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(54) IMAGING PLASTICS ARTICLES

BILDHERSTELLUNG AUF KUNSTSTOFFGEGENSTÄNDE

ARTICLES D'IMAGERIE EN MATIERE PLASTIQUE

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- **PATENT ABSTRACTS OF JAPAN, Vol. 11, No. 241 (M-614)(2688), 7 August 1987; & JP-A-6253887 (Ricoh Co. LTD) 9 March 1987**
- **Product Licensing Index, No. 96, April 1972, Silk Screen Dyeing of Films with Disperse Dyes page 31* Abstract No. 9602***

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Description

The invention relates to providing images on plastics containing articles, as used in security articles.

Multiple layer plastics containing articles are used in a variety of fields but one particularly important application is in the field of security articles such as identification cards, credit cards, charge cards and the like. Such multiple layer plastics containing constructions are also used in passports, identity cards, driving licences, travel passes and the like, for example where a plastics film protects a photograph of the bearer. The article's security is enhanced when a tamper-proof composite is made. Security printing of a general nature is generally included on an inaccessible internal layer. Identification or personalisation is conventionally added separately by including a photograph or signature or by embossing characters. By personalisation is meant the addition of features to a security item which serve to identify the holder of the item. These include monochrome and colour photographs, identification numbers, signatures, fingerprints and the like. Account information may also be added including the name of the account holder, the account number, etc. Other information such as the article's serial number and validity period may also be provided. At present photographs are normally adhered to a security printed surface and then laminated in place by the placement of an upper transparent film of PVC or other plastic layer.

As an alternative to the personalisation of cards, cards may be made individual for other purposes such as by being associated with one object from a similar range, eg. a vehicle. Cards may also be made individual with a view to allowing a group of people access to a service without necessarily identifying group members e.g. airline boarding passes. The term "individual image" thus includes personalised images characteristic of a person as well as other forms of individualization.

In certain instances it may be necessary to produce a unique batch of cards and then validate the whole batch by applying an image immediately after the batch is taken from stock prior to issue. The batch members may also receive individual images.

Individual images by their nature are applied as a or the final production stage and it is essential to be able to change the images quickly. Electronic printing means are particularly suited for this as the alphanumeric and graphical image information can readily be changed.

It is already known to apply electronic images to security items. Known printing methods such as thermal printing, however, give colour images which are thin, suffering from the significant disadvantage that they may be abraded from the outside of the identity card.

Modern cash, charge and credit card production is increasingly centred on the use of polyvinyl chloride. The attractions of PVC are that it is inexpensive, embossable and fusion laminatable. PVC cards are therefore commercially significant. Embossability is necessary for allowing the card holder's particulars and account number to be included so that credit and charge card slips can be reliably and accurately printed with the above information at the time of a transaction.

The ability to produce satisfactory images on PVC is therefore liable to be commercially significant.

Certain forms of electronic imaging allow the use of dyes which may be sublimed or otherwise transferred onto a plastic receiving layer.

It is known, however, that plastics have different efficiencies of receiving sublimed dyes. The receiving efficiency with regard to synthetic fibres, say, decreases from nylon to polyester to acrylic to acetate to polyvinyl acetate. Unfortunately, PVC is known to be a substrate of poor receptivity for sublimable dyes.

WO-A-8403257 describes a process for printing coloured designs onto a polymer surface. This is not suitable, however, where a large variety of different designs are required, each to be printed only once as in personalised data.

US-A-4738949 describes a dye transfer process for providing images on substrates. However, this technique has not been successful since only faint images can be obtained and there is also the problem that the transfer sheet can stick to the substrate leading to an unacceptable image being produced. This patent is also not concerned with laminates made from polyvinyl chloride and its copolymers or blends.

DE-A-2413494 describes a thermal transfer process for transferring dyes to, inter alia, PVC sheets. However, this also suffers from various problems.

US-A-4507349 describes the imaging of security articles in which a barrier layer is provided to prevent dyes transferred on to a substrate from diffusing into other layers.

EP-A-97493 describes a colour formation technique in which a colourless dye diffuses into a receptor layer sufficiently to enable a complex to form.

US-A-4059471 describes a method of absorbing dyes into the surface of plastics by placing polyolefin film between the dye transfer paper and a sheet of thermoplastic and applying pressure and heat thereto. Dyes are absorbed into the surface of the plastic and the materials are then separated to leave a decorated plastic sheet.

US-A-2721821 describes the process for printing on surfaces of plastics material in which paper carrying ink is applied to the plastics and then heated so that ink selectively transfers onto the plastics, the paper then being removed.

Neither of these two methods is particularly suitable for generating security articles since the transferred ink remains on the surface of the substrates concerned.

It should also be noted that commercially available receiver sheets for thermal transfer printers frequently do not laminate successfully, probably owing to the presence of release layers and coatings. Such receiver sheets are often of complex construction.

In accordance with the present invention, a method of providing an image on a security article including at least a first plastics layer and a second layer in contact with and bonded to the first layer comprises transferring portions of at least one diffusible dye onto the first plastics layer, the portions being selected so as to generate a representation of the image on the layer; and causing the or each dye to diffuse into and partially remain in the first layer and at least to mark the second layer.

We have found that for multiple layer articles including plastics layer(s), particularly certain grades of PVC, it is possible to provide good images on the article with adequate tone gradation and improved security by causing a controlled degree of diffusion of the dye into at least the first layer to occur while at least marking the second layer.

Typically, the diffusion step comprises applying heat (and optionally pressure) for a predetermined time to the article. In one example, the image may be provided on the underside of a transparent plastics film, diffusion being caused by applying a heated roller under pressure to the film and then adhering the film to a second layer which then allows the dye to mark it or preferably diffuse within it. This would be useful in the case of a passport where an image of the bearer could be provided on a film which is then adhered (laminated) to a security indicia printed paper page of the passport.

