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EP A1 0012587
GB A 2064153
GB A 2029045
GB A 2011105
GB 1508378
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G2X

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(54) Optically annotatable recording film

(57) A transparent recording film including a pre-recorded primary image layer 13 and a secondary recording means 14 annotatable by the marking light. The two layers 13, 14 are congruent, and in one embodiment comprise superimposed substrates which are joined mechanically (Figure 1). In another embodiment, the two layers 13, 14 are coated jointly on one substrate (Figure 2), and in a further embodiment the two imaging components are intimately mixed to form one bifunctional layer 18 (Figure 4). Various types of secondary recording means are disclosed such that the primary image layer 13 is unaffected by the marking light, and the annotatable secondary layer 14 is unaffected by the projection illumination.

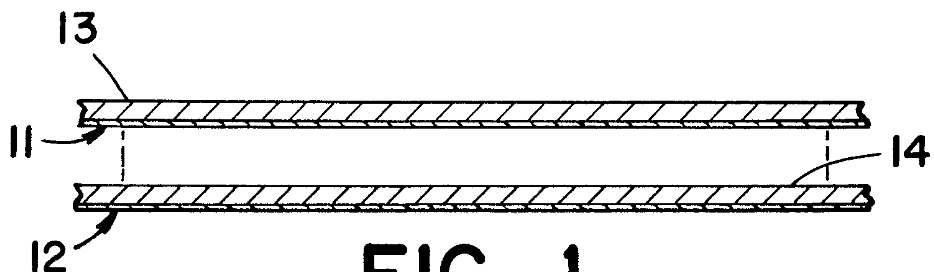

FIG_1

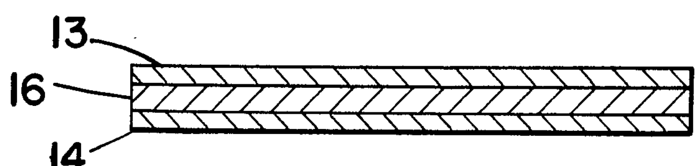

FIG_2

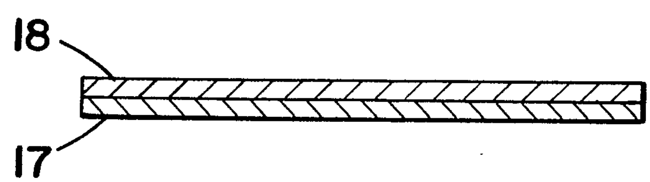

FIG_4

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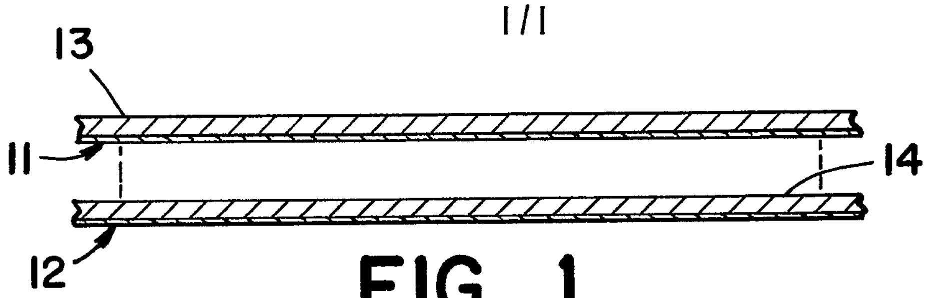

