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(54) Title: ELECTRO-OPTIC DISPLAYS, AND MATERIALS AND METHODS FOR PRODUCTION THEREOF

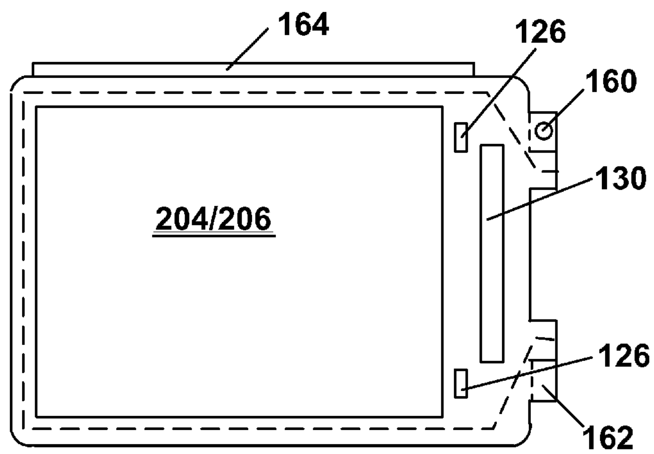

Fig. 5

(57) Abstract: An electro-optic display is produced using a sub-assembly (156) comprising a front sheet (120), an electro-optic medium (204); and an adhesive layer (122). An aperture (128) is formed through the adhesive layer (122) where the adhesive layer (122) is not covered by the electro-optic medium (204), and the sub-assembly is adhered to a backplane (154) having a co-operating member (152) with the aperture (128) engaged with a co-operating member (152), thus locating the sub-assembly (156) relative to the backplane (154). In another form of electro-optic display, a chip (144) extends through an aperture (130) in the electro-optic medium and adhesive layer. In a third form, the aforementioned sub-assembly (156) is secured to a backplane (154) and then a cut is made through both backplane (154) and sub-assembly (156) to provide an aligned edge.

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ELECTRO-OPTIC DISPLAYS, AND MATERIALS AND METHODS FOR PRODUCTION THEREOF

[Para 1] This invention is related to:

(a) U.S. Patent No. 6,982,178;

(b) U.S. Patent Publication No. 2004/0155857;

(c) U.S. Patent No. 7,110,164;

(d) U.S. Patent No. 7,075,703;

(e) U.S. Patent Publication No. 2007/0109219;

(f) U.S. Patent Publication No. 2007/0152956;

(g) U.S. Patent Publication No. 2007/021 133 1; and

(h) U.S. Patent Publication No. 2008/0057252.

[Para 2] This invention relates to electro-optic displays, and to materials and methods for the production of such displays. This invention is particularly, but not exclusively, intended for use with displays comprising encapsulated electrophoretic media. However, the invention can also make use of various other types of electro-optic media which are solid, in the sense that they have solid external surfaces, although the media may, and often do, have internal cavities which contain a fluid (either liquid or gas). Thus, the term "solid electro-optic displays" includes encapsulated electrophoretic displays, encapsulated liquid crystal displays, and other types of displays discussed below.

[Para 3] Electro-optic displays comprise a layer of electro-optic material, a term which is used herein in its conventional meaning in the imaging art to refer to a material having first and second display states differing in at least one optical property, the material being changed from its first to its second display state by application of an electric field to the material.

[Para 4] The terms "bistable" and "bistability" are used herein in their conventional meaning in the art to refer to displays comprising display elements having first and second display states differing in at least one optical property, and such that after any given element has been driven, by means of an addressing pulse of finite duration, to assume either its first or second display state, after the addressing pulse has terminated, that state will persist for at least several times, for example at least four times, the minimum duration of the addressing pulse required to change the state of the display element.

[Para 5] Several types of electro-optic displays are known, for example:

(a) rotating bichromal member displays (see, for example, U.S. Patents Nos. 5,808,783; 5,777,782; 5,760,761; 6,054,071 6,055,091; 6,097,531; 6,128,124; 6,137,467; and 6,147,791);

(b) electrochromic displays (see, for example, O'Regan, B., et al, Nature 1991, *353,* 737; Wood, D., Information Display, *18(3),* 24 (March 2002); Bach, U., et al., Adv. Mater., 2002, *14(11),* 845; and U.S. Patents Nos. 6,301,038; 6,870.657; and 6,950,220);

(c) electro-wetting displays (see Hayes, R.A., et al., "Video-Speed Electronic Paper Based on Electrowetting", Nature, *425,* 383-385 (25 September 2003) and U.S. Patent Publication No. 2005/0151709);

(d) particle-based electrophoretic displays, in which a plurality of charged particles move through a fluid under the influence of an electric field (see U.S. Patents Nos. 5,930,026; 5,961,804; 6,017,584; 6,067,185; 6,118,426; 6,120,588; 6,120,839; 6,124,851; 6,130,773; and 6,130,774; U.S. Patent Applications Publication Nos. 2002/0060321; 2002/0090980; 2003/0011560; 2003/0102858; 2003/0151702; 2003/0222315; 2004/0014265; 2004/0075634; 2004/0094422; 2004/0105036; 2005/0062714; and 2005/0270261; and International Applications Publication Nos. WO 00/38000; WO 00/36560; WO 00/67110; and WO 01/07961; and European Patents Nos. 1,099,207 Bl; and 1,145,072 Bl; and the other MIT and E Ink patents and applications discussed in the aforementioned U.S. Patent No. 7,012,600).

[Para 6] There are several different variants of electrophoretic media. Electrophoretic media can use liquid or gaseous fluids; for gaseous fluids see, for example, Kitamura, T., et al., "Electrical toner movement for electronic paper-like display", IDW Japan, 2001, Paper HCSl-I, and Yamaguchi, Y., et al., "Toner display using insulative particles charged triboelectrically", IDW Japan, 2001, Paper AMD4-4); U.S. Patent Publication No. 2005/0001810; European Patent Applications 1,462,847; 1,482,354; 1,484,635; 1,500,971; 1,501,194; 1,536,271; 1,542,067; 1,577,702; 1,577,703; and 1,598,694; and International Applications WO 2004/090626; WO 2004/079442; and WO 2004/001498. The media may be encapsulated, comprising numerous small capsules, each of which itself comprises an internal phase containing electrophoretically-mobile particles suspended in a liquid suspending medium, and a capsule wall surrounding the internal phase. Typically, the capsules are themselves held within a polymeric binder to form a coherent layer positioned between two electrodes; see the aforementioned MIT and E Ink patents and applications. Alternatively, the walls surrounding the discrete microcapsules in an encapsulated electrophoretic medium may be replaced by a continuous phase, thus producing a so-called polymer-dispersed electrophoretic display, in which the electrophoretic medium comprises a plurality of discrete droplets of an electrophoretic fluid and a continuous phase of a polymeric material; see for example, U.S. Patent No. 6,866,760. For purposes of the present application, such polymer-dispersed electrophoretic media are regarded as sub-species of encapsulated electrophoretic media. Another variant is a so-called "microcell electrophoretic display" in which the charged particles and the fluid are retained within a plurality of cavities formed within a carrier medium, typically a polymeric film; see, for example, U.S. Patents Nos. 6,672,921 and 6,788,449.

[Para 7] Electrophoretic media can operate in a "shutter mode" in which one display state is substantially opaque and one is light-transmissive. See, for example, U.S. Patents Nos. 6,130,774 and 6,172,798, and U.S. Patents Nos. 5,872,552; 6,144,361; 6,271,823; 6,225,971; and 6,184,856. Dielectrophoretic displays can operate in a similar mode; see U.S. Patent No. 4,418,346. Other types of electro-optic displays may also be capable of operating in shutter mode.

[Para 8] Other types of electro-optic materials may also be used in the present invention.

[Para 9] Most prior art methods for the production of electrophoretic displays are essentially batch methods in which the electro-optic medium, the lamination adhesive and the backplane are only brought together immediately prior to final assembly, and it is desirable to provide methods better adapted for mass production.

[Para 10] The aforementioned U.S. Patent No. 6,982,178 describes a method of assembling a solid electro-optic display (including an encapsulated electrophoretic display) which is well adapted for mass production. Essentially, this patent describes a so-called "front plane laminate" ("FPL") which comprises, in order, a light-transmissive electrically-conductive layer; a layer of a solid electro-optic medium in electrical contact with the electrically-conductive layer; an adhesive layer; and a release sheet. Typically, the light-transmissive electrically-conductive layer will be carried on a light-transmissive substrate, which is preferably flexible, in the sense that the substrate can be manually wrapped around a drum (say) 10 inches (254 mm) in diameter without permanent deformation. The term "light-transmissive" is used in this patent and herein to mean that the layer thus designated transmits sufficient light to enable an observer, looking through that layer, to observe the change in display states of the electro-optic medium, which will normally be viewed through the electrically-conductive layer and adjacent substrate (if present); in cases where the electro-optic medium displays a change in reflectivity at non-visible wavelengths, the term "light-transmissive" should of course be interpreted to refer to transmission of the relevant non-visible wavelengths. The substrate will typically be a polymeric film, and will normally have a thickness in the range of about 1 to about 25 mil (25 to 634 μm), preferably about 2 to about 10 mil (51 to 254 μm). The electrically-conductive layer is conveniently a thin metal or metal oxide layer of, for example, aluminum or ITO, or may be a conductive polymer. Poly(ethylene terephthalate) (PET) films coated with aluminum or ITO are available commercially, for example as "aluminized Mylar" ("Mylar" is a Registered Trade Mark) from E.I. du Pont de Nemours & Company, Wilmington DE, and such commercial materials may be used with good results in the front plane laminate. When a very flexible front plane laminate is desired for use in a flexible display, ITO-coated polymeric films having thicknesses of about 0.5 to 1 mil (13 to 25 μm) are commercially available and can be coated with electro-optic material.