Preferably, the first layer is fusion laminated to the second layer, the at least partial diffusion of the or each dye being caused by the lamination step. This avoids the need for an adhesive so as to achieve a highly secure composite. The avoidance of dissimilar properties of the laminating components means that the interface has a high adhesive strength. It is not readily possible to force or peel apart the second layer and the topmost laminating film because they are chemically closely compatible and are essentially welded together. Lamination with adhesive is also possible, however.

By employing sublimable dyes which then diffuse into the plastics, the welding occurs over the image areas, i.e. there is plastics to plastics contact as distinct from, say, plastics to ink to plastics contact as in the majority of security articles of this type. This welding greatly enhances the security of the article.

Preferably, the lamination step includes allowing the bonded laminate to cool under pressure. This maintains surface gloss and overall flatness. Typical pressures may be in the order of 300-600 lbs per square inch (ie. 21kPa to 41kPa).

Typical fusion temperatures are between 130°C and 160°C. Pressure is used during lamination of the order of 20-150 pounds per square inch (ie. 1.4kPa to 10.4kPa). Under these conditions lamination is normally complete within one minute.

We have found, for example, that by heating the dyes for about 30 seconds at 150 degrees Centigrade, penetration depths of the order of 30 microns have been obtained, which can be sufficient for the dyes to move into receptor layers.

The novel diffusion aspect offers a high level of protection against fraudulent alteration as the dyes are contained within the bulk of one layer and at least mark the adjacent layer.

The dyes must be free to diffuse into the first plastics layer securing a significant degree of penetration. Documents may be given different dye images on both sides.

The diffusion of the dyes requires that the depths of penetration achieved by the dyes is significantly greater than would be the case with conventional thermally transferred dyes which are intended to bond principally on the surface or marginally within the receiver layer possibly around 5 microns. Laser transferred dyes are deposited more on the surface.

Generally the dyes for use with this invention will have low molecular weights as very high molecular weights reduce diffusivity. The dyes must be free to penetrate the plastics layer e.g. by thermal diffusion. This may involve diffusion within the polymer or alternatively there may be minute pores provided such as in having a porous particulate pigment present or minute vesicles.

In all cases the dye should be free to pass diffusively into the first (and if necessary, second) layer without significantly chemically associating with polymer, pigment or other additive.

Diffusion may occur during the imaging process or may be a separate process. Generally heat will be applied to a temperature below the softening point of the polymer. The heat may be applied by hot air, infrared radiation including laser radiation, or by contact with a hot surface which is preferably impervious to the dye. Thus for example there may be a metal plate applied to the surface of the first layer to which the dye has been applied, this being held in hot pressure contact so as to allow heat to be transferred by conduction. Such conditions occur during lamination of plastic to plastic and there may be no need to have a separate diffusion stage.

For continuous processes a heated roller having an impervious metal surface, passed over the substrate is suitable for causing diffusion of the dyes.

Alternatively, a plastic surface may be brought into contact with the imaged surface, the plastic being impervious to the dyes.

It is almost impossible to remove the dyes from the image receptive layer(s). Fraudulent scraping or erasure of the dyes from the surface will not permit total removal of the image as would be the case with conventional thermally applied images, which do not significantly diffuse into the image receptive layer. A diffused image will remain. This cannot be removed without damaging the laminated receptor film and any security printed indicia at the interface. Any attempt to place a fraudulent image on top of an earlier image will be readily revealed especially if it is associated with a security printed layer.

The electronically applied images will normally contain at least one of:

security indicia - generally comprising a selection of graphical designs, lineworks, lettering and number works, symbols, dots, guilloches -and issuing agency logos;
account information - comprising one or more of the name, address and account number of the holder, in alphanumeric characters;
item information - comprising one or more of the article's serial number and validity period in alphanumeric characters: and
personalising information - comprising one or more reproductions of the face, signature and fingerprint of the holder, people, groups, or objects, or other individualising information, or
encoding markings such as optically readable bar codes.

The images may also contain computer generated design elements.

In one example, the dye is applied to one surface of the first layer while the other surface of the first layer, ie. the surface which does not carry the transferred dye or dyes is then laminated onto a second, plastics layer, the first layer being sufficiently thin that dye diffusion will occur through the first layer into the second layer. However, in the preferred example, the surface of the first layer carrying the transferred dye or dyes is laminated onto the second layer so that dye partially diffuses into both layers during lamination.

It is necessary that only one dye diffuses into the first layer or dye receptor layer, although if three dyes are applied it is preferable that all three diffuse, either to similar or different extents. The diffusion to different extents adds a security feature.

The marking in the second layer need not represent the whole image present in the first plastics layer e.g. where security printing is present the inks will be marked by the imaging dyes only -where the inks are present.

The first layer will generally be a polymeric material whether in a self supporting film, non-self supporting film on a carrier sheet or a coating. The coating may for example be applied to a plastic film, plastic sheet, plastic laminate, plastic paper laminate or coated paper surface. Dye may also be transferred to a smooth coated paper surface such as high quality printing papers for example on some identity cards.

Suitable laminatable films for receiving the dyes include polyvinyl chloride and polycarbonate. The film may if necessary be adhered to the second layer. The use of an adhesive is normally undesirable from the security aspect but use of adhesives allows many dissimilar layers to be bonded.

Suitable polymeric coatings for receiving diffusible dyes comprise polyvinyl chloride polymers, copolymers and blends, polycarbonates and polyesters.

It is important that the dyes be matched to the first layer so that diffusion can occur. In general any dye electronically applied to the receptor sheet must diffuse in to a depth of at least 10 microns, preferably at least 20 microns, more preferably at least 25 microns, most preferably at least 50 microns, on heating for example to 150 degrees Centigrade for 30 seconds.