FIG_1

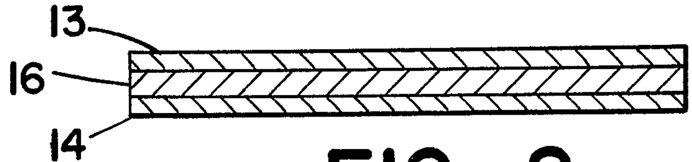

FIG_2

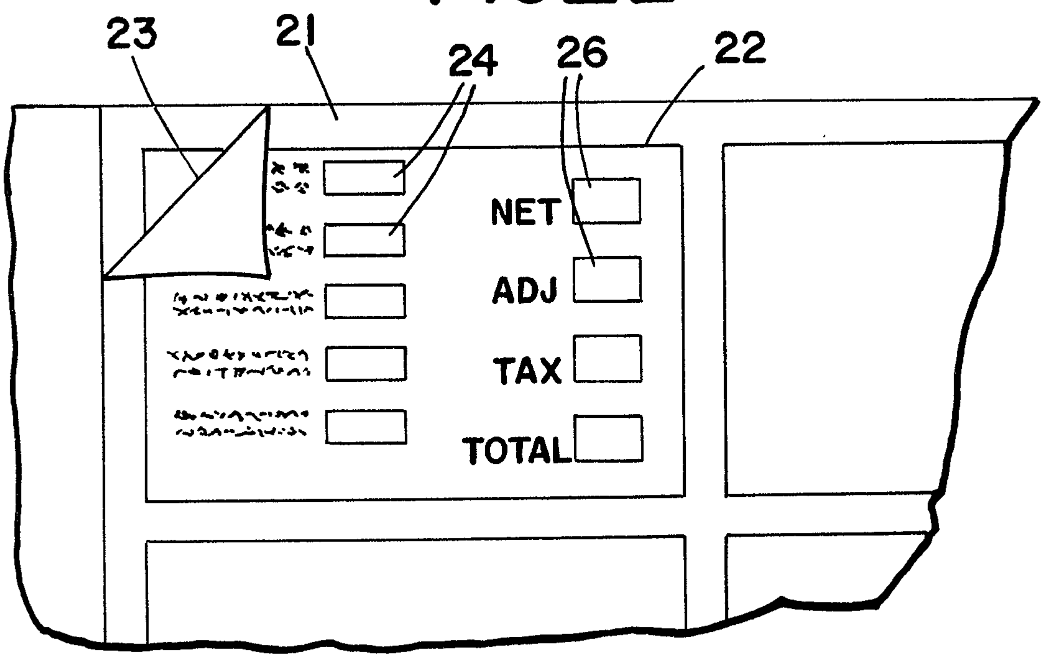

FIG_3

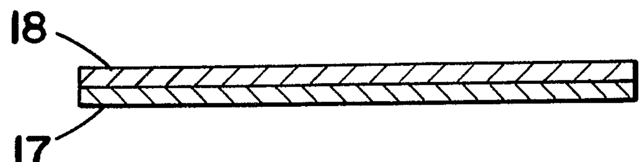

FIG_4

SPECIFICATION

Optically annotatable recording film

This invention concerns a film structure adapted for use in a bi-directional optical apparatus for optically annotating an image projected from a transparency.

U.S. Patent No. 4,191,457, issued March 4, 1980 to Arthur R. Zingher, discloses an apparatus for selectively annotating an optically projected transparency by means of a writing light which is directed at the apparent projected image, through the projection optics, and focussed directly adjacent to the transparency. The present invention is directed toward an annotatable recording film which may be used in this apparatus.

The following United States patents comprise the closest known prior art:

4,133,688	4,121,196
4,127,322	4,000,945
3,684,552	3,892,965
3,682,684	3,664,858
3,852,093	3,592,528
3,843,384	

These prior art references disclose various component technologies in which images are formed by thermographic or photochemical processes. None of these references disclose a film which can be utilized in the apparatus for annotating an optically projected transparency.

In order to overcome this disadvantage the present invention provides a film structure for use in a bi-directional optical apparatus which projects an image from said film structure and which includes a marking light for optically annoating said image, comprising primary image storage means for recording a primary image, secondary image recording means responsive to said marking light to record annotations to said primary image, and means for joining said primary image storage means and said secondary image recording means in closely spaced disposition with said primary image and said annotations in congruent registration.

The film structure includes a primary layer on which a primary image is prerecorded, as well as a secondary layer which is selectively annotatable by means of a marking light which is directed reversably through the projection optics to impinge upon the secondary layer. In one embodiment, the primary layer is a film substrate on which is coated a photochemical emulsion, while the secondary layer includes a thermographic substance which is selectively responsive to the marking light. The two layers are congruent, and may be joined to separate substrates which are mechanically joined by adhesive or mechanical means. In an alternative embodiment, the two layers are coated on opposite sides of a single substrate. In a further embodiment the primary and secondary layers are intimately mixed in a single bifunctional structure. A salient feature of the present invention is that the primary layer, on which the primary image is pre-recorded, is unaffected by the marking light, whereas the secondary layer, which is selectively annotatable by the marking light, is unaffected by the projection illumination. The marking light causes a virtually instantaneous reaction in the secondary layer, the reaction creating a localized change in the transparency or colour of the secondary layer. As a result, the projected image, which is a combination of the pre-recorded primary image and the annotated secondary image, is likewise altered virtually instantaneously. Thus an individual viewing the projected combined image may selectively direct the marking light at portions of the image to alter the informational content of the image.