[Para 11] The aforementioned U.S. Patent No. 6,982,178 also describes a method for testing the electro-optic medium in a front plane laminate prior to incorporation of the front plane laminate into a display. In this testing method, the release sheet is provided with an electrically conductive layer, and a voltage sufficient to change the optical state of the electro-optic medium is applied between this electrically conductive layer and the electrically conductive layer on the opposed side of the electro-optic medium. Observation of the electro-optic medium will then reveal any faults in the medium, thus avoiding laminating faulty electro-optic medium into a display, with the resultant cost of scrapping the entire display, not merely the faulty front plane laminate.

[Para 12] The aforementioned U.S. Patent No. 6,982,178 also describes a second method for testing the electro-optic medium in a front plane laminate by placing an electrostatic charge on the release sheet, thus forming an image on the electro-optic medium. This image is then observed in the same way as before to detect any faults in the electro-optic medium.

[Para 13] The aforementioned 2004/0155857 describes a so-called "double release film" which is essentially a simplified version of the front plane laminate of the aforementioned U.S. Patent No. 6,982,178. One form of the double release sheet comprises a layer of a solid electro-optic medium sandwiched between two adhesive layers, one or both of the adhesive layers being covered by a release sheet. Another form of the double release sheet comprises a layer of a solid electro-optic medium sandwiched between two release sheets. Both forms of the double release film are intended for use in a process generally similar to the process for assembling an electro-optic display from a front plane laminate already described, but involving two separate laminations; typically, in a first lamination the double release sheet is laminated to a front electrode to form a front sub-assembly, and then in a second lamination the front sub-assembly is laminated to a backplane to form the final display, although the order of these two laminations could be reversed if desired.

[Para 14] The aforementioned 2007/0109219 describes a so-called "inverted front plane laminate", which is a variant of the front plane laminate described in the aforementioned U.S. Patent No. 6,982,178. This inverted front plane laminate comprises, in order, at least one of a light-transmissive protective layer and a light-transmissive electrically-conductive layer; an adhesive layer; a layer of a solid electro-optic medium; and a release sheet. This inverted front plane laminate is used to form an electro-optic display having a layer of lamination adhesive between the electro-optic layer and the front electrode or front substrate; a second, typically thin layer of adhesive may or may not be present between the electro-optic layer and a backplane. Such electro-optic displays can combine good resolution with good low temperature performance.

[Para 15] The aforementioned 2007/0109219 also describes various methods designed for high volume manufacture of electro-optic displays using inverted front plane laminates; preferred forms of these methods are "multi-up" methods designed to allow lamination of components for a plurality of electro-optic displays at one time.

[Para 16] The aforementioned U.S. Patent 6,982,178 also describes methods for forming an electrical connection between a backplane to which the front plane laminate is laminated and the light-transmissive electrically-conductive layer within the front plane laminate. As illustrated in Figures 21 and 22 of this patent, the formation of the layer of electro-optic medium within the front plane laminate may be controlled so as to leave uncoated areas ("gutters") where no electro-optic medium is present, and portions of these uncoated areas can later serve to form the necessary electrical connections. However, this method of forming connections tends to be undesirable from a manufacturing point of view, since the placement of the connections is of course a function of the backplane design, so that FPL coated with a specific arrangement of gutters can only be used with one, or a limited range of backplanes, whereas for economic reasons it is desirable to produce only one form of FPL which can be used with any backplane.

[Para 17] Accordingly, the aforementioned U.S. Patent 6,982,178 also describes methods for forming the necessary electrical connections by coating electro-optic medium over the whole area of the FPL and then removing the electro-optic medium where it is desired to form electrical connections. However, such removal of electro-optic medium poses its own problems. Typically, the electro-optic medium must be removed by the use of solvents or mechanical cleaning, either of which may result in damage to, or removal of, the electrically-conductive layer of the FPL (this electrically-conductive layer usually being a layer of a metal oxide, for example indium tin oxide, less than 1 μm thick), causing a failed electrical connection. In extreme cases, damage may also be caused to the front substrate (typically a polymeric film) which is used to support and mechanically protect the conductive layer. In some cases, the materials from which the electro-optic medium is formed may not be easily solvated, and it may not be possible to remove them without the use of aggressive solvents and/or high mechanical pressures, either of which will exacerbate the aforementioned problems.

[Para 18] Similar methods using selective coating of electro-optic medium and/or selective removal of electro-optic medium may also be applied to the double release films and inverted front plane laminates discussed above.

[Para 19] It is common practice to use laser cutting to separate from a continuous web of FPL pieces of appropriate sizes for lamination to individual backplanes. Such laser cutting can also be used to prepare areas for electrical connections to the backplane by "kiss cutting" the FPL with the laser from the lamination adhesive side so that the lamination adhesive and electro-optic medium are removed from the connection areas, but the electrically-conductive layer is not removed. Such kiss cutting requires accurate control of both laser power and cutting speed if the thin and relatively fragile electrically-conductive layer is not to be removed or damaged. Also, depending upon the location of the connection, bending of the electrically-conductive layer and the associated front substrate may crack the conductive layer, resulting in failure to make a proper connection between the backplane and the conductive layer, and hence display failure.

[Para 20] The aforementioned 2007/021 1331 describes methods of forming electrical connections to the conductive layers of front plane laminates. This application describes a first process for the production of a front plane laminate which comprises forming a sub-assembly comprising a layer of lamination adhesive and a layer of electro-optic medium; forming an aperture through this sub-assembly; and thereafter securing to the exposed surface of the lamination adhesive a light-transmissive electrode layer extending across the aperture.

The resultant FPL has a pre-cut aperture through the electro-optic medium and adhesive layers, this pre-cut aperture allowing contact to be made with the electrode layer.

[Para 2 1] The aforementioned 2007/0211331 also describes a second process for the production of a front plane laminate which comprises forming a sub-assembly comprising a layer of lamination adhesive and a layer of electro-optic medium; and thereafter securing to the exposed surface of the lamination adhesive a light-transmissive electrode layer, the electrode layer having a tab portion which extends beyond the periphery of the lamination adhesive and electro-optic layers.

[Para 22] One area of electro-optic display manufacture which still present problems is aligning the FPL or similar front sub-assembly with the backplane. As already noted, the FPL or other front sub-assembly is formed as a web or large sheet which must be cut to provide pieces of appropriate size for formation of single displays. It is normally necessary to ensure that the FPL or similar front sub-assembly piece is accurately aligned with certain features of the backplane; for example, it may be necessary to ensure that an electrode layer in a FPL contacts electrical contacts present on the backplane. The present invention provides methods for facilitating such alignment. One form of the present invention is especially adapted for achieving a clean edge alignment between an FPL or similar front sub-assembly and a backplane substantially the same size as the front sub-assembly.

[Para 23] The present invention also provides a method to facilitate mounting of driver chips or other circuitry on the backplane of an electro-optic display.

[Para 24] Accordingly, in one aspect this invention provides a process for the production of an electro-optic display, the process comprising:

forming a sub-assembly comprising in order, a front sheet; a layer of electro-optic medium; and an adhesive layer, the adhesive layer being larger in at least one dimension than the layer of electro-optic material;

forming an aperture through the adhesive layer in an area where the adhesive layer is not covered by the layer of electro-optic medium;

bringing the sub-assembly having the aperture formed through the adhesive layer adjacent a backplane comprising at least one electrode and having at least one co-operating member associated therewith, with the aperture engaged with a co-operating member, thereby locating the sub-assembly relative to the backplane.

[Para 25] This process of the present invention may hereinafter for convenience be called the "adhesive layer locating aperture" or "ALLA" process of the invention.

[Para 26] In such an ALLA process, the front sheet may comprise a light-transmissive electrically-conductive layer which will form a front electrode in the final display, so that the sub-assembly has the form of a FPL or inverted FPL. Also, in such a case, the front sheet will typically also comprise at least one supporting or protective layer on the opposed side of the electrically-conductive layer from the layer of electro-optic medium, the supporting or protective layer serving to support the electrically-conductive layer and to protect it against mechanical damage. The supporting or protective layer may also serve other functions, for example by acting as a barrier against water vapor and/or ultra-violet radiation, and/or providing a desired surface texture. (The electro-optic medium is of course normally viewed from the side opposite to the backplane.) Alternatively, the front sheet may comprise a second adhesive layer, typically covered by a release sheet, to permit later lamination of the layer of electro-optic medium to a front electrode and optionally other layers.

[Para 27] In the ALLA process, it is normally desirable to provide at least two locating apertures to ensure that the sub-assembly cannot rotate relative to the backplane and hence is unambiguously fixed in a known position relative to the backplane. It is not necessary that the co-operating member or members be physically located on the backplane; for example, the co-operating members could be provided on a support member, and both the backplane and the sub-assembly provided with apertures which engage the co-operating members on the support member, thereby locating the backplane and the sub-assembly in known positions relative to each other. When, as is typically the case, the sub-assembly is formed as a web or sheet containing material for a plurality of displays, the formation of the aperture through the adhesive layer is conveniently effected at the same time as the sub-assembly is divided into sections corresponding to individual displays. Also, in the ALLA process, typically, the adhesive layer is larger in both dimensions than the layer of electro-optic material.