Heat (and optionally pressure) is applied to allow the dyes to diffuse into the polymeric receptor layer. If a heat lamination stage is involved e.g. when laminating a film to a plastic card substrate, the diffusion will occur during this stage without the necessity for a separate diffusion heating stage.

In a particularly preferred method, the second plastics layer includes previously printed indicia such that during the lamination step, the dye or dyes on the first layer diffuse to and through the printed indicia. This printed indicia may have been provided on a surface of the second layer or the second layer itself may comprise a lamination With the printed information being provided within the lamination while being visible externally of the second layer. In any event, this is particularly useful in the case of a security article where the printed indicia define a security print since any attempt to forge the security article (by replacing the image defined by the dye or dyes) will simultaneously cause destruction of the printed indicia.

A typical set of parameters which have been used are:

Temperature	100° - 200 °
Pressure	0 - 800psi (0-55kPa)
Times	≤ 1 minute

By selection of appropriate combinations of temperature and pressure it has been possible to diffuse laser thermally transferred dyes through a 20 μm top layer of PVC coating, a layer of security print of 2 microns thick and finally marking the layer beneath. The total depth of diffusion in this case was measured as about 52 microns.

Further experiments have resulted in depths of between 50 and 100 microns being measured, for example through three layers - plastic (20 microns): ink (2 microns): plastic core (e.g. 30 micron penetration).

One important application of this method is in the production of a security article in which case the image may comprise an indication of the bearer of the article such as an image of the bearer, an image of his signature and the like. The term "image" however should be understood to include text characters and other types of information such as serial numbers, bar codes and other machine readable characters and codes.

In the case of security cards which typically comprise a relatively thick core and relatively thin cover layers, the first substrate could be provided by the core or one of the cover layers.

In addition to use in financial and identity plastic cards, the invention may be used, suitably adapted, on other security items such as passports, plastic surfaced identity cards, service entitlement cards, promotional cards, cheques, driving licences, voting cards, integrated circuit containing cards, and the like.

Thus for example passports normally have a film on the bearer's photograph page which protects the photograph of the bearer. This film normally bears security markings and is adhered to the passport page with a heat activatable or cold seal pressure sensitive adhesive. Such a film may be imaged electronically by a method according to the invention. The film may be imaged either before or after adhering to the passport and then heated to ensure the dye diffuses into the film, preferably at least reaching the security layer. If necessary the film may be supplied on a peelable carrier.

The receptor layer may bear security indicia on either side if printing is feasible, in addition to any printing on the substrate to which it is attached.

The main use of the invention is in printing colour photographs of holders onto security items as there is no other way of readily doing this.

Thermally diffusible dyes may be placed on the receiving substrate by using an electronically driven imager which generates a radiation beam, such as a laser, or a printer having a multiplicity of individually heatable elements (ie. a printer having a thermal imaging head). In both cases a dye donor sheet or carrier is placed in close contact with the image receiving surface, and the laser beam or the thermal head element causes a point of dye to be transferred thermally to the dye receptive surface. The whole image is made from a multiplicity of individually applied points of dye. For a full colour image the process is conducted by sequentially transferring yellow, magenta, and cyan dyes.

At this stage, which is normally the final stage in thermal imaging, the deposited dyes reside essentially on the surface of the receptor and are not thought to penetrate more than about 2 microns. It should be understood that by thermal transfer we include various transfer methods such as those known as dye diffusion and dye sublimation. Those transfer methods should be distinguished, however, from printing where a plate carrying the image is provided which is then coated with an ink before being impressed on a substrate.

Electronic laser imaging equipment employing a Nd:YAG laser suitable for use in the invention is described in EP-A-202811. This is particularly useful for imaging the substrates which have been employed in this invention.

Thermal printing heads for use in thermal transfer printers are supplied by Mitsubishi, Dai Nippon, Fujitsu and TDK. Such heads are more readily adaptable to use with the less rigid laminating films. Such heads will generally allow a resolution of 150 to 300 points per inch (6-12 points per mm).

The electronic imager may use images supplied from an electronic or video camera, a charge coupled device, a flat bed or rotary scanner or in the case of computer generated designs from a computer.

Thus one preferred method according to the invention comprises intimately contacting the dye releasing surface of a dye donor film with the first plastics layer, exposing the dye releasing layer to an image creating beam of laser radiation such the dye is then imagewise transferred to the plastics layer and then diffusing the dye into the plastics layer and adjacent second layer.

The imaging beam may be continuous, describing lines or discontinuous, forming individual spots.

The preferred laser is one which provides heat energy to the dye and Nd:YAG lasers have proved suitable.

Another preferred method comprises intimately contacting the dye releasing surface of a dye donor film with the first plastics layer, contacting the dye releasing layer with an image creating pattern of thermally activated pins in a thermal printing head such that dye is then imagewise transferred to the plastics layer, and diffusing the dye into the plastics layer to a significant depth, allowing marking of the adjacent second layer.

Other methods of transferring dyes on to the first plastics layer include:-

1) ink jet imaging means in which the dye is delivered in an ink jet to form the image;

2) imaging or printing means in which the diffusible dye is releasably incorporated in a composition which is intended to remain bonded to the surface of the first plastics film, for example

a) xerographic toner deposition, the toner releasably incorporating the diffusible dye; in this case the non-dif-

fusible portion of the toner would remain on the surface and the dye would diffuse into the plastic layer;
b) magnetically deposited powders incorporating diffusible dye;

3) plotter pens depositing an ink which contains diffusible dye.