The primary and secondary images may comprise positive images or negative images in complementary colours, so that the primary information and the secondarily annotated information in the combined image may be distinguished. In an alternative embodiment a bi-functional layer contains both primary and secondary image recording substances which are intimately intermixed. A primary image may be pre-recorded in the bi-functional layer, with the marking light causing localized discoloration or bleaching of the primary image during secondary annotation thereof.

The invention will be described further, by way of example, with reference to the accompanying drawings in which:-

Figure 1 is a cross-sectional elevation of one embodiment of the film structure of the present invention;

Figure 2 is a cross-sectional elevation of a further embodiment of the film structure of the present invention;

Figure 3 is a partial plan view of one adaptation of the embodiment of Figure 1; and

Figure 4 is a cross-sectional elevation of another embodiment of the film structure of the present invention.

The present invention generally comprises a film transparency structure for use in a bi-directional optical apparatus which projects an image from the transparency and also permits selective annotation of the projected image. The projection apparatus is disclosed in U.S. Patent No. 4,191,457, issued March 4, 1980; that disclosure is hereby incorporated by reference in the present description.

With reference to Figure 1, one embodiment of the film structure of the present invention includes a primary substrate 11 and a secondary substrate 12. Adhering to the primary substrate 11 is a primary image storing layer 13. Likewise, a secondary image recording layer 14 is secured to the secondary substrate 12. The primary image recording layer is generally pre-recorded prior to use of the film structure in an image annotating apparatus. The prerecording of the primary image may be accomplished by photographic or electrographic techniques. The secondary image recording layer 14 is generally not pre-recorded, but is adapted to be annotated by use of the marking light of the bi-directional apparatus which projects the image stored in the primary layer 13.

The image stored in the primary layer 13 may be recorded by a photochemical reaction in which a full image frame is recorded at once. For example, the layer 13 may comprise a silver halide emulsion which is exposed to the primary image and then developed and fixed with a thiosulfate process known in the prior art. Alternatively, the primary layer 13 may comprise a static charge storing compound which is photoelectrically or photoconductively exposed to the primary image, and subsequently fixed using electrophotographic techniques known in the prior art. The charge carrying surface may be the layer 13 itself or another surface which transfers the primary image to the layer 13 during the electrophotographic process.

The primary image may be formed upon the primary layer 13 by direct printing or embossing thereon through direct mechanical contact, or by the use of ink jet printing techniques, or the like. Other means of forming the primary image in the primary layer 13 include intense, directed local radiation such as various diazo processes known in the prior art. Likewise, thermographic, pyrographic, or lasergraphic processes may be used to create the primary image in the primary layer 13. For some of these image forming processes, the primary layer 13 may comprise the primary substrate itself.

The secondary layer 14 is adapted to record and display immediately annotations to the primary image which are created by a brief exposure of the secondary layer 14 to the marking light of the bidirectional projection and annotation apparatus. The secondary image must appear immediately after exposure, without a macroscopic interruption for development of the secondary image, so that the primary image may be annotated and viewed in a real time process. In one embodiment, the secondary layer 14 comprises polyvinyl chloride which is coated or intermixed with iron acetyl acetonate. The iron acetyl acetonate absorbs the marking light of the annotation apparatus, causing localized heating in the layer 14. The localized heating of the polyvinyl chloride produces a visible char which is much more opaque than the polyvinyl chloride layer.

Alternatively, the secondary imaging layer 14 may include a substance such as lead dithioformate. When the lead diothioformate is illuminated by the marking light, it undergoes a thermographic monomolecular decomposition. Upon decomposing, it deposits black lead sulfide, creating a localized opacity in the secondary layer. Monomolecular reactions such as this thermographic decomposition are advantageous in that they exhibit a fast microscopic initiation speed. Hence they are particularly suitable for pulsed marking light sources, such as pulsed lasers.