[Para 28] In another aspect, this invention provides a process for the production of an electro-optic display, the process comprising:

forming a sub-assembly comprising in order, a front sheet; a layer of electro-optic medium; and an adhesive layer;

forming an aperture through the front sheet, layer of electro-optic medium and adhesive layer;

securing the sub-assembly to a backplane comprising at least one pixel electrode; and mounting at least one electronic circuit device on the backplane, the electronic circuit device extending through the aperture in the sub-assembly.

[Para 29] This process of the present invention may hereinafter for convenience be called the "chip in sub-assembly aperture" or "CSAA" process of the invention.

[Para 30] In the CSSA, the electronic circuit device will typically be at least partially surrounded by a potting material. As is well known in the electronics art, such a potting material can serve to protect bonds between the electronic circuit device and the backplane from environmental contaminants and mechanically stabilize the interconnections between the electronic circuit device and the backplane. In a preferred form of the CSSA process, the potting material contains a portion of the sub-assembly adjacent the aperture.

[Para 3 1] In the CSSA process, as in the ALLA process, the front sheet may comprise a light-transmissive electrically-conductive layer which will form a front electrode in the final display, so that the sub-assembly has the form of a FPL or inverted FPL. Also, in such a case, the front sheet will typically also comprise at least one supporting or protective layer on the opposed side of the electrically-conductive layer from the layer of electro-optic medium, the supporting or protective layer serving to support the electrically-conductive layer and to protect it against mechanical damage. The supporting or protective layer may also serve other functions, for example by acting as a barrier against water vapor and/or ultra-violet radiation, and/or providing a desired surface texture. Alternatively, the front sheet may comprise a second adhesive layer, typically covered by a release sheet, to permit later lamination of the layer of electro-optic medium to a front electrode and optionally other layers.

[Para 32] In another aspect, this invention provides a process for the production of an electro-optic display, the process comprising:

forming a sub-assembly comprising in order, a front sheet; a layer of electro-optic medium; and an adhesive layer;

securing the sub-assembly to a backplane comprising at least one pixel electrode; and

cutting through both the sub-assembly and the backplane, thereby removing peripheral portions of both the sub-assembly and the backplane, and forming an edge portion in which the edge of the sub-assembly is aligned with the edge of the backplane.

[Para 33] This process of the present invention may hereinafter for convenience be called the "simultaneous trimming" or "ST" process of the invention.

[Para 34] In the ST process, the front sheet may comprise a light-transmissive electrically-conductive layer which will form a front electrode in the final display, so that the sub-assembly has the form of a FPL or inverted FPL. Also, in such a case, the front sheet will typically also comprise at least one supporting or protective layer on the opposed side of the electrically-conductive layer from the layer of electro-optic medium, the supporting or protective layer serving to support the electrically-conductive layer and to protect it against mechanical damage. The supporting or protective layer may also serve other functions, for example by acting as a barrier against water vapor and/or ultra-violet radiation, and/or providing a desired surface texture. The supporting or protective layer may be larger than the layer of electro-optic medium (and possibly larger than the adhesive layer) and only a peripheral portion of the supporting or protective layer may be secured to the backplane, thus forming a seal around the electro-optic medium. In such a case, the ST process may only require cutting through the peripheral portion of the supporting or protective layer and the adjacent portion of the backplane to form the aligned edge portion.

[Para 35] The ST process may be used to do more than simply remove peripheral portions of the sub-assembly and backplane to produce an aligned edge. As described in copending International Application No. PCT/US08/68263, filed June 26, 2008, and as illustrated below, it may be convenient to provide the sub-assembly with certain auxiliary structures, for example a tacking strip and an inspection tab, which are useful in assembly or testing of the display, but which are not desired in the final product. The trimming of the peripheral portions of the sub-assembly and backplane to produce an aligned edge provides a convenient opportunity for removal of such auxiliary structures. The trimming operation may also conveniently be used to provide mechanical alignment or attachment points, for example by forming apertures through the sub-assembly and backplane.

[Para 36] The electro-optic medium used in the processes of the present invention may be any solid electro-optic medium of the types previously described. Thus, the electro-optic medium may be a rotating bichromal member or electrochromic medium. The electro-optic medium may also be an electrophoretic material comprising a plurality of electrically charged particles disposed in a fluid and capable of moving through the fluid under the influence of an electric field. The electrically charged particles and the fluid may be confined within a plurality of capsules or microcells. Alternatively, the electrophoretic material may be of the polymer-dispersed type, with the electrically charged particles and the fluid present as a plurality of discrete droplets surrounded by a continuous phase comprising a polymeric material. The fluid used may be liquid or gaseous.

[Para 37] This invention extends to the novel sub-assemblies and displays produced by the processes of the present invention. Electro-optic displays produced using the methods of the present invention can be used in any of the applications in which electro-optic displays have previously been used. Accordingly, this invention extends an electronic book reader, portable computer, tablet computer, cellular telephone, smart card, sign, watch, shelf label or flash drive comprising a display of the present invention, or produced using a method or component of the present invention.

[Para 38] The accompanying drawings are not strictly to scale. In particular, for ease of illustration, the thicknesses of the various layers are greatly exaggerated relative to their lateral dimensions. The present invention is well adapted for the production of thin, flexible electro-optic displays; typically, the sub-assemblies used in the processes described below will have thicknesses of about 100 μm, and can be laminated to flexible backplanes of similar thickness.

[Para 39] Figures IA to IE are schematic side elevations of various stages in the production of a sub-assembly used in a process of the present invention which makes use of both the adhesive layer locating aperture and chip in sub-assembly aperture aspects of the invention.

[Para 40] Figures 2A and 2B are schematic top plan views at the same stages of the process as Figures ID and IE respectively.

[Para 41] Figure 3 is a schematic side elevation showing a chip disposed in an aperture in a display formed from the sub-assembly produced in Figures IA to IE, 2A and 2B.

[Para 42] Figures 4A to 4C are schematic side elevations of various stages in a first simultaneous trimming process of the present invention, while Figure 4A also illustrates the manner in which the front plane laminate shown in Figures IE and 2B can be laminated to a backplane.

[Para 43] Figure 5 is a top plan view of the front plane laminate used in the process shown in Figures 4A to 4C.

[Para 44] Figures 6A to 6B are schematic cross-sections illustrating different stages in a second simultaneous trimming process of the present invention.

[Para 45] Figure 6C is a schematic cross-section, similar to those of Figures 6A and 6B, through a modified version of the display shown in Figures 6A and 6B.

[Para 46] As will be apparent from the foregoing Summary of the Invention, the present invention has a number of different aspects. However, as illustrated in the preferred embodiments discussed below, a single physical electro-optic display or process for the production thereof may make use of multiple aspects of the present invention. For example, the process described below with reference to Figures IA to IE, 2A and 2B uses both the ALLA and CSSA aspects of the present invention.

[Para 47] Before describing in detail various embodiments of the present invention it is useful to set out certain definitions. The term "backplane" is used herein consistent with its conventional meaning in the art of electro-optic displays and in the aforementioned patents and published applications, to mean a rigid or flexible material provided with one or more electrodes. The backplane may also be provided with electronics for addressing the display, or such electronics may be provided in a unit separate from the backplane. In flexible displays (and the present invention is especially although not exclusively intended for use in flexible displays), it is highly desirable that the backplane provide sufficient barrier properties to prevent ingress of moisture and other contaminants through the non-viewing side of the display. If one or more additional layers need to be added to the backplane to reduce ingress of moisture and other contaminants, the barrier layers should be located as closely as possible to the electro-optic layer so that little or no edge profile of low barrier materials is present between the front (discussed below) and rear barrier layers.

[Para 48] As already indicated, the sub-assembly used in the present processes may comprise at least one electrode layer, most commonly a single continuous front electrode extending across the entire display. Typically, the surface of the sub-assembly which remains exposed after lamination to the backplane will form the viewing surface through which an observer views the display. As with the backplane, the sub-assembly may provide barrier properties to prevent ingress of moisture and other contaminants through the viewing side of the display. If one or more additional layers need to be added to the sub-assembly to reduce ingress of moisture and other contaminants, the barrier layers should be located as closely as possible to the electro-optic layer so that little or no edge profile of low barrier materials is present between the front and rear barrier layers.

[Para 49] Reference will be made hereinafter to "loose" and "tight" release sheets. These terms are used in their conventional meaning in the art to indicate the magnitude of the force necessary to peel the relevant release sheet from the layer with which it is in contact, a tight release sheet requiring more force than a loose release sheet. In particular, if a stack of layers has a tight release sheet on one side and a loose release sheet on the other, it is possible to peel the loose release sheet away from the stack without separating the tight release sheet from the stack.

[Para 50] Some of the displays and sub-assemblies used in the present invention contain two separate adhesive layers. When necessary or desirable, the two adhesive layers will be denoted as "front" and "rear" adhesive layers, these terms denoting the position of the relevant adhesive layer in the final display; the front adhesive layer is the adhesive layer lying between the electro-optic medium and the viewing surface of the display, while the rear adhesive layer lies on the opposed side of the electro-optic layer from the front adhesive layer. In the common situation where a display has a single front electrode between the electro-optic layer and the viewing surface and a plurality of pixel electrodes on the opposed side of the electro-optic layer, the front adhesive layer lies between the electro-optic layer and the front electrode, while the rear adhesive layer lies between the electro-optic layer and the pixel electrodes.