As an alternative to using conductive heating under pressure to cause diffusion, the or each dye may include a heat radiation absorbing dye, wherein the diffusion step comprises activating the heat absorbing dye to cause the diffusible dye to diffuse. For example, this may be implemented by including an infrared (heat) absorbing dye which is transferred imagewise with the diffusible dye, and then applying IR radiation (e.g. 1060nm Nd;YAG laser or from an incandescent source) to cause local heating in the areas where the IR dye is. The laser heating exposure can be overall or imagewise. The incandescent heating will be overall but in both cases heating will occur only where the IR dye is.

As an alternative to incorporating heat radiation absorbing compounds, a source of radiation may be chosen which will heat the plastic layer by for example the plastic or a compound blended with the plastic absorbing and so becoming hot. Use of radiative heat sources may allow more control of the heating conditions and local heating within the layers than conductive sources.

The second layer will preferably be plastic but may also be a paper plastic laminate or surface treated paper such as plastic coated, resin coated, and highly filled papers which have a smooth surface or simply an ink or printed lacquer layer on a surface of the first layer. The paper may be made of natural or synthetic fibres.

In some cases, particularly where the second layer is ink, a third or further (preferably plastics) layer is provided, the second layer being positioned between the first and third layers, wherein the or each dye is caused to diffuse into all three or more layers.

The plastics material typically comprise PVC although other materials may also be suitable such as polyesters and polycarbonates. The "PVC" used for security cards Which is suitable with the invention need not be pure PVC homopolymer. A small percentage of polymerised vinyl acetate may also be present. This may be included as a copolymer with vinyl chloride. Opacifying pigments may be included in the PVC although the topmost film must normally be transparent.

We have found that approximately 5% by weight of vinylacetate incorporation gives adequate dye diffusing properties with approximately 10% or more giving unsatisfactory results.

The glass temperature of the PVC may also have an affect, with those materials having higher glass transition temperatures showing better results. Commercially available PVC homopolymer of medium molecular weight allows improved image quality with the dyes which we have used. PVC homopolymer of high molecular weight gives further improved images.

The plastics first layer in the form of a film tray cover all or part of the surface to which it is attached. Attachment may be before or after imaging.

Plastics polymeric coatings such as of PVC may be coated on all or part of the surface of the second layer or may be selectively applied such as by screen printing. Plastics coatings may also be applied by depositing a curable lacquer and subsequently curing it by for example exposure to ultraviolet radiation.

In this case the plastics polymeric coating will adhere directly to the second layer. Only a portion of the surface need be covered.

It is generally desirable that the first and second layers be composed of chemically similar plastics so as to allow high adhesive strength at the interface.

Normally the first plastics layer will be transparent and colourless although it may be tinted. Normally the second plastics layer will be opaque allowing viewing of the completed image through the first substrate.

In certain circumstances it may be desirable to employ two transparent plastics layers or a first layer which is opaque but which allows the dyes to diffuse through so as to allow the image to be viewed through the second layer which must be transparent.

Preferably, the image is characteristic of the bearer of the security article such as a representation of the bearer of the article or a representation of his signature.

In accordance with a second aspect of the present invention, a security article comprises two layers in contact and bonded together, at least one of the layers comprising a first plastics layer which contains an image formed by a diffusible dye, the other layer having been marked with the diffusible dye.

Some examples of methods according to the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 illustrates, schematically, apparatus for performing one method according to the invention; and,
Figures 2A and 2B are schematic cross-sections through security cards which have been provided with coloured images according to two different methods according to the invention;
Figure 3 is a cross-section through an example of an identity card;
Figures 4 and 5 are cross-sections through an article before and after lamination respectively; and,

Figure 6 is a cross-section through a triple laminate article

The apparatus shown in Figure 1 comprises a first stock roller 1 on which is provided a stock or a thin, transparent, laminatable PVC tape 11 which is supplied to an imaging station 2. The imaging station comprises a roller 3, a thermal printing head 4 and a dye donor module 5. The dye donor module 5 comprises a stock spool 6, a pair of guide rollers 7, 8 and a take-up spool 9. A length of dye donor film 10 is wound initially around the stock spool 6 and is guided around the guide rollers 7, 8 to the take-up spool 9. The colour dye donor film 10 is of conventional form and comprises a plastics base layer on which is carried a series of transfer dyes having colours cyan, magenta, and yellow repeated throughout its length. An example of a suitable dye donor film is Hitachi colour video printer material Type VY-T50A. For four colour printing a black dye may be transferred in addition to the cyan, magenta, and yellow. For monochrome images the dye donor film may have any colour.

In operation, as a length of the transparent PVC tape 11 reaches the imaging station 2, the first dye to be transferred, for example yellow, is brought between the thermal head 4 and the roller 3 by rotating the take-up spool 9. This is achieved via conventional control electronics indicated schematically at 12. The control electronics 12 then actuate the thermal head 4 in such a manner that the yellow dye is transferred at the correct places on to the tape 11 corresponding to pixels of an image which is to be provided on the tape. During this process, the tape 11 is stationary while the head 4 is moved (by means not shown) along the tape. Once the yellow dye has been transferred, the take-up spool 9 is activated to bring the next dye into line with the thermal head 4, for example magenta, and the process repeated. The process is again repeated with the cyan dye following which the tape 11 is drawn out from the imaging head towards the lamination rollers, to be described.

The manner in which the thermal head 4 is activated is determined by reference to a digital version of the image to be transferred which is stored in a store 13.

The imaged PVC tape 11 is then drawn through a laminating station 14 where the tape is fusion laminated between a pair of rollers 15, 16 to another PVC tape substrate 17 fed from a second stock spool 18. This second substrate may comprise a single plastics layer or may itself comprise a number of layers which are either already laminated or are laminated by the rollers 15, 16. Fusion lamination takes place at a temperature in the range 130-160°C and under a pressure of about 150lbs per square inch (10.4kPa). The hot, bonded card must then be allowed to cool whilst remaining under pressure in order to maintain surface gloss and overall flatness of the card. The pressure here may be about 600 lbs per square inch (41kPa). Following lamination, the laminated tape is fed to a cutting station 19 where the tape is cut into individual security articles.