In another embodiment, the secondary layer 14 may include a meltable binder material in which a silver salt is intermixed with soap granules. Impingement of the marking light upon the secondary layer causes a thermographic bimolecular reaction in which melting and diffusion takes place in the binder in the localized area where the silver salt absorbs the marking light. The localized heating caused by the silver salt reacting to the marking light creates a localized melting zone in which the soap granules diffuse, thus altering the light transmitting characteristics thereof.

In a further embodiment, the secondary layer 14 may comprise a transparent plastic material which includes an infra red light absorbing dye. For this embodiment the projection and annotating apparatus includes an infra red marking light which is absorbed by the dye in the secondary layer. When sufficient infra red energy is absorbed by the dye in a localised area, the layer 14 melts. After the marking light illumination terminates, or translates to another part of the secondary layer, the melted zone resolidifies with an irregular optical texture. The irregular optical texture may be enhanced by the optical arrangement of the projection apparatus; for example, by the use of polarizing filters or Schlieren optics, or the like.

It may be appreciated that any of the embodiments of the secondary layer may be combined advantageously with any of the embodiments of the primary layer. The two layers must be congruent and closely adjacent so that their respective images will be superimposed by the projection illumination. The secondary substrate 12 may be joined to the primary substrate 11 by means of an adhesive layer having a peelable backing layer. Thus, the backing layer could be removed to expose the adhesive layer, and the secondary substrate could then be adhered to the primary substrate. This structure is useful for retrofitting pre-existing microfiche or microcard records. It may be appreciated that the secondary image could be separated and removed from the primary substrate, so that the annotations to the primary image could be renewed or replaced by the addition of another secondary structure. The two substrates 11 and 12 may also be joined by more permanent mechanical means, such as adhesive, tape, ultrasonic or thermal plastic welding, staples, rivets, and the like. In these latter examples it is apparent that the secondary, annotating image could not easily be renewed or replaced.

With reference to Figure 2, a further embodiment of the present invention includes a unitary substrate 16 on which the primary layer 13 and the secondary layer 14 are coated on opposite sides thereof. The secondary layer 14 may be secured to the substrate 16 after the image recorded in the primary layer 13 is developed or otherwise fixed, according to the image recording process embodied therein. The primary and secondary layers are applied to opposed sides of substrate 16 to minimize any adverse chemical reaction that may take place therebetween. The primary and secondary layers 13 and 14 may embody any of the image recording process described with reference to the previous embodiment. The embodiment of Figure 2 may be adapted for use with computer output micrographic systems by the addition thereto of a device which applies the secondary layer 14 to the micrographic output film after an image has been recorded thereon by any of the computer output micrographic (COM) systems known in the prior art.

In the embodiments shown in Figures 1 and 2, it is advantageous for the secondary layer to be disposed nearer to viewing screen, and the primary layer farther from the viewing screen, so that the opaque areas of the primary image do not prevent the marking light from impinging upon the secondary layer.

With reference to Figure 4, a further embodiment of the film structure of the present invention includes a substrate 17 and a bifunctional layer 18 adhered to one surface of the substrate. The bifunctional layer includes primary and secondary components intimately combined, so that the primary image and the annotated secondary image may be formed within the single layer 18. For example, the primary image recording component may comprise standard silver halide photochemicstry, with the addition of an extra infra red light selective absorber in the developed emulsion. After the primary image has been exposed and developed, it may be annotated pyrographically by localized absorption of an infra red marking light which is matched in wavelength to the band width of the infra red absorber in the layer 18.

Alternatively, the embodiment of Figure 4 may form the secondary image by means of a thermographic binary chemical reaction between the primary and secondary components. The primary image may be formed photochemically or electrostatically using a primary image pigment or dye which is subject to chemical discoloration or chemical bleaching. Dispersed in the layer 18 are fine grains or coated microspheres of a meltable solid in which are embedded a suitable bleaching compound and a selective infra red light absorbing compound. When the marking light impinges upon the selective infra red absorber, it causes localized heating which melts the solid material in the grains or microspheres and causes release of the bleaching compound in the localized, melted area. The bleaching compound discolours the primary image in the localized area, thus altering the informational content thereof.

As another alternative, the embodiment of Figure 4 may include in the layer 18 a primary image pigment or die which is subject to radiant bleaching action by the secondary marking light. For example, most dyes are faded or deteriorated by exposure to ultra violet light. Assuming that the projection and annotating apparatus provides an ultraviolet marking light, the marking light may radiantly bleach the dye compound which forms the primary image. Due to the fact that this embodiment involves no diffusion or chemical reaction, it exhibits an advantageous microscopic speed.

It is apparent that the superimposed primary and secondary images should be clearly visible and distinguishable. Assuming that transmission images are employed, if both images are positive (dark letters and marks on a light background), then both images will be visible. However, this arrangement is disadvantageous in that a bright background tends to produce eye fatigue in the reader or viewer. If negative superimposed images are used, with transparent letters and marks on separate black backgrounds, the combined image will be dim, low contrast, and difficult to view.

A salient feature of the present invention is the use of complementary colours for the two negative images. For example, the primary image may comprise clear letters on a red transmitting background, while the secondary image comprises clear letters on a green transmitting background. The projected, combined images of the superimposed separate images will show the bright green letters of the primary image and bright red marks of the annotating image against a dark black background. Of course, the optical system of the projection and annotating apparatus will be matched to this two-colour system, including the light sources, lenses, mirrors, screen, and anti-ambient filters or coatings.

It may be appreciated that the embodiments of the present invention which employ bleaching, bifunctional bleaching, or discolouration do not require the use of complementary colours for the separate images. The process of recording the secondary image by bleaching or discoloration creates a clear spot in an otherwise absorbing primary background. Thus both the primary letters and the secondary marks will be projected as bright picture elements on a dark background.

It may be appreciated that the secondary image forming component of the film structure must be sensitive to a brief illumination by the marking light, while being insensitive to prolonged exposure to the projection illumination. Fortunately, many thermographic melting processes known in the prior art exhibit a sharply defined transition temperature. They respond to momentary intense local heating, but are unaffected by prolonged illumination at sub-threshold temperatures. Therefore the secondary image forming component easily may be made to distinguish between the intense marking light illumination and the steady but much less intense projection illumination.

Indeed, the projection illumination acts synergistically to facilitate secondary annotation of the film structure. In a typical microfiche reader, the film is heated to approximately 160° Fahrenheit by the projection illumination, despite the use of infrared squelching filters in the projection light commimator source. This preheating of the film assists most secondary recording process described in the foregoing, and permits a more reliable annotation with a less powerful marking light. Since a typical thermographic secondary image forming process exhibits a transition temperature of 175° Fahrenheit, the marking light is required to heat the localized area of the secondary layer from room temperature (approximately 65° Fahrenheit) to the transition temperature of 175° Fahrenheit, an increment of 110° Fahrenheit. This far larger increment would necessitate a much more intense marking light, a requirement that is obviated synergistically by the heating effect of the projection illumination.

The film structure of the present invention is also uniquely adaptable as a computer input micrographic (CIM) medium. With reference to Figure 3, a microfiche field 21 includes one or more frames 22. The frames 22 are provided with primary images which catalogue a large amount of data; for example, replacement parts for appliances and other items sold by a retail outlet, or inventory records of an automotive parts department in a franchise dealership. Adhered to the microfiche field 21 is an overlay 23 which is releasably secured to the microfiche card. The overlay 23 includes defined response areas 24 and 26 in which secondary image forming components are disposed. To order parts or the like from the microfiche catalogue, the operator or dealer uses the marking light of the annoating apparatus to mark the proper response areas 24 and 26. The microfiche card may then be sent to a central warehouse or other processing area where the overlay 23 is removed and scanned by a suitably adapted computer. A new overlay 23 may then be applied to the field 21 of the microfiche card, which is then returned to the dealer for refuse. This system avoids the errors often incurred in copying part numbers and quantities or in making adquate parts descriptions on order forms. The primary micrographic images are very economical in displaying large amounts of customized data, even on a one-of-a-kind basis.

The defined response zones 24 and 26 prevent stray markings on the overlay 23 which might causes errors in the machine reading of the order form. Machine reading of the order form may be facilitated by use of the two colour complementary system described in the foregoing, since the annotation may be automatically separated from any primary image by suitable filters. This computer input micrographic system also offers distinct advantages over computer terminal systems in low-cost applications. For example, detailed diagrams which often accompany component lists and the like require a very high quality computer graphical terminal, in addition to a large amount of electronic storage. For this type of application, the CIM system described herein is much more economical.

CLAIMS

1. A film structure for use in a bi-directional optical apparatus which projects an image from said film structure and which includes a marking light for optically annotating said image, comprising primary image storage means for recording a primary image, secondary image recording means responsive to said marking light to record annotations to said primary image, and means for joining said primary image storage means and said secondary image recording means in closely spaced disposition with said primary image and said annotations in congruent registration.

2. A film structure as claimed in claim 1, further including a common substrate, said primary image storage means and said secondary image recording means adhering to said common substrate.

3. A film structure as claimed in claim 1, further including a primary substrate to which said primary image storage means is adhered, and a secondary substrate to which said secondary image recording means is adhered.

4. A film structure as claimed in claim 1, further including a bifunctional layer in which said primary image storage means and said secondary image recording means are combined.

5. A film structure as claimed in claim 1, wherein said primary image storage means comprises photochemical means.

6. A film structure as claimed in claim 1, wherein said primary image storage means comprises electrophotographic means.

7. A film structure as claimed in claim 1, wherein said primary image storage means comprises printed means.

8. A film structure as claimed in claim 1, wherein said primary image storage means comprises diazo process means.

9. A film structure as claimed in claim 1, wherein said primary image storage means comprises thermographic means.

10. A film structure as claimed in claim 1, wherein said secondary image recording means comprises pyrographic means.

11. A film structure as claimed in claim 10, wherein said pyrographic means includes iron acetyl acetonate coated on polyvinyl chloride.

12. A film structure as claimed in claim 1, wherein said secondary image recording means comprises thermographic monomolecular decomposing means.

13. A film structure as claimed in claim 12, wherein said last mentioned means includes lead dithioformate.

14. A film structure as claimed in claim 1, wherein said secondary image recording means comprises thermographic bimolecular reacting means.

15. A film structure as claimed in claim 14, wherein said last mentioned means includes a silver salt and granules of soap intermixed in a meltable binder compound.

16. A film structure as claimed in claim 1, wherein said secondary image recording means comprises thermographic melting means.

17. A film structure as claimed in claim 16, wherein said thermographic melting means includes a transparent layer and an infra red wavelength absorbing dye dispersed in said transparent layer.

18. A film structure as claimed in claim 2, wherein said primary image storage means and said secondary image recording means are adhered to opposed sides of said common substrate.

19. A film structure as claimed in claim 4, wherein said primary image storage means comprises photochemical means, and said secondary image recording means comprises an infra red wavelength absorbing compound.

20. A film structure as claimed in claim 4, wherein said primary image storage means comprises dye means, and said secondary image recording means comprises means for bleaching localized portions of said dye means.

21. A film structure as claimed in claim 20, wherein said means for bleaching comprises a meltable compound combined with a bleaching compound and an infra red wavelength absorbing compound.

22. A film structure as claimed in claim 4, wherein said primary image storage means includes means responsive to ultra-violet wavelengths for radiant bleaching thereby.

23. A film structure as claimed in claim 1, wherein said primary image storage means compris-

es transparent portions on a translucent field having a first colour, said secondary image recording means includes transparent portions on a translucent field having a second colour, said first and second colours being complementary.

24. A film structure as claimed in claim 1, wherein said primary image storage means comprises a first transparency having a primary image prerecorded thereon.

25. A film structure as claimed in claim 24, further including a second transparency mechanically joined to said first transparency.

26. A film structure as claimed in claim 25, wherein said secondary image recording means comprises defined response zones in said second transparency, said defined response zones being aligned with selected portions of said primary image.

27. A film structure as claimed in claim 25, wherein said second transparency is selectively removable from said first transparency.

28. A computer input micrographic medium adapted for use with a bi-directional optical apparatus which projects an image from said medium and which includes a marking light for optically annotating said image, comprising primary image storage means defining a micrographic image data field with information recorded thereon, secondary image recording means responsive to said marking light to record selective marking of said image, said secondary image recording means comprising a plurality of defined response zones, each associated with and disposed in congruent registration with a selected portion of said micrographic image data field so that selective marking of any of said defined response zones comprises a response to its associated selected portion of said image data field, said defined response zones being readable by machine as input data.

29. A computer input medium as claimed in claim 28, wherein said secondary image recording means is removable from said primary image storage means after marking thereof and is replaceable by further, unmarked secondary image recording means.

30. A computer input medium as claimed in claim 28, wherein said secondary image recording means includes a transparency mechanically joined to said primary image storage means.

31. A computer input medium substantially as hereinbefore described with reference to the accompanying drawings.

32. A film structure substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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