[Para 5 I] A preferred process which makes use of both the ALLA and CSSA aspects of the present invention will now be described with reference to Figures IA to IE and 2A to 2B of the accompanying drawings.

[Para 52] Figures IA to IE are schematic sections through various stages in the production of a sub-assembly used in a first process of the present invention. In the first step of the process, an electro-optic medium is coated or otherwise deposited on to a tight release sheet 102 to form an electro-optic layer 104. Separately, a front adhesive layer 106 is coated on to a loose release sheet 108. The two resulting sub-assemblies are then laminated to each other with the adhesive layer 106 is contact with the electro-optic layer 104 to produce the structure shown in Figure IA. These steps are as described in the aforementioned U.S. Patent No. 7,1 10,164, and the resulting assembly is a double release sheet as described in the aforementioned 2004/0155857.

[Para 53] In the second step of the process, the structure shown in Figure IA is kiss cut with the loose release 108 facing the cutter (typically a laser cutter), the kiss cutting being effected such that the loose release sheet 108, the front adhesive layer 106 and the electro-optic layer 104 are severed but the tight release sheet 102 is not. The continuous portions of the loose release sheet 108, the front adhesive layer 106 and the electro-optic layer 104 are then removed, either manually or mechanically, thus leaving the structure shown in Figure IB, in which there extend upwardly from the tight release sheet 102 multiple "mesas" comprising the islands 208 of the loose release sheet and similarly sized areas 206 and 204 of the front adhesive layer and electro-optic layer respectively. Each of these mesas will eventually form a separate display. (In some cases, it may be possible to recycle the portions of the front adhesive layer and electro-optic layer removed with the loose release sheet 108 in other small displays.)

[Para 54] The stages of the process described thus far will typically be carried out either on continuous webs of material, or on large sheets of material sufficient to form several final displays. For ease of illustration, Figure IB shows only two separate mesas but it will be appreciated that in practice a larger number of mesas will be present on a single large sheet or web. When the process is carried on a web, on a roll-to-roll basis, the webs used may include tractor feed holes formed along the side edges of the web of material to serve as alignment holes.

[Para 55] In the next step, the remaining portions 208 of the loose release sheet are peeled from the structure shown in Figure IB and the remaining layers of the structure are laminated to a sheet of a front substrate 120. The front substrate 120 is a multi-layer structure including an indium-tin-oxide (ITO) layer which forms the front electrode of the final display. The front substrate may further comprise a removable masking film, which can be removed before the final display is placed in use.

[Para 56] The front substrate is designed to provide the front light-transmissive electrode for the final display. The front substrate 120 can also provide the necessary mechanical support for this thin and relatively fragile front electrode. In addition, the front substrate preferably provides all necessary water vapor and oxygen barriers, and ultra-violet absorption properties, desirable to protect certain electro-optic layers, especially electrophoretic layers. The front substrate may also provide desirable anti-glare properties to the viewing surface of the final display. The front substrate 120 serves all of these functions while still being thin and flexible enough to enable the formation of a final display sufficiently flexible to be wound around a mandrel of (say) 15 mm diameter. As already noted, the front substrate includes a masking film; this masking film is provided primarily to increase the thickness of the front substrate so as to facilitate handling of this substrate during laminations. In a preferred process, the total thickness of the front substrate as it remains in the final display (i.e., with the masking film removed) is only about 1 mil (25 μm) and the masking film is used to add about 2 mil (51 μm) to this thickness for ease of handling. The masking film also typically serves to prevent scratching or adhesion of dust or debris to an adjacent anti-glare layer during the laminations. The structure resulting from this step of the process is shown in Figure 1C.

[Para 57] The steps of the process described so far as essentially identical to those of the process described with reference to Figures 2A to 2E of the aforementioned 2008/0057252, to which the reader is referred for further information.

[Para 58] At this point, a second, thin adhesive layer 122 is coated on to a third release sheet 124, and apertures 126 are formed though both the adhesive layer 122 and the release sheet 124 at positions corresponding to where top plane connections (connections between the backplanes and the front electrodes) will be present in the final displays. At the same time, the release sheet is cut, preferably discontinuously, along a line 127 (see Figure 2A) to form a tacking strip (discussed further below). The release sheet 102 is peeled from the structure shown in Figure 1C and the adhesive layer 122 laminated to the electro-optic layer portions 204 to give the structure shown in Figure ID. Figure 2A shows a corresponding top plan view which only illustrates a single mesa and its associated aperture 126 and the line 127; at this stage of the process, the material is still in web or large sheet form and Figure 2A illustrates only part of the web or sheet, as indicated by the curved boundary of front substrate 120 in Figure 2A. The adhesive layer 122 must of course be correctly aligned with respect to the mesas to ensure that the apertures 126 and 128 and the line 127 are in the proper positions relative to their associated mesa, as shown in Figure 2A. (For ease of illustration, Figure 2A shows only a single aperture 126 associated with the mesa. In practice, it is usually desirable to provide two or more apertures 126 associated with each mesa so as to provide redundant top plane connections in each final display, thereby ensuring that each display will still function correctly even if one of its top plane connections is not correctly formed or becomes damaged during use.)

[Para 59] The next stage of the process is singulation, that is to say separation of the portions of the sub-assembly corresponding to individual displays. The result of this singulation step is illustrated in Figures IE and 2B. The singulation step simultaneously effects three logically separate operations, namely:

(a) cutting of the sheet or web into pieces of the size required for individual displays;

(b) formation of apertures through the adhesive layer 122 required for mechanical alignment of the sub-assembly during subsequent lamination to a backplane; and

(c) formation of an aperture through the front substrate 120, and the adhesive layer 122, this aperture being ultimately used to mount an electronic circuit device on the backplane of the final display.

[Para 60] As illustrated in Figures IE and 2B, operation (a) is effected by cutting the front substrate 120, the adhesive layer 122 and the release sheet 124 along the same rectangular perimeter, thus defining a separate unit (piece) of front plane laminate which will eventually be laminated to a backplane to form a single display. In addition to the singulation of the separate unit of front plane laminate, this step creates an extended tab or "tail" of non-optically active material (the portion of the front plane laminate lying below the electro-optic layer 204 as illustrated in Figure 2B) that adds to the thickness of the corresponding section of the final display. Were this tail of non-optically active material not present, the thickness of the final display in this region would be only the thickness of the backplane itself, and in thin, flexible displays, the thickness of this backplane may be only about 25 μm; the extended tail section will typically provide an additional 25 μm of thickness, thus doubling the thickness of this region to about 50 μm. See the aforementioned 2007/021 1331 for further discussion of providing a tab or tail portion of a front electrode layer, and use of such a tab or tail portion to provide electrical contact with the front electrode layer.

[Para 6 1] Operation (b) is effected by providing two small circular apertures 128 adjacent one edge (the lower edge as illustrated in Figure 2B) of the rectangular front plane laminate. (For ease of comprehension, the apertures 128 are shown in broken lines in Figure IE even though Figure IE is a section looking upwardly in Figure 2B so the apertures 128 would not actually be visible in the section of Figure IE.) As shown in Figure IE, the apertures 128 lie within the tail section of the FPL and extend through the whole thickness of the FPL, passing through the front substrate 120, the adhesive layer 122 and the release sheet 124. The apertures 128 can be used to mechanical alignment or attachment of the FPL during lamination to a backplane or during later stages of manufacture. As described below with reference to Figures 4A to 4C, the apertures 128 can used to engage registration pins or similar co-operating members provided on the backplane, or on a substrate carrying the backplane, to ensure accurate registration of the FPL with respect to the backplane. The apertures 128 can also be used in later stages of the manufacturing process to locate the final display module accurately with respect to a housing or other surrounding portion (for example, a printed circuit board) of the final commercial display unit, or to attach the display module to such housing or surrounding portion.

[Para 62] Operation (c) is effected by providing a rectangular aperture 130 in the tail portion of the FPL, this rectangular aperture 130 extending completely through the FPL, i.e., through the front substrate 120, the adhesive layer 122 and the release sheet 124. As discussed below with reference to the ST process of the present invention, the type of FPL shown in Figures IE and 2B is typically used with a backplane which is essentially the same size as the FPL, so that the FPL covers essentially the whole of the backplane. Accordingly, if it is desired to have electrical access to the backplane, for example for mounting driver chips on the backplane, an aperture must be formed to permit this, and this is the function of the aperture 130. Driver chips or other electronic circuit devices can be placed within the aperture 130, and the FPL surrounding the aperture provides a region of increased thickness which assists ruggedization of the display.

[Para 63] As also illustrated in Figure 2B, the singulation of the FPL piece from the web results in the line 127 extending close to and parallel to one edge of the FPL piece, so that between the line 127 and the adjacent edge is formed a tacking strip 129, in the form of an elongate area running along one edge of the FPL piece. Because the release sheet 124 is severed along line 127, the section of the release sheet 124 underlying the tacking strip 129 can be removed without removing the release sheet 124 from the main part of the FPL piece. The tacking strip 129 is provided to assist in locating the FPL piece on a backplane prior to the lamination of these two parts to form a display; the section of the release sheet 124 underlying the tacking strip 129 is removed and the portion of the adhesive layer 122 thus exposed can be pressed manually into the correct position for lamination to the backplane, before the main portion of the release sheet 124 is removed and the lamination operation completed.