Of course, several variations of this apparatus are possible and for example the imaging station could comprise three printing heads arranged sequentially, each ink being transferred at a separate station. Lamination of sheets may also be undertaken.

In the case of security articles such as security cards each will comprise one or a number of core layers leading to a typical core thickness of 650μm. On each side of the core may be superposed a number of relatively thin cover layers leading to a total thickness of core plus cover layers of approximately 750μm. It is normal to have only one top layer with a thickness of approximately 100μm. For simplicity, we will describe various different methods of providing coloured images on or in these cards by reference to just two layers, a core layer 20 and a thin, transparent cover layer 21.

Figure 2A illustrates the result of carrying out the method defined by the apparatus shown in Figure 1 with the core layer 20 forming part of the laminated substrate fed from the second stock spool 18 while the layer 21 corresponds to the imaged PVC tape 11. As can be seen, the transferred dye, indicated at 22 has diffused into both the core layer 20 and the cover layer 21 during the lamination stage. In the case of security articles, this makes it very difficult to forge such cards where "forgery" refers to the illegal alteration of the articles, in view of the diffusion of the dye into each layer. Furthermore, the diffusion leads to the production of high contrast images with adequate tone gradation and without the need for special release layers to prevent sticking as in known transfer techniques. In an alternative method the image could be transferred to the core layer 20 and then the transparent layer 21 laminated on to the core layer.

Figure 2B illustrates a modified form of the Figure 2A construction in which the layer 21 is reversed relative to the core layer 20 so that the imaged surface of the cover layer 21 is exposed. During the lamination stage, the dye 22 diffuses into and partially through the cover layer 21 and marks the core layer 20 by diffusing into it.

In preferred examples, the surface of the core layer 20 through which the dye diffuses is preprinted with a security print.

In a typical thermal transfer process such as that shown in Figure 1, the temperature of the head will be about 200°C while the time to expose all pixels in a line of three inches corresponding to the length of the head is typically about 10ms although it is possible to introduce a grey scale graduation by varying the time per pixel. The total time in practical thermal transfer imaging equipment to expose a 3 inch x 4 inch (ie. 75 mm x 100 mm) area at a density of 150 pixels per inch (ie. 6 per mm) to all three colours is about 2 minutes.

In contrast, a laser induced transfer system is far quicker and enables much higher pixel densities to be achieved, typically of the order of 1000 pixels per inch (40 per mm). Typical temperatures can be up to 300°C with a typical exposure time per line of pixels being about 2 ms with the pixels being exposed serially. This leads, to a total time to image a 3 inch x 4 inch (75mm x 100mm) area with all three colours in the order of 12 seconds.

Figure 3 shows a plastic laminate construction with plastic (PVC) layer 30 bearing security printed indicia 32, bonded to plastic (PVC) core 31 at interface 33. Thermally transferred diffusible dye was initially deposited on the surface 34 and then the dye was diffused in by heat forming the image in layer 30 at 35, and also in the ink of the security printed indicia 36 and the underlying layer at 37. Fraudulent removal of the dye is therefore made difficult.

This structure would typically serve as an identity card.

Figure 4 shows a plastic foil 38 bearing security indicia 39 on a surface which has received diffusible dye 40.

Figure 5 shows the layer of Figure 4 laminated to a plastics substrate 41 at interface 42, the dye having been heated and allowed to diffuse into plastic layers 43 and 44, and through the ink 39.

Figure 6 shows three plastic layers bonded together. First layer 46 bearing security printed indicia 47 is bonded at interface 48 to plastic layer 49 which is further bonded at interface 50 to opaque plastic layer 51. Diffusible dye initially deposited on the surface at 52 is diffused into the matrix and stains plastic layers in the shaded area 53 which extends through all three layers and the ink. A different ink printed at 54 inhibits the diffusion of the dye into the underlying layers by absorbing the dye and therefore is marked.

Some Examples of methods according to the invention will now be described.

EXAMPLE 1

A white PVC security card substrate of 650 microns thickness is lithographically printed to impart background security indicia. The PVC substrate contains a small proportion of polyvinyl acetate and contains a white pigment.

A film of PVC laminating film of thickness 100 microns is electronically imaged to give a colour picture of the card holder. This is achieved by capturing the holder's image on a colour camera and preparing a series of data according to red, green and blue colour components. This data is then used to cause yellow, magenta and cyan dye to be deposited imagewise on the PVC film. The imaging device is a Hitachi thermal printer having a thermal head composed of individually heatable elements, there being 150 per inch (6 per mm). Yellow, magenta and cyan Hitachi thermal colour transfer films are employed as the dye donors.

The imaged surface of the film is then laminated to the security print bearing surface of the substrate for 75 seconds at 140 degrees Centigrade and allowed to cool under pressure. The overall cold-to-cold cycle time is 6 to 8 minutes.

During the heating the dye diffuses across into the PVC core and into the film itself to a depth of at least 20 microns. The film and substrate are thus securely fused together.

The diffusion depths were of the order of 30 to 80 microns.

The laminate is then cut to ISO financial card size to form a card ready to receive embossing with account information.

The construction is tamperproof as any attempt to change the electronically applied image or the security printing will result in inevitable damage to the other.

Magnetic and signature strips may be added during the making of such cards if necessary.

EXAMPLE 2

A white PVC security card substrate of 650 microns thickness is lithographically printed to impart background security indicia. The PVC contains a small proportion of polyvinyl acetate and is pigmented.

A film of high softening point PVC of thickness 30 microns is laminated to the security print bearing surface of the substrate for 75 seconds at 140 degrees Centigrade. The total cold-to-cold cycle time is within 6 to 8 minutes.

The film surface of the card blank is then electronically imaged to give a colour picture of the card holder. This is achieved by the method in Example 1 except that the dye is transferred to the outer surface of the card by placing yellow, magenta and cyan dye transfer films in sequential intimate contact with the card surface and using laser imaging equipment as described in EP-A-202811 to cause imagewise dye transfer thereby forming a colour picture of the holder.

The card is then heated between heated platens at 150 degrees for 30 seconds to allow the dyes to diffuse into the film towards and beyond the security printed layer. A diffusion depth of about 30 microns was achieved, which is adequate to ensure the dyes penetrate to the security layer.

The diffusion conditions are generally arranged to be sufficient than the card suffers no significant distortion from the plane.

The imaged laminate is then cut to ISO financial card size to form a financial card ready to receive embossing with account information.

The construction is tamperproof as any attempt to change the electronically applied image or the security printing will result in inevitable damage to the other.

The construction is also very convenient to use as the electronic image is applied to a card blank which can be produced in multiples with minimal further processing. The completed card offers a very high level of security.

EXAMPLE 3

This is conducted as Example 2 except that the security printing is applied to the underside, that is the laminatable side, of the film rather than the substrate.

Again this results in a secure financial card with the dyes having diffused in from the outside to a depth of at least 30 microns in 30 seconds, sufficient to dye the security printed layer. Any lateral movement of the dye is minor and does not adversely affect the appearance of the final image.

EXAMPLE 4

This is conducted as Example 2 except that instead of a film being laminated to the card, a coating of polyvinyl chloride is applied by screen printing at thicknesses of 10, 20, 30, 50 and 100 microns wet. This coating covered all of the surface of the card. After drying the PVC coating is imaged as in Example 2 and the imaged card heated at 150 degrees Centigrade for 30 seconds. The dye penetrates to a depth of at least 30 microns into the card, resulting in a secure card.

EXAMPLE 5

A film of 100 micron thick clear PVC is security printed in the normal manner. The security printed side of the film is then coated with a 20 micron thick dye receiving layer of polyvinyl chloride. After drying this coated film is then imaged with a thermal printing head as in Example 1.

The composite film is then laminated to 750 micron PVC substrate bearing security indicia on its laminatable surface, at 150 degrees Centigrade for a few minutes. The surface of the composite film bearing the electronic image of the holder is used as its laminating surface. The thermally applied dyes diffuse through the coating into the film and also into the substrate. Thus this format offers increased security as there are two separate security printed layers each of which has received the diffused dye image.

The completed card may be given a further electronic dye image e.g. of the signature of the holder, by applying the diffusible dyes to the outer surface of the card and then heating the card for sufficient time to cause diffusion.

In order to measure the depths of dye penetration typical yellow, magenta and cyan dyes were sequentially deposited by means of a Hitachi thermal head printer onto PVC substrates to form parallel black lines of 0.7mm width.

The PVC substrates were 80 micron thick transparent PVC film (supplied by the Stauffen Company) and the same material coated with a 20 micron dry thickness coating of high molecular weight PVC homopolymer (supplied by BDH Ltd., Type 29784). The coating was applied by solvent deposition.

Thermal imaging as described above was then conducted. For the uncoated substrate the side which was to be coated for the comparison was imaged. For the coated substrate the coated side was imaged.

The imaged substrates were then laminated with their printed side outwards onto PVC card base stock of thickness 650 microns.

After lamination under a variety of conditions the imaged surface was physically removed to increasing depths in order to give a comparative method of measuring dye penetration depth. The depth was taken at the point where the density of dye started to decrease noticeably. Some of the dye however penetrated to a greater depth at lower density but at such a density that would still cause difficulties for fraudulent alteration.

The depths were measured by use of Talysurf Ltd. surface profile measuring equipment.

Results are recorded in Table 1 which gives two measurements for two samples and their average.

As expected the diffusion depth was found to increase with time and temperature. The depth of diffusion was generally about two to four times greater through the coated PVC.

The dyes were measured here to have penetrated by at least fifty percent more than was measured on equivalent samples measured by inspecting sections by electron microscopy.

The results show that significant diffusion depths can be achieved during lamination. The results in the table also show that the first substrate coated layers allow deeper diffusion than laminate films under the same conditions. This can have considerable advantages.

TABLE 1

DYE DIFFUSION DEPTH BY ENGRAVING AND TALYSURF TRACING						
Card No.	Print on Uncoated (UC) or Coated(C) PVC	Lamination Conditions Hot Cycle		Diffusion Depth (microns)		
		Temp (°C)	Time (secs)	Trace A	Trace B	Av.
1	UC	155	10	9 9	9 7	8.5±1
2	C	155	10	14 16	19 18	16.8±2.2
3	UC	155	30	9 8.5	9 8	8.6±0.5
4	C	155	30	38 40	32 32	35.5±4
5	UC	180	10	15 17	14 16	15.5±1.3
6	C	180	10	34 32	44 48	39.5±8
7	UC	145	75	34 34	26 28	30.5±4
8	C	145	75	80 80	62 65	71.8±10

Investigations have shown that incorporating an infra-red absorber in the dye it is possible to promote differential absorption between written and unwritten areas of PVC by ensuring that some infra-red absorber is transferred with the dye from the carrier or donor sheet. If this absorber is sufficiently sensitive and does not degrade upon transfer,the dye-written areas of the card will preferentially absorb radiation (of the selected wavelength) and therefore differential heating will occur. By differentially heating the specific areas required in this way it is possible to avoid distorting or otherwise altering the condition of the bulk of the card.

Claims

1. A method of providing an image on a security article including at least a first plastics layer and a second layer in contact with and bonded to the first layer, the method comprising transferring portions of at least one diffusible dye onto the first plastics layer, the portions being selected so as to generate a representation of the image on the layer; and causing the or each dye to diffuse into and partially remain in the first layer and at least to mark the second layer.

2. A method according to claim 1, wherein the or each dye diffuses into both layers.

3. A method according to claim 1 or claim 2, wherein the second layer comprises pre-printed indicia.

4. A method according to claim 3, wherein the pre-printed indicia are carried on a plastics substrate, the or each dye diffusing partially through the pre-printed indicia into the plastics substrate.

5. A method according to any of the preceding claims, wherein the second layer is a plastics material.

6. A method according to claim 5, wherein one or both of the first and second layers comprises a PVC containing material.

7. A method according to any of the preceding claims, wherein the diffusion step comprises applying heat for a predetermined time to the first and second layers.

8. A method according to any of the preceding claims, wherein the diffusion step comprises causing at least the first plastics layer to absorb radiation and thereby generate heat.

9. A method according to any of the preceding claims, wherein the first layer is fusion laminated to the second layer, the at least partial diffusion of the or each dye being caused by the lamination step.

10. A method according to claim 9, wherein the lamination step includes allowing the bonded laminate to cool under

pressure.

11. A method according to any of claims 8 to 10, wherein the first and second layers are heated to a temperature of 130°C-160°C and subjected to a pressure of 300-600 lbs per square inch (21 to 41 kPa) for up to a minute.

12. A method according to any of the preceding claims, wherein the surface of the first layer carrying the transferred dye or dyes contacts the second layer.

13. A method according to any of the preceding claims, wherein the first and second layers are placed in contact after the transferring step.

14. A method according to any of the preceding claims, wherein the or each dye diffuses into at least the first layer to a depth of greater than 5μm.

15. A method according to claim 14, wherein the or each dye diffuses to a depth of at least 10μm.

16. A method according to claim 15, wherein the or each dye diffuses to a depth of at least 50μm.

17. A method according to at least claim 5, wherein the article further comprises a third plastics layer, the second layer being positioned between the first and third layers, wherein the or each dye is caused to diffuse into all three layers.

18. A method according to any of the preceding claims, wherein the or each dye is transferred onto the first layer from a carrier.

19. A method according to claim 18, wherein a radiation beam is used to cause the portions of dye to transfer onto the first layer.

20. A method according to claim 19, wherein the radiation beam is a laser beam.

21. A method according to claim 18, wherein the or each dye is transferred using a thermal head.

22. A method according to any of the preceding claims, wherein portions of more than one dye are transferred on to the first layer so as to generate a multi-coloured image.

23. A method according to any of the preceding claims, wherein the or each dye is intimately associated with a heat radiation absorbing dye, wherein the diffusion step Comprises activating the heat absorbing dye to cause the diffusible dye to diffuse.

24. A method according to any of the preceding claims, wherein the image of the security article defines an individual identification.

25. A method according to claim 24, wherein the image is characteristic of the bearer of the article.

26. A method according to claim 24 or claim 25, wherein the image is a serial number.

27. A security article comprising two layers in contact and bonded together, at least one of the layers comprising a first plastics layer which contains an image formed by a diffusible dye, the other layer having been marked with the diffusible dye.

28. A security article according to claim 27 which has been made by a method according to any of claims 1 to 26.

Patentansprüche

1. Verfahren zum Herstellen eines Bildes auf einem Sicherheitserzeugnis, das eine erste Kunststoffschicht und eine zweite Kunststoffschicht enthält, die mit der ersten Schicht in Kontakt und mit ihr verklebt ist, wobei bei dem Verfahren Teile wenigstens eines diffusionsfähigen Farbstoffs auf die erste Kunststoffschicht übertragen werden, wobei die Teile so ausgewählt werden, daß eine Darstellung des Bildes auf der Schicht hergestellt wird; und der oder jeder Farbstoff in die erste Schicht hineindiffundiert wird und teilweises in selbiger verbleibt und wenigstens die zweite Schicht markiert.

2. Verfahren nach Anspruch 1, wobei der oder jeder Farbstoff in beide Schichten hineindiffundiert.

3. Verfahren nach Anspruch 1 oder Anspruch 2, wobei die zweite Schicht vorgedruckte Zeichen enthält.

4. Verfahren nach Anspruch 3, wobei die vorgedruckten Zeichen von einem Kunststoffträger getragen werden und der oder jeder Farbstoff teilweise durch die vorgedruckten Zeichen hindurch in den Kunststoffträger hineindiffundiert.

5. Verfahren nach einem der vorangehenden Ansprüche, wobei die zweite Schicht ein Kunststoffmaterial ist.

6. Verfahren nach Anspruch 5, wobei eine oder sowohl die erste als auch die zweite Schicht ein Material umfassen, das PVC enthält.

7. Verfahren nach einem der vorangehenden Ansprüche, wobei der Schritt des Diffundierens das Einwirken von Wärme auf die erste und die zweite Schicht über eine vorgegebene Zeit umfaßt.

8. Verfahren nach einem der vorangehenden Ansprüche, wobei der Schritt des Diffundierens die Absorption von Strahlung durch die erste Kunststoffschicht und die Erzeugung von Wärme dadurch umfaßt.

9. Verfahren nach einem der vorangehenden Ansprüche, wobei die erste Schicht auf die zweite Schicht schmelzlaminiert wird, und das wenigstens teilweise Diffundieren des oder jedes Farbstoffs durch den Schritt des Laminierens bewirkt wird.

10. Verfahren nach Anspruch 9, wobei der Schritt des Laminierens das Abkühlenlassen des verklebten Laminats unter Druck einschließt.

11. Verfahren nach einem der Ansprüche 8 bis 10, wobei die erste und die zweite Schicht bis zu einer Minute auf eine Temperatur von 130°C bis 160°C erwärmt und einem Druck von 300 - 600 lbs pro Quadratinch (21 bis 41 kPa) ausgesetzt werden.

12. Verfahren nach einem der vorangehenden Ansprüche, wobei die Oberfläche der ersten Schicht, die den übertragenen Farbstoff oder die übertragenen Farbstoffe trägt, mit der zweiten Schicht in Kontakt kommt.

13. Verfahren nach einem der vorangehenden Ansprüche, wobei die erste und die zweite Schicht nach dem Übertragungsschritt miteinander in Kontakt gebracht werden.

14. Verfahren nach einem der vorangehenden Ansprüche, wobei der oder jeder Farbstoff bis zu einer Tiefe von mehr als 5 μm in wenigstens die erste Schicht hineindiffundiert.

15. Verfahren nach Anspruch 14, wobei der oder jeder Farbstoff bis zu einer Tiefe von wenigstens 10 μm diffundiert.

16. Verfahren nach Anspruch 15, wobei der oder jeder Farbstoff bis zu einer Tiefe von wenigstens 50 μm diffundiert.

17. Verfahren wenigstens nach Anspruch 5, wobei das Erzeugnis weiterhin eine dritte Kunststoffschicht umfaßt, wobei die zweite Schicht zwischen der ersten und der dritten Schicht angeordnet ist und der oder jeder Farbstoff in alle drei Schichten hineindiffundiert wird.

18. Verfahren nach einem der vorangehenden Ansprüche, wobei der oder jeder Farbstoff von einem Träger auf die erste Schicht übertragen wird.

19. Verfahren nach Anspruch 18, wobei ein Strahlungstrahl eingesetzt wird, um die Teile von Farbstoff auf die erste Schicht zu übertragen.

20. Verfahren nach Anspruch 19, wobei der Strahlungstrahl ein Laserstrahl ist.

21. Verfahren nach Anspruch 18, wobei der oder jeder Farbstoff unter Verwendung eines Thermokopfes übertragen wird.

22. Verfahren nach einem der vorangehenden Ansprüche, wobei Teile mehr als eines Farbstoffs auf die erste Schicht

übertragen werden, um so ein mehrfarbiges Bild herzustellen.

23. Verfahren nach einem der vorangehenden Ansprüche, wobei der oder jeder Farbstoff eng mit einem Wärmestrahlung absorbierenden Farbstoff verbunden ist, wobei der Schritt des Diffundierens das Aktivieren des wärmeabsorbierenden Farbstoffs umfaßt, um das Diffundieren des diffusionsfähigen Farbstoffs zu bewirken.

24. Verfahren nach einem der vorangehenden Ansprüche, wobei das Bild des Sicherheitserzeugnisses eine individuelle Identifizierung darstellt.

25. Verfahren nach Anspruch 24, wobei das Bild charakteristisch für den Inhaber des Erzeugnisses ist.

26. Verfahren nach Anspruch 24 oder Anspruch 25, wobei das Bild eine Seriennummer ist.

27. Sicherheitserzeugnis, das zwei Schichten umfaßt, die miteinander in Kontakt und verklebt sind, wobei wenigstens eine der Schichten eine erste Kunststoffschicht umfaßt, die ein Bild enthält, das durch einen diffusionsfähigen Farbstoff gebildet wird, und die andere Schicht mit dem diffusionsfähigen Farbstoff markiert wurde.

28. Sicherheitserzeugnis nach Anspruch 27, das mit einem Verfahren nach einem der Ansprüche 1 bis 26 hergestellt wurde.

Revendications

1. Procédé pour fournir une image sur un article de sécurité comprenant au moins une première couche en matière plastique et une seconde couche en contact avec et liée à la première couche, le procédé comprenant le transfert de parties d'au moins un colorant diffusible sur la première couche en matière plastique, les parties étant choisies pour produire une représentation de l'image sur la couche; et faisant en sorte que le ou chaque colorant diffuse dans et reste partiellement dans la première couche et marque au moins la seconde couche.

2. Procédé selon la revendication 1, dans lequel le ou chaque colorant diffuse dans les deux couches.

3. Procédé selon la revendication 1 ou la revendication 2, dans lequel la seconde couche comprend des timbres préimprimés.

4. Procédé selon la revendication 3, dans lequel les timbres préimprimés sont portés sur un substrat en matière plastique, le ou chaque colorant diffusant partiellement à travers les timbres préimprimés dans le substrat en matière plastique.

5. Procédé selon l'une quelconque des revendications précédentes dans lequel la seconde couche est un matériau en matière plastique.

6. Procédé selon la revendication 5, dans lequel une ou chacune des première et seconde couches comprend un matériau comprenant du PVC.

7. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'étape de diffusion comprend l'application de chaleur pendant une durée prédéterminée aux première et seconde couches.

8. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'étape de diffusion consiste à faire en sorte qu'au moins la première couche en matière plastique absorbe un rayonnement et produise par là de la chaleur.

9. Procédé selon l'une quelconque des revendications précédentes, dans lequel la première couche est stratifiée par fusion sur la seconde couche, la diffusion au moins partielle du ou de chaque colorant étant occasionnée par l'étape de stratification.

10. Procédé selon la revendication 9, dans lequel l'étape de stratification consiste à laisser refroidir sous pression le stratifié lié.

11. Procédé selon l'une quelconque des revendications 8 à 10, dans lequel les première et seconde couches sont chauffées jusqu'à une température de 130°C-160°C et soumises à une pression de 300-600 livres par pouce carré

(21 à 41 kPa) sur une durée allant jusqu'à une minute.

12. