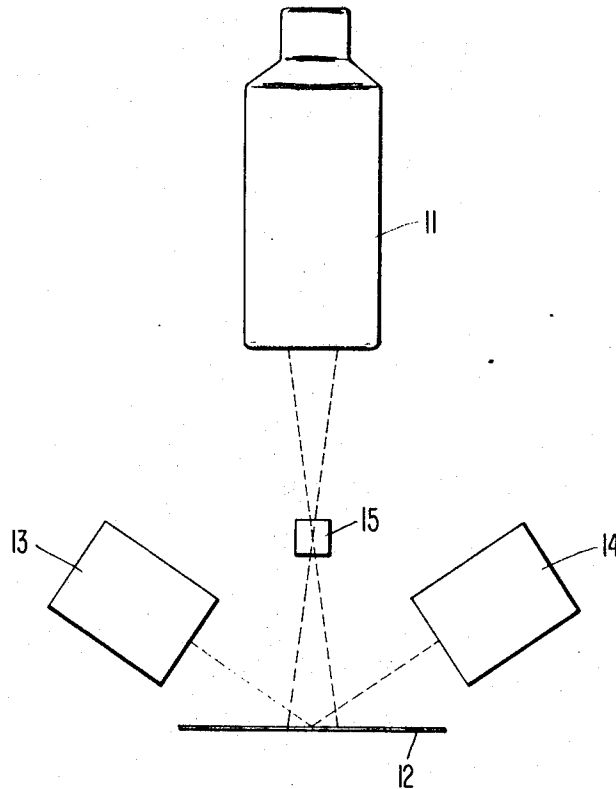


Fig. 2

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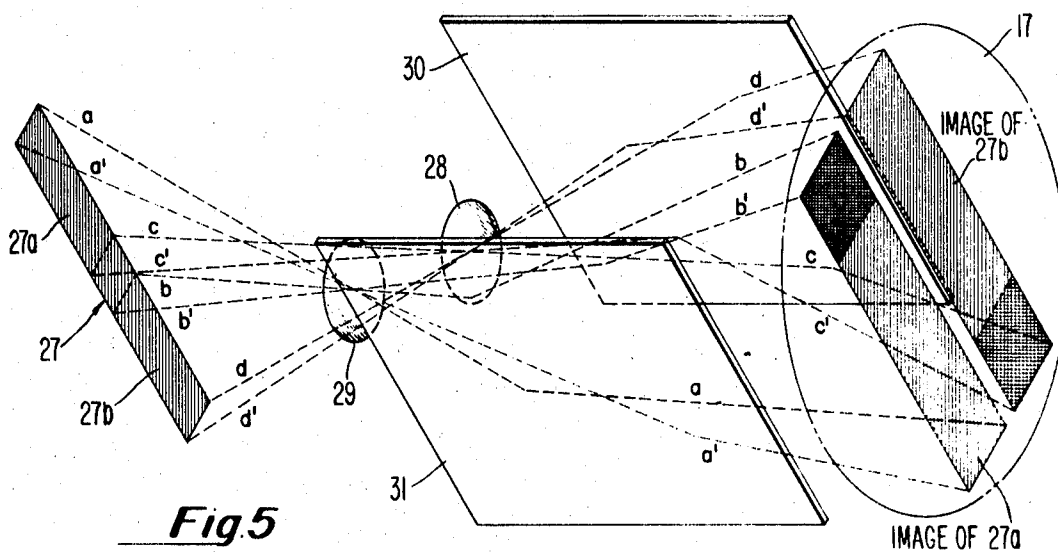
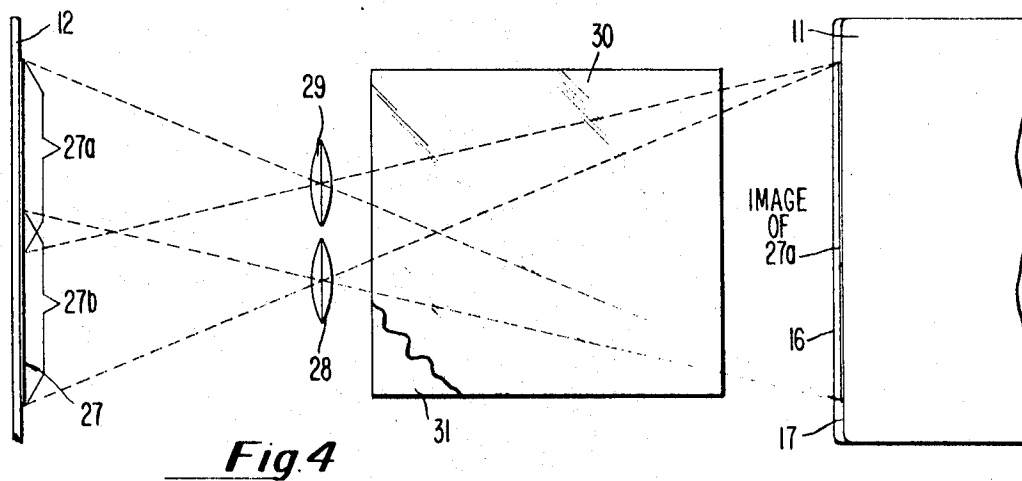
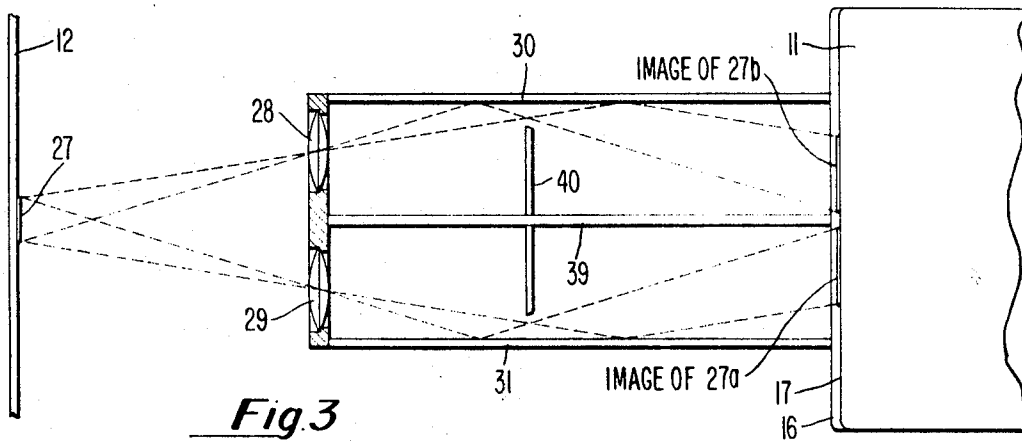
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3 Sheets-Sheet 2



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5 Sheets-Sheet 3

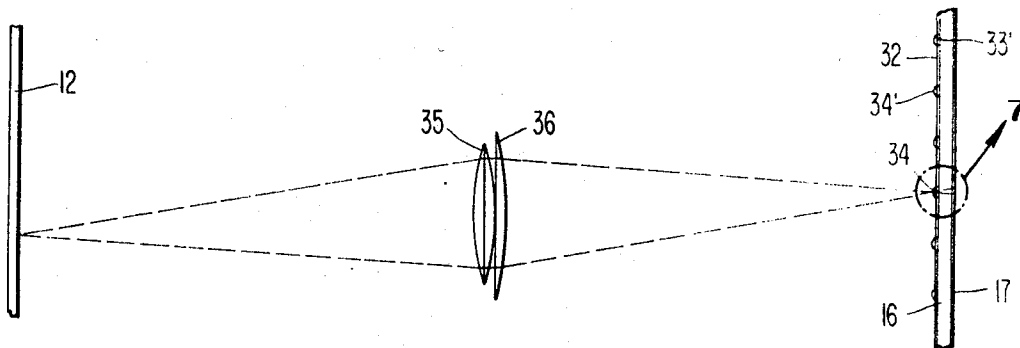


Fig 6

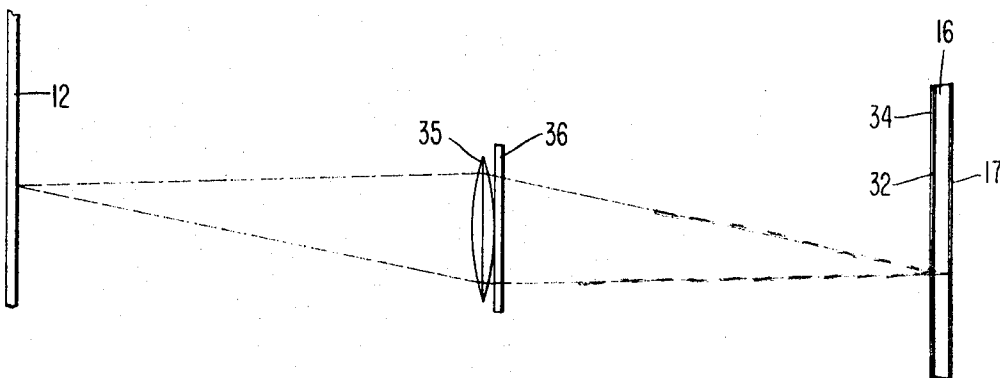


Fig 8

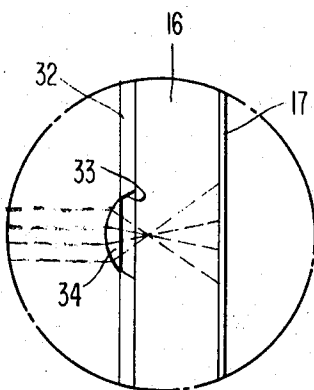


Fig 7

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3,467,775

IMAGE DISSECTOR SCANNER

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Filed Jan. 3 1967, Ser. No. 609,989

Int. Cl. H04n 5/38, 3/02

U.S. Cl. 178—7.2

17 Claims

ABSTRACT OF THE DISCLOSURE

An optical system combined with an image dissector tube for reforming the light image which normally would be focused on the photocathode of the image dissector tube into a light image of substantially larger area relative to the area of the photocathode. In one embodiment of the invention, top and bottom portions of the object are enlarged and imaged in side-by-side relationship on the photocathode. In another embodiment of the invention, the object is imaged on the photocathode and enlarged in the horizontal direction but not in the vertical direction.

This invention relates to an optical scanner and, more particularly, to an optical scanner for converting visual images into electronic data for use in a high speed character recognition apparatus.

The invention comprises an image dissector tube in combination with a unique optical system which reforms the light image normally focused on the photocathode of the image dissector into a light image of substantially larger area relative to the area of the photocathode.

Such an increase in the area of the light image is desirable for the purpose of maintaining electron current density at the photocathode at an acceptable level while at the same time, insuring that the total number of electrons emitted from a particular area of the photocathode is large enough to compensate for statistical variations inherent in the electron emission process, i.e., a large enough number of electrons must be collected so that the statistical variations may be averaged to smooth their characteristics.

If high electron current density on the surface of the photocathode did not result in heating at the surface and decrease the life and sensitivity of the photocathode, electron current density could then be maintained at a high enough level so that the problem of statistical variations of the emitted electrons would be nonexistent. In such a case, the significant advantage of an image dissector scanner over other types of optical scanners could be realized without the need for the present invention.

However, such is not the case and the present invention was conceived to provide in novel combination with an image dissector an optical system which overcomes the above problems. The combination of the present invention provides a light image on the photocathode of an image dissector which permits the total number of emitted electrons to be large enough to overcome the problem of statistical variations while maintaining electron current density at an acceptable level.

Most prior art optical scanning devices used in character recognition systems employ a cathode ray tube. For example, a cathode ray tube flying spot scanner is commonly used. The two most important necessities of optical scanning devices are high speed and high resolution. Obtaining a reasonable life for the phosphor utilized by the cathode ray tube greatly limits the beam current and therefore, the light output of a cathode ray tube where high resolution of the transferred image pattern is also required.

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However, the speed or response time required by character recognition systems limits the choice of phosphor used in the cathode ray tube to the area of the spectrum provided by a P16 phosphor. The extremely rapid aging characteristics of the P16 phosphor is a very undesirable characteristic of this phosphor. In addition, where there is a necessity for a visible spectrum color capability, the P16 phosphor is unsuitable. Many character recognition systems call for scanning devices having a high degree of spectrum color capability.

An image dissector tube system provides speed or a response time unlimited by the decay time of a phosphor such as is used in a cathode ray tube. The speed of the image dissector is the fast response time of the photocathode and photomultiplier components of an image dissector. At the same time, the image dissector camera tube system of the present invention, which employs tungsten illuminators and an S-11 photocathode, provides a broad response in the visible spectrum and a color response greatly in excess of that obtainable by optical scanners utilizing a cathode ray tube. In addition, the image dissector provides a high resolution compatible with the required response time. This is so because the resolution provided by the image dissector is independent of the art of the phosphor fabrication process as it relies on the optics involved and the fixed aperture built into the image dissector tube.

The combination of the present invention overcomes the above-discussed disadvantages of a scanning system utilizing a cathode ray tube and at the same time, the present invention provides a scanning system utilizing an image dissector tube such that the light image focused onto the photocathode of the image dissector is caused to have an area sufficient in size to permit electron current density to be maintained at a level consistent with long life. The total number of electrons emitted from the light image is made large enough to permit the statistical variations inherent in the electron emission process to be averaged over enough electrons to smooth or average out the electron emission noise component.

The physical configuration which the optical system takes in the combination of the present invention depends on the particular geometry of the desired scan. The geometry of the scan in turn, depends on the information to be extracted from the visual pattern presented. One type of scan is a search scan wherein the scanning device is looking for a particular location in the visual pattern at which to commence reading. A second type of scan is the read scan where the symbols or characters in the visual pattern are scanned in a typical read mode. In both such scan situations it is the purpose of the present invention to reformat the light image of the visual pattern as it is projected onto the face of the photocathode of the image dissector.

Therefore, it is an object of the present invention to provide an optical scanner wherein the basic scan element is an image dissector.

Another object of the present invention is to provide an optical scanner for use in a high speed character recognition system having broad response in the visible spectrum and wherein resolution of the image and response time are not limited by the phosphor used in a cathode ray tube.

It is a further object of the present invention to provide an optical scanner wherein the resolution and response time obtainable are limited only by the photocathode and photomultiplier of an image dissector tube.

Yet another object of the present invention is to provide an optical scanner utilizing an image dissector wherein the visual pattern to be scanned is caused to be imaged over a large enough area of the photocathode of the image dissector to maintain the electron current density

below a predetermined level and total number of collected photoelectrons above a certain level.

A still further object of the present invention is to provide an optical scanner utilizing an image dissector employing optical means disposed between the visual pattern and the photocathode of the image dissector for increasing the area which the light image occupies on the photocathode over that which it would occupy without the optical means.

Other objects and many other advantages of the present invention will become more apparent with the reading of the following description in conjunction with the drawings wherein:

FIGURE 1 illustrates in block diagram form the generic form of the present invention;

FIGURE 2 illustrates an image dissector tube of the kind used in the present invention;

FIGURES 3, 4 and 5 illustrate respectively, a plan view, an elevational view and an isometric view of one embodiment of the present invention;

FIGURES 6 and 8 illustrate respectively, a plan view and an elevational view of another embodiment of the present invention; and

FIGURE 7 is a blown-up view of a portion of FIGURE 6.

Referring now more particularly to FIGURE 1, there is shown an image dissector tube 11 disposed to receive light reflections from an object or document 12 containing visual patterns generally in the form of alphanumeric symbols. The reflectivity of the visual pattern on the document 12 is a function of the information contained on the visual pattern. The variations in reflectivity caused by black or dark alphanumeric symbols printed on a white or light background provide the requisite information to the image dissector which scans a predetermined geometrical area of the light image formed on its photocathode and converts such information into electronic signals for further use by, for example, a character recognition system.

A pair of illuminators 13 and 14 provide the light necessary for the reflection. With an ordinary lens system the illuminators 13 and 14 in combination with the image dissector 11 would cause the visual pattern appearing on the document 12 to be focused in the form of a light image onto the photocathode of the image dissector 11, substantially in a size ratio such that the maximum dimension of the scanned field falls within the available photocathode dimension. The lens system 15 which may consist of one or more different optical arrangements is interposed between the photocathode of the image dissector 11 and the visual pattern containing document 12. The illuminators 13 and 14 may be of a conventional type, e.g., lamps employing tungsten filaments for broadest spectral response in combination with a lens or reflector system to provide the requisite illumination. The image dissector tube 11 is also of a conventional type and is described more fully in connection with FIGURE 2. The image dissector 11 is described somewhat in detail to provide a better understanding of the present invention, and the manner in which the combination of the present invention provides an optical scanner having all the inherent advantages of the image dissector tube while minimizing its disadvantages.

The image dissector tube 11 is conventional and may be of the type classified by the model number ITTF4010. An image dissector is similar to a television camera tube in that it has a continuous photocathode on which is formed a light image which provides a photoelectric emission pattern. The image dissector scans by moving its electron-optical image over an aperture within the tube. An image dissector tube capable of being used in the present invention is shown in FIGURE 2.

The image dissector tube 11 shown in more detail in FIGURE 2 comprises an elongated cylindrical envelope

15 which might be made, e.g., of glass. One end of the tube is a transparent faceplate window 16. Adjacent the inner surface of the window 16 is a semitransparent photocathode 17 which for all practical purposes may be considered as part of or integral with the window 16. However, for purposes of presentation, it is shown separately as a dashed line opposite the window 16 just inside the envelope 15. At the other end of the tube 15 is a photomultiplier 18. The photomultiplier 18 is a conventional one and comprises a plurality of dynodes 19 within a casing 20. The casing 20 is maintained at a positive potential with respect to the photocathode 17. The casing 20 includes a flat portion 21 facing the photocathode 17 to which the electrons emitted from the photocathode 17 are attracted. The photocathode 17 may be maintained at ground or some other potential negative with respect to the potential of the casing 20. The flat portion 21 of the casing 20 contains an aperture 22 past which the emitted electrons may be swept in the horizontal and vertical directions. The multiplier 18 has an output terminal 23 which provides the video information via a video amplifier to the character recognition system. For example, the data on the output terminal 23 may be supplied to the storage and correlation components of a character recognition system through a video amplifier.

A focusing coil 24, a vertical deflecting coil 25 and a horizontal deflecting coil 26 concentrically surround the tube 15. The focusing coil 24 provides the proper field for the electron-optical section while the vertical and horizontal deflecting coils 25 and 26 provide the transverse fields. By whatever form the light image of the visual pattern, including characters or symbols, is formed on the window 16, each minute area of the photocathode 17 emits electrons as a function of the incident light. The field of the focus coil is adjusted to form an electron image substantially at unity magnification, in the plane of the aperture 22. The aperture 22 accepts only a small sample portion of the emitted electrons at any time but a systematic sweep and scan by the vertical and horizontal deflection coils or plates 25 and 26 causes the electron image to be serially transformed into video information and appear at the output terminal 23 of the multiplier 18.

In practice the diameter of the image dissector tube 11 might be $2\frac{3}{4}$ inches. A photocathode type, for example, S-11 is chosen to provide good spectral response of sufficient range to provide color response which is greatly in excess of that obtainable by an optical scanner utilizing a cathode ray tube. With a given size of the aperture 22, for example, .005 inch referred to the document, the resolution provided is more than adequate.

The fact that the image dissector tube has no charge storing surface provides several advantages. For example, the tube may be scanned in any desired mode unlike image orthicons and vidicons. Furthermore, with an image dissector tube there are no edge effects and no recharging problems. The fact that the image dissector utilizes only a photocathode provides long life and high reliability not obtainable by tubes such as vidicons and image orthicons and cathode ray tubes which all utilize thermionic cathodes.

The image dissector utilizes no storage mechanism such as those of the vidicon and of the image orthicon. Consequently, the electrons emitted by an elementary area of the photocathode are utilized only during the time when, in the course of scanning, that elementary area is imaged electronically on the image dissector aperture. The signal current thus entering the multiple section is, in some applications, limited by the achievable light level at the photocathode. However, the present invention is concerned with applications where the photocathode illumination is not the limiting factor. The photocathode current density must be kept below a certain level in order to assure good life for the tube. When the aperture is small, thus defining a small elementary photocathode area

and giving half resolution, this current density limitation tends to limit the image dissector to low bandwidth applications, that is, applications where the sampling interval is relatively long, in order to maintain adequate signal to noise ratio by collective sharing each sample time a sufficiently large number of electrons. The present invention overcomes this disadvantage while retaining the advantages which the image dissector has over the cathode ray tube and the conventional television camera tubes.

The present invention is being illustrated in two embodiments where each embodiment employs somewhat different optical systems in combination with the image dissector tube 11 to minimize the effects of the above-discussed statistical fluctuations and maintain photocathode current density at an appropriate level.

Many other character recognition systems utilize two types of scan. One type is known as the search scan and is utilized to locate the line and the location within the line of the characters to be read. The second type of scan is the read scan which is conducted on completion of the search scan.

The search scan and the read scan normally have quite different geometrical configurations. The search scan in this embodiment comprises a plurality of horizontal traces of the order of 0.3 inch long which progress upward a distance of up to three inches. The read scan consists of a plurality of short vertical traces whose length is determined by the height of the symbol or character to be scanned. The optical system disclosed in FIGURES 3, 4 and 5 reformats the search scan geometrical configuration by splitting and shifting the area to be scanned into equal top and bottom portions and projecting them side-by-side onto the photocathode of an image dissector tube.

Referring now more particularly to FIGURES 3, 4 and 5, there is shown the optical system for reformatting the rectangularly shaped search area or swath to be scanned on the document 12 into enlarged top and bottom portions of the swath and projecting these top and bottom portions in side-by-side relationship onto the photocathode 17 of the image dissector tube 11. The document 12 which contains the visual pattern may be a sheet of printed material such as a card, an envelope or a page of a manuscript. While the swath may have various dimensions, the dimensions of the swath in a practical embodiment has a width substantially equal to 0.3 inch and a length equal to 2.5 inches. The swath itself, hereinafter referred to by reference numeral 27, is nothing more than an area on the document 12 selected ultimately to be scanned by the image dissector 11 driving one vertical tracing of the object.

A pair of objective lenses 28 and 29, shown schematically as simple lenses in FIGURES 3, 4 and 5 are mounted in a light proof bulkhead between the object plane and the image dissector window. Referring to FIGURE 4, each lens is offset from the center line between the swath 27 and the photocathode 17. Thus, the upper portion 27a of the swath 27 is imaged by lens 29 at that same height as the image of a lower portion 27b formed by the lens 28. Referring to FIGURE 3, the lenses are offset horizontally so that the image of 27b, after reflection in mirror 30, and the image of 27a after reflection in mirror 31, fall adjacent one another on the photocathode 17. The presence of the two first surface mirrors allows the horizontal offset of the lenses to be sufficient to accommodate a light baffle which prevents light from object areas outside the swath 27 from reaching the image areas on the photocathode. A small separation is allowed between the images in order to avoid vignetting, that is shading, of the adjacent edges of the images of the portion 27a and 27b by the baffle. Depending on the required swath dimensions on the required lens apertures and on the photocathode life, the lenses as seen in FIGURE 3 can sometimes be placed sufficiently close to each other so that the baffle can be accommodated without the use of the mirrors.

As may be best seen from FIGURE 5, the lenses 28 and 29 accomplish reformatting of the rectangular swath 27 on the photocathode 17 by splitting the swath into an upper region 27a and a lower region 27b. The lenses 28 and 29 image the two regions 27a and 27b in side-by-side relationship on the photocathode 17 laterally disposed one from the other. The parameters such as the focal length of the lenses 28 and 29 and their relative distances with respect to the document 12 and the photocathode 17 provide a magnification in this embodiment of 1.75. In practice, a region of overlap is permitted in the vertical direction of the upper and lower halves of the swath 27 to permit the search scan to complete the identification of a line of print without interruption by the shift from one region to the other before the line is completely scanned. This region of overlap is shown in FIGURE 5 by the dashed lines appearing on the regions 27a and 27b.

When the vertical scan caused by the vertical deflection coil 25 of the image dissector tube 11 is required to shift from region 27b to 27a on the photocathode 17, it does so to a nominal position slightly below the corresponding position whence it came thereby eliminating the possibility of any loss of data.

The manner in which the lenses 28 and 29 and the mirrors 30 and 31 reformat the swath 27 at the photocathode 17 is best seen by following the ray diagram set forth in FIGURE 5. Considering the upper region 27a of the swath 27, lines or rays *a* and *a'* project from the corners of the upper region 27a of the swath 27. In optical terms these corners may be considered as the objects. The rays *a* and *a'* then reflect from the surface of the mirror 31 and form images at the photocathode 17 which are the lower corners of the image of the region 27a of the swath 27. In a similar manner, the rays represented by the lines *b* and *b'* project through the lens 29, reflect from the mirror 31 and locate the upper corners of the image of the region 27a. Likewise, the rays *c* and *c'* projecting from the upper corners of the lower region 27b of the swath 27 and the lines *d* and *d'* projecting from the lower corners of the lower half 27b respectively pass through the lens 28 and are reflected from the mirror 30 to form the upper and lower corners of the image of region 27b of the swath 27 on the photocathode.

Naturally, the lines *a* and *a'*, *c* and *c'*, *b* and *b'*, *d* and *d'* are representative of only a few optical rays which would in reality, be infinite in number. The physical parameters of the lenses 28 and 29 as related to the swath 27, the mirrors 30 and 31 and the photocathode 17 effects the splitting of the swath 27 into the upper and lower regions 27a and 27b and provides the magnification and relocation of the swath on the photocathode 17. That the distance between the reflective surfaces of the mirrors 30 and 31 controls the amount of separation between the upper and lower regions 27a and 27b of the swath 27 may be seen by disregarding the mirrors and extending the rays *a*, *a'*, *c*, *c'*, *b*, *b'* and *d*, *d'* to the plane defined by the photocathode 17. It may then be seen that the absence of the mirrors 30 and 31 causes the upper and lower regions 27a and 27b of the swath 27 to be projected onto the photocathode 17 at a much greater separation than shown in FIGURE 5.

The vertical and horizontal deflection coils 25 and 26 of the image dissector 11 cause the upper and lower regions 27a and 27b to be scanned by a plurality of horizontal scans progressing upwardly in the vertical direction. To be more precise, the electrons emitted by the photocathode in the areas receiving the image of the regions 27a and 27b are swept past the aperture 22 of the image dissector tube 11 providing the multiplier 18 with approximate video information representative of the black and white information of the scanned images. The lower half of the search field represented by the region 27b is scanned first while the upper half 27a is next scanned.

As the document 12 containing the visual pattern is moved past the scan field, successive swaths similar to swath 27 are imaged on the photocathode 17 for scanning by the image dissector tube 11.

In practice the lenses 28 and 29 may have comparatively short focal length and a small F number. Lenses of relative aperture F:6.3 to F:8 would be appropriate, in this application, providing sufficient depth of field.

The use of the mirrors 30 and 31 permit the lenses 28 and 29 to be separated by sufficient distance to accommodate baffling. Without the mirrors the lenses 28 and 29 would have to be placed so close together to gain sufficient closeness of the swath halves 27a and 27b as to prohibit baffling.

A baffle 39 is disposed between the lenses 28 and 29. It is parallel to the lines of the mirrors 30 and 31 and extends substantially from the lenses 28 and 29 to the photocathode 17 or more correctly the window of the image dissector which is not shown in FIGURE 3, 4 or 5. The baffle 39 may be serrated or blackened on its surface to prevent specular reflections. The purpose of the baffle is to prevent light from either lens 28 or 29 from reaching the photocathode area assigned to the other lens, thus preventing superimposition of different portions of the search field on the photocathode 17.

An opaque, transverse baffle 40 perpendicular to the baffle 39 and having a depth substantially equal to the depth of the mirrors 30 and 31 as shown in FIGURE 3, extends on either side of the baffle 39 nearly to the reflective surfaces of the respective mirrors 30 and 31. The baffle 40 prevents formation of spurious images by the lenses 28 and 29 in the photocathode area assigned to the lenses. In other words, light from the lens 28 can only reach the photocathode 17 by reflection from the mirror 30 and light from the lens 29 can only reach the photocathode 17 by reflection from the mirror 31.

The lenses 28 and 29 are in practice mounted in an opaque wall 41 which together with the baffle 39 and the mirrors 30 and 31, form two channels to the photocathode. The mirrors would, of course, extend from this wall to the photocathode 17. By providing top and bottom coverings for the channels all extraneous light is eliminated.

The foregoing baffling has been omitted in FIGURES 4 and 5 for clarity. It is desirable, of course, that the lenses 28 and 29 be assembled in compact barrels in order to provide good mounting in the close proximities involved.

Thus, there is provided a reformatting of the area to be scanned which permits more photocathode surface to be used during scanning operation which substantially eliminates problems associated with high electron current density and the statistical fluctuations of the emitted electrons. The magnification being made higher would not be possible without this reformatting, the dissector aperture 22 is made correspondingly larger and collects a higher photoelectron signal without increasing photocathode current density.

Once the search operation is completed and the line and the location within the line containing the data to be read is located, the read scan may begin. The typical read scan consists of a plurality of vertical traces of sufficient vertical length to scan the largest character contemplated with the movement of the document itself providing the horizontal displacement of the scans. In the read scan the problem of electron current density and statistical variation of the emitted electrons is the same as in the search scan. While a different structural arrangement of the optical system is adopted for the read scan, the function and principles of the optical system used in combination with the image dissector are essentially the same.

FIGURES 6, 7 and 8 illustrate a second embodiment of the present invention wherein the scan field to be reformatted is a typical read scan field. The image dissector tube utilized in combination with the optical system de-

scribed in these figures may be similar or identical to the image dissector tube 11.

In this embodiment, however, the basic scan trace consists of a single vertical line and horizontal deflection is used only to provide for repeated scanings of portions of the document whose horizontal motion both carries it past the viewing area and provides the horizontal component of the read scan. The window 16 of the image dissector 11 is provided with an opaque mask having a plurality of vertical slits through which the image to be scanned projects onto the photocathode. Thus, a plurality of rescan opportunities are provided. In this event the horizontal deflection coil is used to select a specified slit.

The light and dark information contained on the document is imaged onto the photocathode 17. The photocathode, in turn, converts the photo image into an electron image. The electron image formed by the focusing coil 24, emits electrons which are then swept past the aperture 22 of the image dissector 11 by means of its vertical deflection coil 26. The electron image is scanned continuously as the document moves past the viewing area thereby constantly changing the scan location relative to the document.

An opaque mask 32 having substantially the same circular cross-section or diameter as the window 16, is placed in a contiguous relationship with the window 16. A plurality of slits similar to slit 33 which is shown and which are elongated in the vertical direction are formed in the mask 32. Normally if only one slit is used, it would be in a position on the mask so as to center it on the window 16.

FIGURE 6 which is a top view of the optical system shows an objective lens 35 represented schematically as a simple line, disposed substantially midway between the document 12 and the window 16 of the image dissector 11. The objective lens 35 used here may typically have a focal length of six inches with a F:5.6 or F:8 relative aperture. An astigmatizer lens 36 which is a cylindrical lens having a cylindrical curvature in one direction is disposed adjacent to the lens 35. The cylindrical axis of the astigmatizer lens 36 is parallel to the length of the slit 33. The astigmatism introduced by the astigmatizer lens 36, is low and its effect on the design of the other lenses in the system is negligible.

An astigmatizer lens does not effect or change the point of focus of light rays that are in a plane parallel to its cylindrical axis. However, an astigmatizer lens effects changes in the point of focuses of light rays in a plane perpendicular to its axis. Referring to FIGURE 8 which is a side view, it is seen that light rays emanating from a point on the document 12 pass through the objective lens 35 and converge to focus via the slit 33 at the photocathode 17. The astigmatizer lens 36 having its axis parallel to the plane of the light rays does not disturb the focus point on the photocathode 17. However, by referring to the top view presented in FIGURE 6, where it can be seen that the axis of the astigmatizer lens 36 is in a plane perpendicular to the plane of the shown light rays, the horizontal focus occurs at the slit 33 within the mask 32.

A miniature cylindrical lens 34 shown in FIGURE 7 is located at the slit 33 as well as the other slits with its axis parallel to the vertical direction of the slit 33 causes the light rays focused at the lens 34 to be dispersed to cover a wider area on the photocathode 17. The lens 34, which is as long as the slit 33, may be fixed, for example, by cementing it at the slit 33. The lens 34 may be positive or negative. The image which is transferred from the document 12 is reformatted so that the vertical scan line is spread horizontally to occupy an increased area of the surface of the photocathode 17. The parameters may be so chosen that the horizontal spread of the scan line is increased over the scan line on the document by a factor of 10 or more. Thus, where the slits 33 have a width of .005 inch, the width of the image on the photocathode will be .05 inch, and the dissector aperture can be made correspondingly wider.

However, the height of the light image on the photocathode 17 is unaffected by the cylindrical lenses 34 and 36 due to the orientation of the axes of these lenses. In the example shown, the astigmatism introduced into the objective lens 35 by the lens 36 causes the diverging rays seen in the plane illustrated in FIGURE 6 to be focused at the cylindrical lens 34 located in the slit 33 of the mask 32, while the rays seen in the plane represented by FIGURE 8 pass through parallel glass surfaces of the lenses 36 and 34 to be focused onto the photocathode 17, and the dissector aperture height remains that of the elementary area.

Since the area viewed by the image dissector 11 is a narrow, elongated vertical line always one elementary area this wide line may be imaged in a plane other than the plane of the photocathode 17, and is defined in its horizontal extent by the physical mask 32. The vertical resolution is, of course, determined by the dimension of the aperture 22. The mask 32 may be located at various distances from the window 16 of the image dissector tube 11. In FIGURES 6, 7 and 8, it is shown as being adjacent to the faceplate 16 and external of it. Astigmatic power of the lens 36 is a function of the distance the mask 32 is disposed from the photocathode 17. The closer the mask is to the photocathode, the less astigmatic power is required. Similarly, the further away the mask is from the photocathode, the more astigmatic power is required.

Conversely, if the mask 32 is close to the photocathode 17 higher power is required in lens 34, whereas if the mask 32 is further away, less power is required and at a certain distance, lens 34 may even be omitted.

As aforementioned where it is desired to provide rescanning opportunities, a plurality of slits 33' parallel to slit 33 and having cylindrical lens 34' similar to lens 34 may be provided in the mask 32. In this situation, the slits should be placed at distances from each other so that the image falling on the photocathode 17 from one of the slits is discrete from the image falling on the photocathode from an adjacent slit. Baffling may be used between the slits so that only the light from any one slit is capable of reaching the assigned location on the photocathode 17. Thus, eliminating the slit to slit cross-talk which may result from diffraction at the edges of the slits.

The rescanning portion employed for rescanning a particular image is selected by horizontal deflection of the electrons emanating from the photocathode 17 since all of the slits 33 are simultaneously illuminated.

In any event, the optical system provides a light image of the desired scan area on the photocathode 17 ten times wider than the light image that would have been imaged on the photocathode 17 without the optical system, while at the same time, not increasing the vertical height of the light image. Thus, the light image presented to the image dissector for scanning makes it possible to maintain an acceptable electron current density and to prevent introduction of error due to the statistical fluctuations of emitted electrons at the photocathode.

What is claimed is:

1. An optical system for imaging a rectangularly shaped area to be scanned onto a screen as upper and lower halves of the scanned area arranged in side-by-side relationship comprising in combination

- a first objective lens disposed to one side of and midway down the upper half of said scanned area,
- a second objective lens disposed to the other side of and midway up the lower half of said scanned area,
- each of said first and second lenses disposed in a plane parallel to the plane of the screen and between said screen and said scanned area, and
- a pair of mirrors having planar reflective surfaces parallel to and facing each other with said surfaces perpendicular to the plane of said screen and to the direction in which the image of said light source is split for causing the distance between the upper and

lower halves of the search area projected onto the screen to be maintained at a selected distance.

2. An optical system for imaging light from a data surface onto a screen as narrow elongated light images comprising in combination

- an opaque mask having a plurality of narrow elongated slits adjacent the screen, and
- a lens arrangement disposed between the data surface and the screen causing the light passing through said slits to be projected onto the screen as a plurality of light images each having a width substantially greater than the width of its respective slit and a maximum length equal to the length of its respective slit, said lens arrangement comprising
- an objective lens disposed between the data surface and said mask for focusing light at the screen,
- an astigmatic lens disposed adjacent said objective lens having its axis of cylinder parallel to the direction of elongation of said slits causing the light passing through said objective lens in one plane to be focused at said slits while leaving unaffected the light in the plane perpendicular to said one plane, and
- a plurality of cylindrical lenses each covering the length of one of said slits for dispersing the light focused at its respective slit whereby the associated light image projected onto the screen has a width substantially greater than the width of the slit and a maximum length equal to the length of the slit, each cylindrical lens having its axis of cylinder parallel to the axis of cylinder of said astigmatic lens.

3. An optical scanner for converting a visual pattern into electrical signals comprising

- an electronic device having a light-sensitive surface,
- illuminator means disposed relative to said surface for causing a light image of the visual pattern to be scanned to be projected onto said surface, and
- optical means disposed between said surface and the visual pattern to be scanned for expanding said image along its shorter axis when said image is projected onto said surface so that the area of said image projected onto said surface is increased, said optical means comprising

- an opaque mask having a narrow elongated slit, and
- a lens arrangement disposed between the visual pattern to be scanned and said surface causing the light passing through said slit to be projected onto said surface as a light image having a width substantially greater than the width of said slit, said lens arrangement comprising
- an astigmatic objective lens group between the visual pattern to be scanned and said mask for focusing light from the visual pattern onto said slit in the azimuth perpendicular to said slit while focusing the light from the visual pattern at said surface in the azimuth parallel to said slit.

4. An optical scanner according to claim 3 in which said astigmatic objective lens group comprises an objective lens and a cylindrical lens.

5. An optical scanner according to claim 4 in which said cylindrical lens is a positive cylindrical lens.

6. An optical scanner according to claim 3 in which the dispersion of light between the slit and said surface in the azimuth perpendicular to said slit is aided by a dispersing element.

7. An optical scanner according to claim 6 wherein said dispersing element is a cylindrical lens covering the length of said slit and having its axis of cylinder parallel to the axis of cylinder of said positive cylindrical lens.

8. An optical scanner according to claim 7 in which said electronic device is an electron tube having a light-sensitive photocathode.

9. An optical scanner according to claim 8 in which said electron tube is an image dissector.

10. An optical scanner for converting a visual pattern into electrical signals, comprising in combination:

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an image dissector electron tube having a light-sensitive photocathode,
 illuminator means disposed relative to said photocathode for causing a light image of the visual pattern to be scanned to be projected onto said photocathode, and
 optical means disposed between said photocathode and the visual pattern to be scanned for increasing the area of said light image projected onto said photocathode,
 said optical means comprising an optical arrangement for expanding said image along its shorter axis when said image is projected onto said photocathode and for splitting said light image into a plurality of sections and repositioning said sections onto said photocathode to use as great an area of said photocathode surface as is commensurate with the number of said sections.

11. An optical scanner according to claim 10 wherein said optical system comprises:
 a plurality of objective lens equal to the number of said sections, each of said lenses disposed to project an image of the area of the visual pattern defined by each of said sections onto said photocathode,
 each of said objective lens spacially offset relative to each other to provide images on the photocathode in a fixed relationship.

12. An optical scanner according to claim 10 wherein said optical means comprises an optical system for splitting said light image into top and bottom portions and projecting said top and bottom portions of said light image in side-by-side relationship onto said photocathode.

13. An optical scanner according to claim 12 wherein said optical system comprises:
 first and second objective lenses disposed between the visual pattern and the plane of said photocathode, said first objective lens disposed to project the upper half of the visual pattern as a light image onto said photocathode,
 said second objective lens diagonally offset relative to said first objective lens to project the lower half of the visual pattern as a light image onto said photo-

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cathode in side-by-side relationship with the upper half of the visual pattern.

14. An optical scanner according to claim 12 wherein said optical system comprises:
 first and second objective lenses disposed in a plane parallel to the plane of said photocathode, said first objective lens disposed on one side and substantially midway down the upper half of the visual pattern to be scanned,
 said second objective lens disposed on the other side and substantially midway up the lower half of the visual pattern to be scanned,
 whereby said light image is projected onto said photocathode split into upper and lower halves and arranged in side-by-side relationship.

15. An optical scanner according to claim 14 wherein said optical system further comprises:
 means causing the upper and lower halves of said light image projected onto said photocathode to be separated by a selected distance.

16. An optical scanner according to claim 15 wherein said means comprises:
 a pair of mirror means with planar reflective surfaces facing each other with said surfaces perpendicular to the direction in which said image is split.

17. An optical scanner according to claim 16 further including:
 baffle means extending between said mirror means preventing light from said first and second lenses from intermingling and permitting only light reflected from said surfaces of said mirror means to reach said photocathode.

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