[Para 64] Figure 3 of the accompanying drawings is a highly schematic side elevation of a driver die 144 disposed within an aperture (designated 130') of a display formed by laminating a front plane laminate 140 to a backplane 142. As shown in Figure 3, the driver die 144 extends through the aperture 130' and makes electrical contact with contacts (not shown) present on the backplane 142. A potting material 146 surrounds the die 144 and contacts portions of the FPL 140 surrounding the aperture 130', this potting material 146 serving to protect the drive contacts from environmental factors and the mechanically stabilize the interconnection between the die 144 and the backplane 142.

[Para 65] Figure 4A illustrates, in a highly schematic manner, a process in which the piece of front plane laminate shown in Figures IE and 2B is laminated to a backplane. As shown in

Figure 4A, a support table 150 is provided with a pair of pins 152 (only one of which is visible in Figure 4A). A backplane 154 is provided with apertures which engage the pins 152. The release sheet 124 (see Figure IE) is removed from the front plane laminate 156, which is then laid over the backplane with the apertures 128 (see Figures IE and 2B) engaged with the pins 152. A roller 158 passes over the front plane laminate 156, thus adhering the adhesive layer 122 (see Figure IE) to the adjacent surface of the backplane 154 and thus laminating the front plane laminate to the backplane to form a display. Following this lamination, the laminated FPL and backplane are removed from the support table 150 as the structure shown in Figure 4B. (The meaning of the arrows in Figure 4B will be explained below with reference to the ST process of the present invention.)

[Para 66] Detailed consideration will now be given to the simultaneous trimming (ST) process of the present invention. As noted above, when laminating front plane laminates to a backplane, the FPL must typically be aligned with respect to backplane features, for example contact pads designed to provide contacts to the electrode layer present in the front plane laminate. Depending on the design requirements, the FPL can be designed to be smaller than the backplane (to allow access to electrical connections on areas of the backplane not covered by the FPL) or the same size as the backplane. If the FPL, or a barrier layer laminated over the FPL, is the same size as the backplane, achieving a clean edge alignment can be difficult in practice, since there is always some tendency for the FPL not to line up exactly with the backplane. Also, certain features desirable during manufacture, such as inspection tabs or tacking strips, can be undesirable if present in the finished display module.

[Para 67] There is an increasing tendency to use electro-optic media with thin backplanes based on polymeric films (for example, poly(ethylene terephthalate) or poly(ethylene naphthalate), PEN, available commercially under the Registered Trade Mark TEONEX from DuPont Teijin Films of Hopewell VA) or metal foils. Electro-optic displays based on such thin backplanes can be flexible or reliable and hence usable in certain applications (for example, a large display screen capable of being stored in a cellular telephone - see the aforementioned 2002/0090980) where traditional displays cannot be used. It has now been found that, using the simultaneous trimming process of the present invention, an FPL laminated to such a polymeric or metal foil backplane can readily be cut by industrial methods, for example laser cutting or die cutting, and that such cutting of an FPL/backplane laminate enables an accurately matched edge to be achieved between the FPL (or a barrier layer overlying the FPL) and the backplane, without adverse effects on the functionality of the final display. Such cutting also allows for the removal of features useful during manufacture but not wanted in the final display.

[Para 68] A preferred simultaneous trimming process of the present invention will now be described with reference to Figures 4A to 4C and 5. Figure 5 shows a front plane laminate which is generally similar to that shown in Figure 2B. In Figure 5, the electro-optic layer 204, the adhesive layer 206, and the apertures 126 and 130 differ in size and position from the corresponding integers in Figure 2B but are otherwise similar and serve the same functions. However, the front plane laminate shown in Figure 5 has a number of additional features. These features include a top plane contact tab 160, which is used to make electrical contact with the electrode layer of the FPL during testing, a release contact tab 162 which is similarly used to make electrical contact with a conductive layer provided in the release sheet 124 for testing purposes (see the testing methods described in the aforementioned U.S. Patent No. 6,982,178) and a tacking strip 164. The tacking strip 164 is constructed in the same manner as, and functions in the same way as, the tacking strip 129 described above with reference to Figures 2A and 2B.

[Para 69] The FPL shown in Figure 5 is designed to be laminated to a backplane having transistors on a thin plastic film, for example a PEN film. The lamination of the FPL to the PEN film backplane is effected in the manner shown in Figures 4A and 4B, as previously described. The resulting laminate is then trimmed by laser cutting (die cutting could alternatively be used), as indicated schematically by the arrows in Figure 4B and along the periphery indicated by the broken line in Figure 5 to produce the final display module, illustrated schematically in Figure 4C. This trimming operation removes the contact tabs 160 and 162, and the tacking strip 164. Apertures for mechanical alignment or for attachment points can be incorporated into the display during the trimming operation. Such apertures may be useful, for example, for securing the display to fixtures, or for optical alignment, during later manufacturing operations or for securing the display to a display housing.

[Para 70] In the simultaneous trimming process shown in Figures 4A to 4C and 5, the front substrate of the FPL acts as a barrier layer protecting the electro-optic layer from environmental contaminants and radiation. However, as described for example in the aforementioned U.S. Patent No. 6,982,178 (see especially Figures 18-20 and the related description), electro-optic display can be produced having a barrier layer which is separate from the front substrate of the display, with an edge seal formed between the barrier layer and the backplane. The ST process of the present invention can also be applied to this type of display, and a preferred process of this type is illustrated in Figures 6A and 6B.

[Para 71] Figure 6A illustrate a barrier-layer-protected display (generally designated 600) of the type shown in Figure 3 of the aforementioned 2007/0152956. The display 600 comprises a backplane 602, an adhesive layer 122, an electro-optic layer 204 (illustrated as an encapsulated electrophoretic layer in Figure 6A), a front substrate 120 and a barrier layer 622. A peripheral portion 622P of the barrier layer 622 is crimped around the periphery of the electro-optic layer 204 and sealed, either adhesively or, depending upon the materials used, in some cases by welding, to the peripheral part of the backplane 602 to form an edge seal which seals the electro-optic layer 204 from outside contaminants.

[Para 72] It will be seen from Figure 6A that the barrier layer 622 is slightly smaller than the backplane 602; in practice, with this type of edge seal it is very difficult to keep the edges of the barrier layer and the backplane closely aligned. In accordance with the ST process of the present invention, the structure shown in Figure 6A can be cut, as indicated by the arrows in that Figure, to produce the structure shown in Figure 6B, in which the edges of the barrier layer and backplane are aligned.

[Para 73] The ST process shown in Figures 6A and 6B only cuts through the barrier layer and the backplane. Other ST processes may require cutting through the barrier layer, the backplane, and one or more of the electro-optic layer, adhesive layers and front substrate.

[Para 74] Figure 6C shows a modified display (generally designated 650) generally similar to the display of Figure 6B but having an aperture 624 extending through a peripheral portion thereof. The display 650 of Figure 6C is produced from the untrimmed display 600 shown in Figure 6A, and the left-hand side of the display 600 (as illustrated in Figure 6A) is trimmed in the same way as in Figure 6B to provide a trimmed edge. However, the right-hand edge of display 600 is not trimmed but instead a punch (not shown) is used to form the aperture 624 extending through the display 650.

[Para 75] It will be apparent to those skilled in the technology of electro-optic displays that numerous changes and modifications can be made in the preferred embodiments of the present invention already described without departing from the scope of the invention. For example, in the preferred processes of the invention illustrated in the drawings, the inverted front plane laminate is cut into pieces of the size required for an individual display (see Figures IE and 2B) before being laminated to a backplane. When high volume production is desired, it may be convenient to reverse the order of these singulation and lamination operations, i.e., a sheet or web of inverted front plane laminate sufficient to form a plurality of displays could be laminated in an aligned manner to a sheet or web of backplanes to form a plurality of displays which are thereafter singulated from the sheet. When the lamination operation is performed on sheets, the sheet of backplanes will typically be held on a support member during the lamination, and the singulation operation can be effected with the sheet of displays still held on the support member. Such a process permits singulation of the displays and the ST process of the present invention to be effected in a single operation.

[Para 76] Furthermore, although the invention has been shown in Figures 6A and 6B applied to an edge seal formed by sealing a protective layer to a backplane, the present invention can be used with a variety of other types of edge seals. In particular, the aforementioned U.S. Patent No. 6,982,178 describes several different types of so-called "underfill edge seals" in which peripheral portions of a backplane, and either a front substrate or a protective layer overlying a front substrate, extend outwardly beyond the periphery of an electro-optic layer, and an edge seal is formed extending between the peripheral areas of the backplane and either the front substrate or the protective layer. The simultaneous trimming process, and the other processes of the present invention, can be applied to displays having such underfill edge seals either before or after the edge sealing material is applied. Similarly, although the processes of the present invention have primarily been described above with reference to displays constructed using inverted front plane laminates, these processes can also be used with displays using "classic" front plane laminates, double release films and other sub-assemblies.

CLAIMS

1. A process for the production of an electro-optic display, the process comprising:

forming a sub-assembly comprising in order, a front sheet (120); a layer of electro-optic medium (204); and an adhesive layer (122), the adhesive layer (122) being larger in at least one dimension than the layer of electro-optic material (204);

forming an aperture (128) through the adhesive layer (122) in an area where the adhesive layer (122) is not covered by the layer of electro-optic medium(204);

bringing the sub-assembly having the aperture (128) formed through the adhesive layer (122) adjacent a backplane (154) comprising at least one electrode and having at least one co-operating member (152) associated therewith, with the aperture (128) engaged with a co-operating member (152), thereby locating the sub-assembly relative to the backplane (154).

2. A process according to claim 1 wherein the front sheet (120) comprises a light-transmissive electrically-conductive layer.

3. A process according to claim 1 wherein the front sheet (120) also comprises at least one supporting or protective layer on the opposed side of the electrically-conductive layer from the layer of electro-optic medium, the supporting or protective layer serving to support the electrically-conductive layer and to protect it against mechanical damage.

4. A process according to claim 1 wherein the front sheet comprises a second adhesive layer (206).

5. A process according to claim 4 wherein the second adhesive layer is covered by a release sheet.

6. A process according to claim 1 wherein at least two apertures (128) are formed through the adhesive layer (122) and at least two co-operating members (152) are associated with the backplane (154) and engaged with the apertures (128).

7. A process according to claim 1 wherein the sub-assembly is formed as a web or sheet containing material for a plurality of displays, and the formation of the at least one aperture is effected at the same time as the sub-assembly is divided into sections corresponding to individual displays.

8. A process according to claim 1 wherein the adhesive layer (122) is larger in both dimensions than the layer of electro-optic material (204).

9. A process for the production of an electro-optic display, the process comprising:

forming a sub-assembly comprising in order, a front sheet (120); a layer of electro-optic medium (204); and an adhesive layer (122);

forming an aperture (130) through the front sheet (120) and adhesive layer (122);

securing the sub-assembly to a backplane (142) comprising at least one pixel electrode; and

mounting at least one electronic circuit device (144) on the backplane (142), the electronic circuit device (144) extending through the aperture (130) in the sub-assembly.

10. A process according to claim 9 wherein a potting material (146) at least partially surrounds the electronic circuit device.

11. A process according to claim 10 wherein the potting material (146) contacts a portion of the sub-assembly adjacent the aperture (130).

12. A process according to claim 9 wherein the front sheet (120) comprises a light-transmissive electrically-conductive layer.

13. A process according to claim 12 wherein the front sheet (120) comprises a second adhesive layer .

14. A process for the production of an electro-optic display, the process comprising:

forming a sub-assembly (156) comprising in order, a front sheet (120); a layer of electro-optic medium (204); and an adhesive layer (122);

securing the sub-assembly (156) to a backplane (154) comprising at least one pixel electrode; and

cutting through both the sub-assembly (156) and the backplane (154), thereby removing peripheral portions of both the sub-assembly (156)and the backplane (154), and forming an edge portion in which the edge of the sub-assembly (156) is aligned with the edge of the backplane (154).

15. A process according to claim 14 wherein the front sheet comprises a light-transmissive electrically-conductive layer.

16. A process according to claim 15 wherein the front sheet (120) also comprises at least one supporting or protective layer (622) on the opposed side of the electrically-conductive layer from the layer of electro-optic medium (204), the supporting or

protective layer (622) serving to support the electrically-conductive layer and to protect it against mechanical damage.

17. A process according to claim 16 wherein the supporting or protective layer (622) is larger than the layer of electro-optic medium (204) and only a peripheral portion (622p) of the supporting or protective layer (622) is secured to the backplane(602), thereby forming a seal around the layer of electro-optic medium (204).

18. A process according to claim 17 wherein the cutting through the sub-assembly and the backplane is effected by cutting only through the supporting or protective layer (622) and the adjacent portion of the backplane (602).

19. A process according to claim 14 wherein the cutting step also effects at least one of:

(a) removal of at least one contact tab from the sub-assembly;

(b) removal of at least one tacking strip from the sub-assembly; and

(c) formation of at least one aperture through the display.

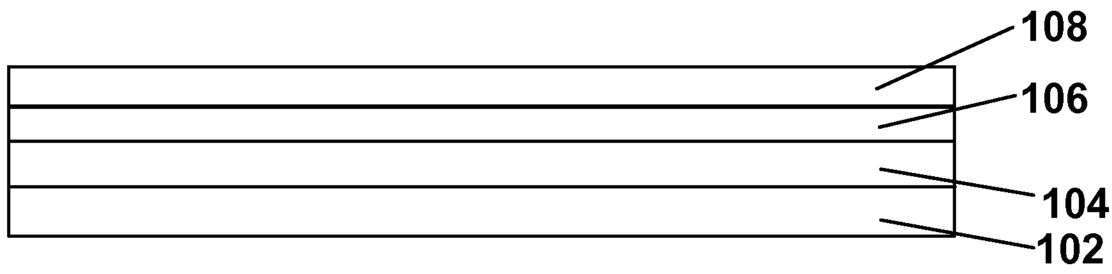

Fig. 1A

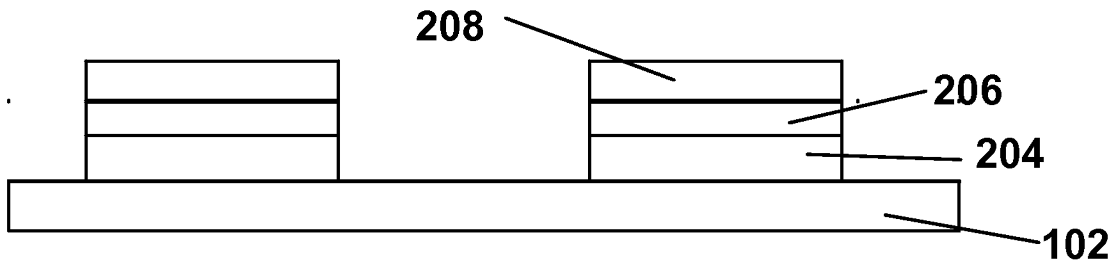

Fig. 1B

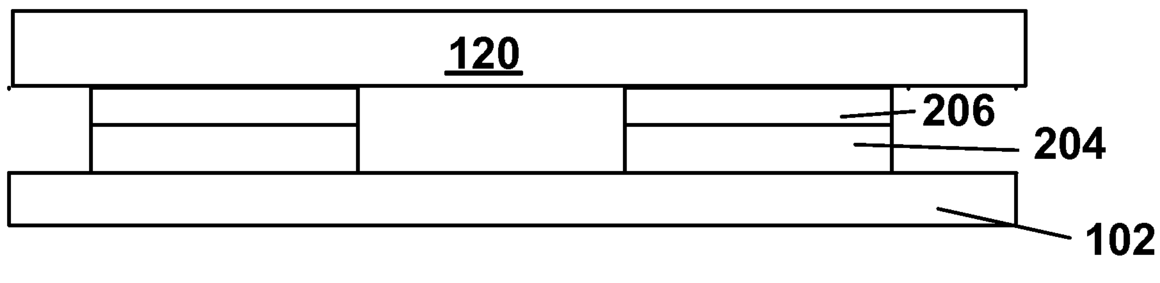

Fig. 1C

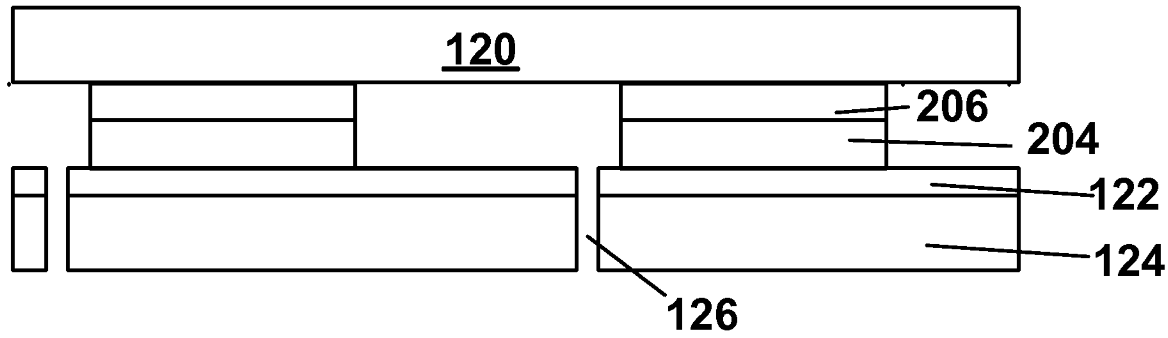

Fig. 1D

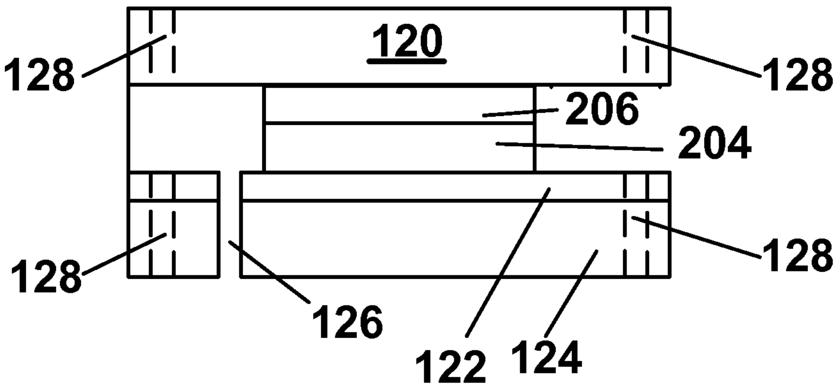

Fig. 1E

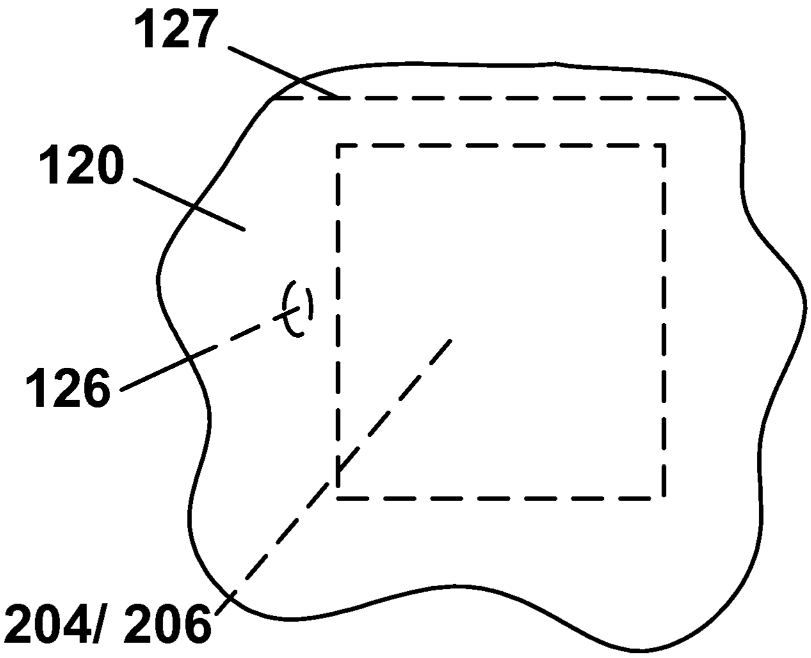

Fig. 2A

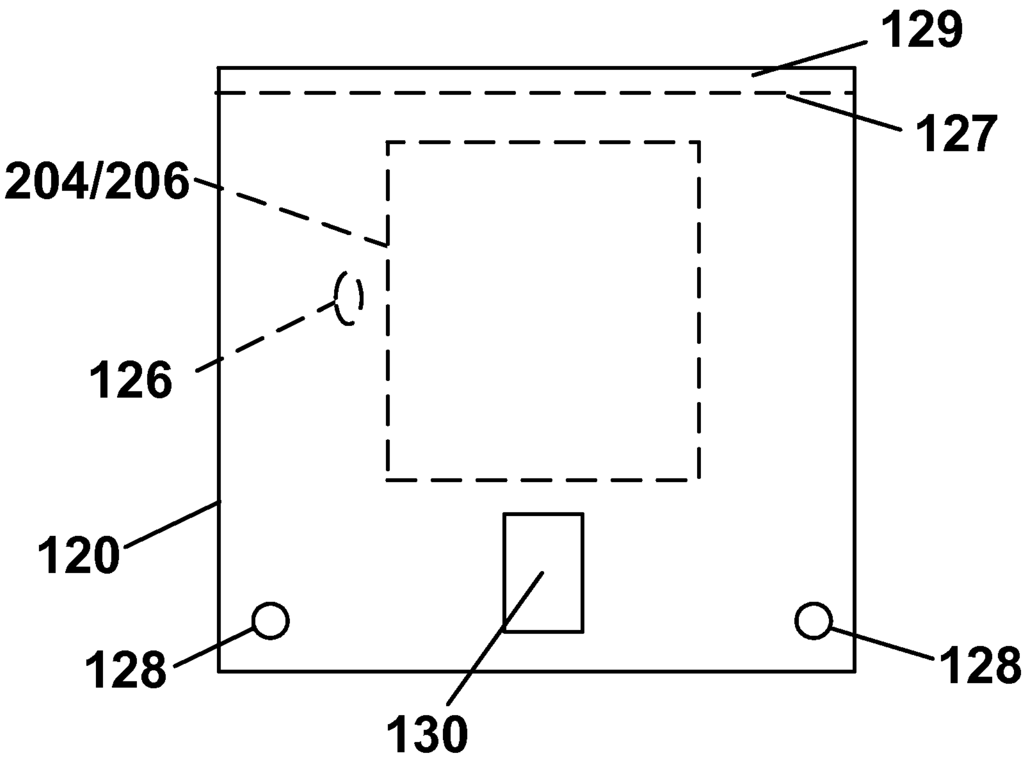

Fig. 2B

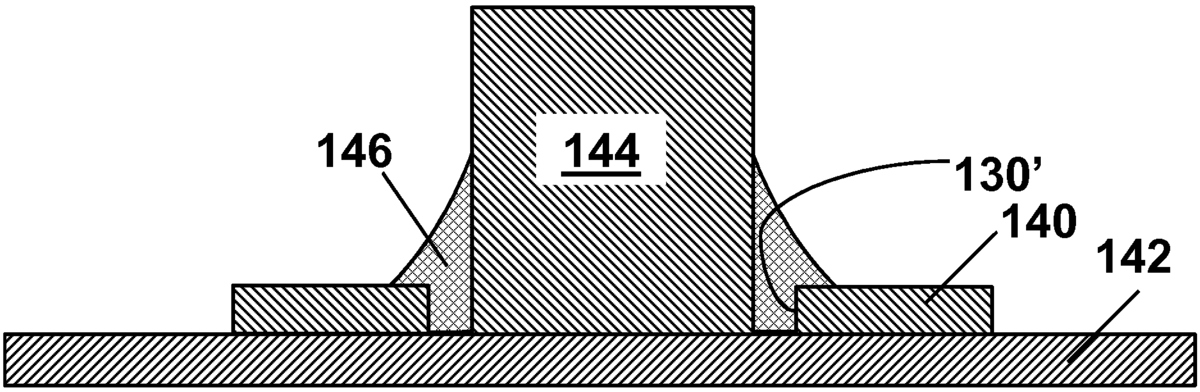

Fig. 3

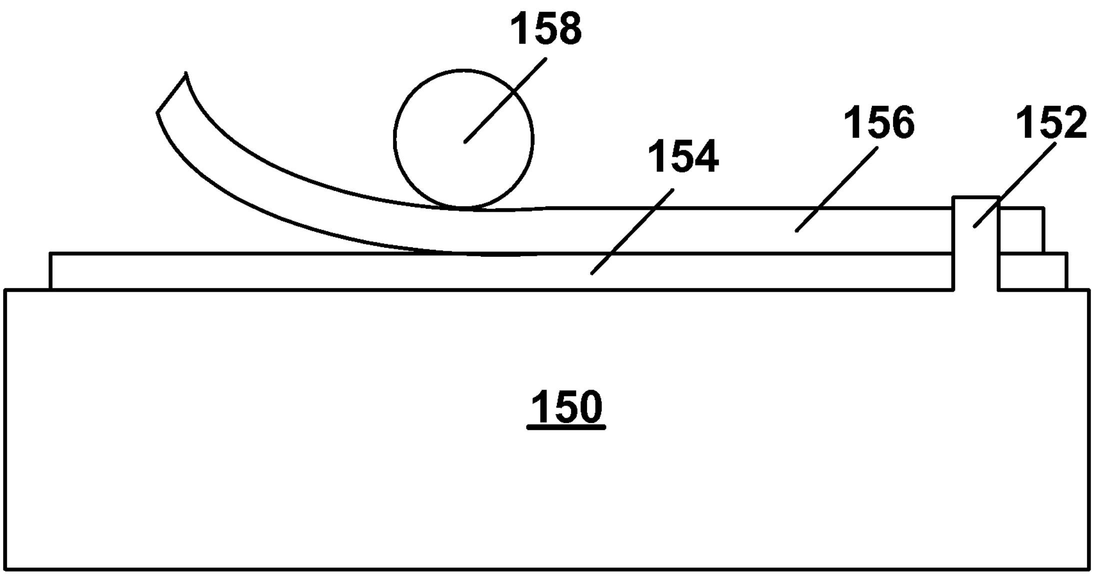

Fig. 4A

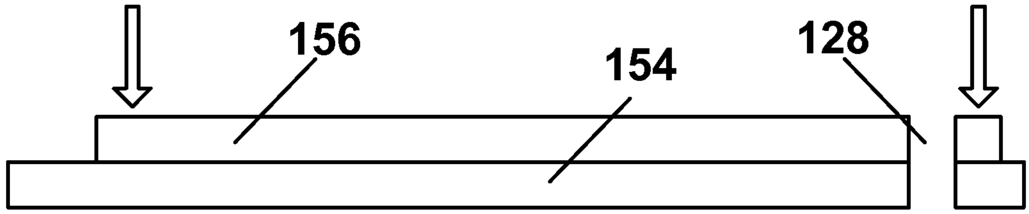

Fig. 4B

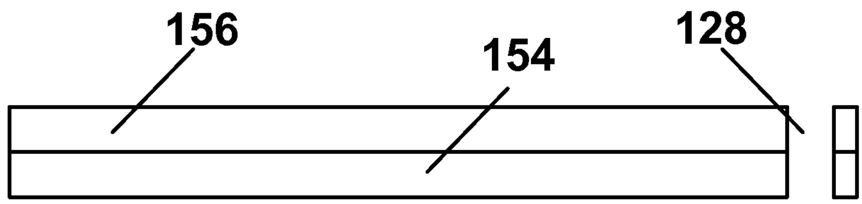

Fig. 4C

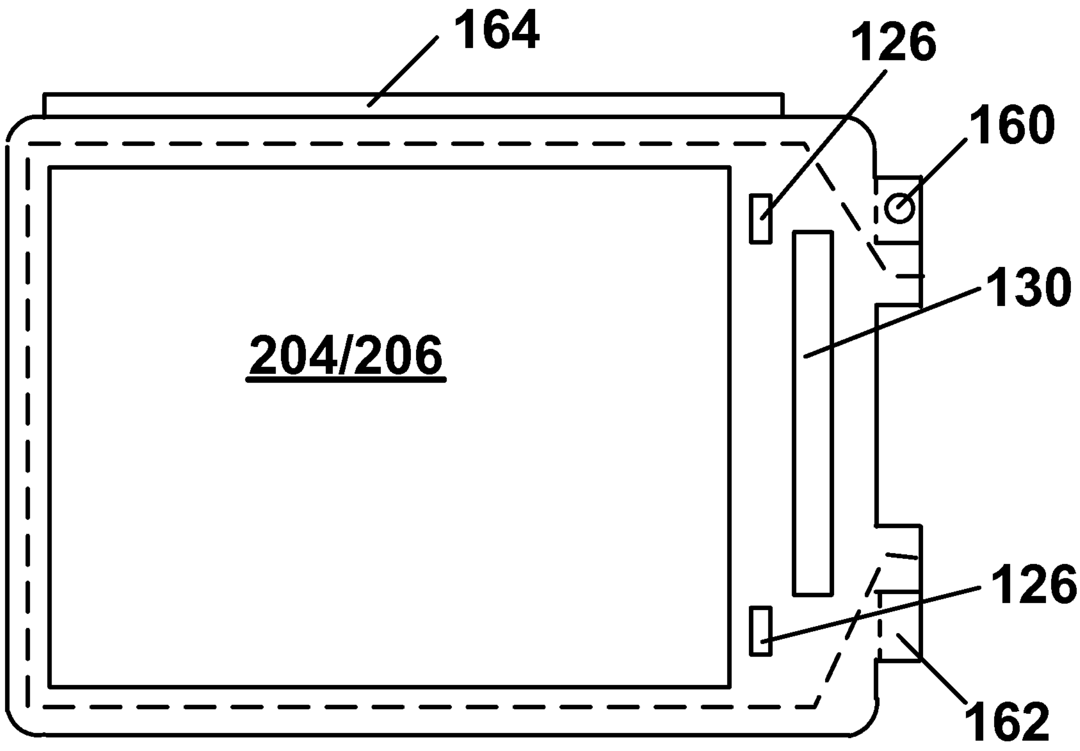

Fig. 5

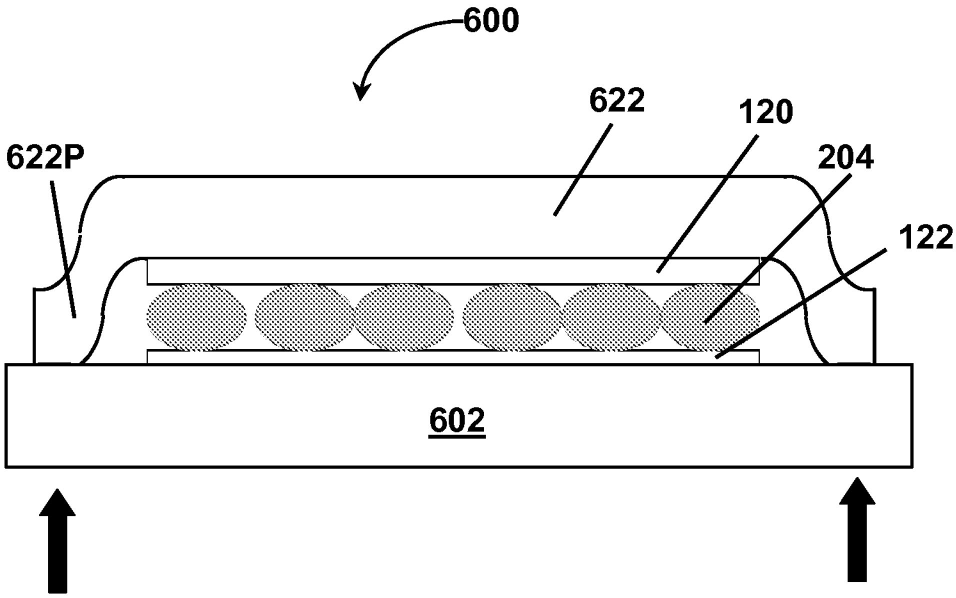

Fig. 6A

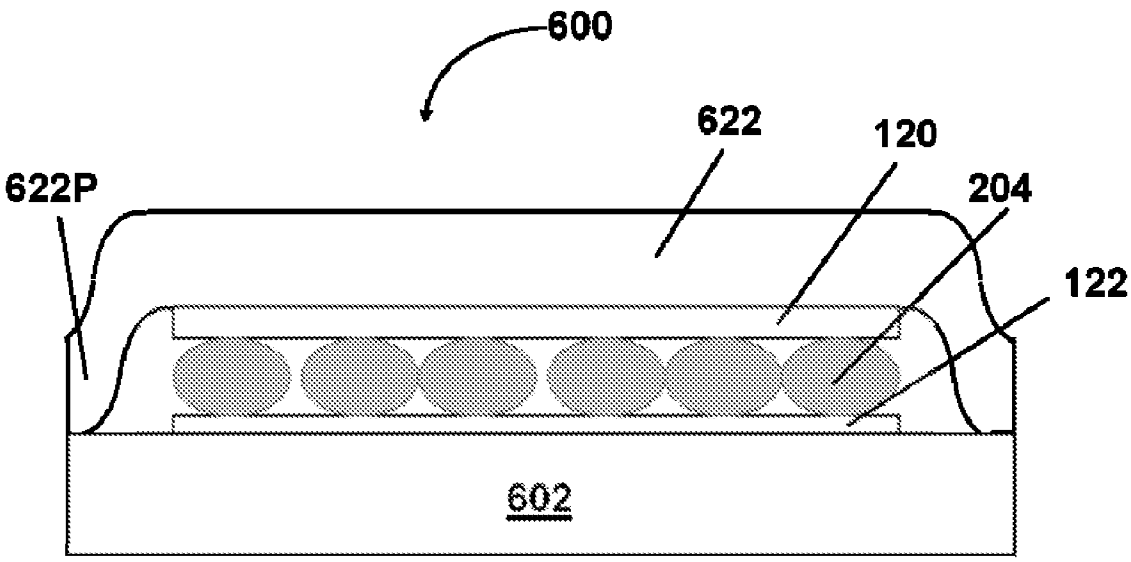

Fig. 6B

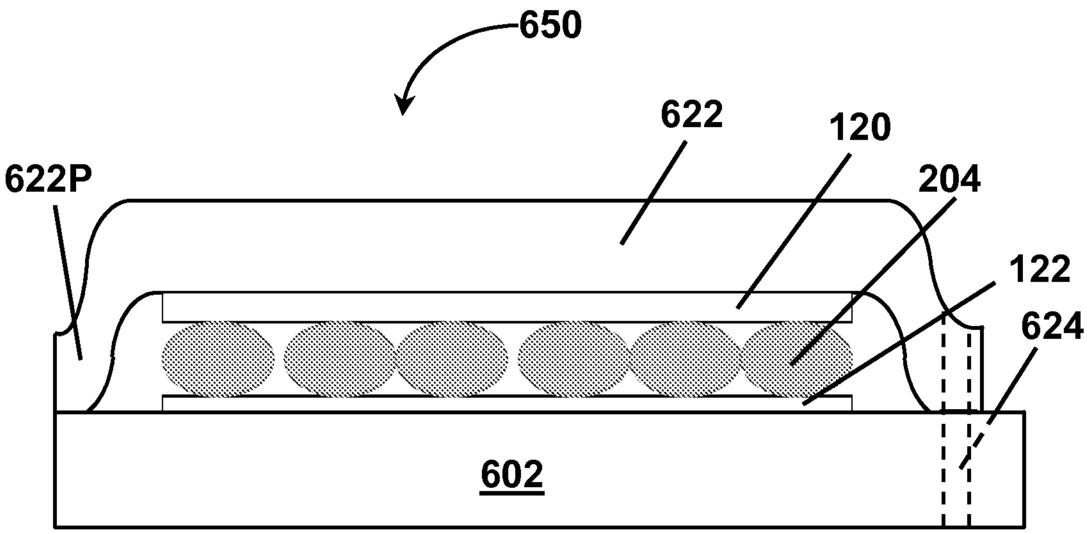

Fig. 6C

INTERNATIONAL SEARCH REPORT

International application No
PCT/US 08/68471

A CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G02F 1/03 (2008.04)
USPC - 359/245
According to International Patent Classification (IPC) or to both national classification and IPC

B FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC 359/245

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC 359/296, 428/41 8, 156/273 9, 428/40 1, 428/98, 528/422

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST(USPT,PGPB,EPAB,JPAB), DialogPRO(Eng ineering), Google Scholar
Search Terms Used display, electrode, optic, adhesive, conductive, release, sheet, pixel, circuit, backplane, cut, peripheral, edge, assembly, tacking, strip, adjacent

C DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
X -- Y	US 2005/0146774 A1 (LeCain et al) 07 July 2005 (07 07 2005), entire document especially abstract, Fig 1, para [0013], [0014], [0029]-[0031], [01 11] [01 13], [0128], [0135], [0164]	1-17, 19 -------- 18
Y	US 5,848,548 A (Latour et al) 15 December 1998 (15 12 1998), col 6, ln 36-41	18
A	US 6,900,851 B2 (Morrison et al) 31 May 2005 (31 05 2005)	1-18

☐ Further documents are listed in the continuation of Box C ☐

* Special categories of cited documents
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Date of the actual completion of the international search
01 September 2008 (01 09 2008)

Date of mailing of the international search report
11 SEP 2008

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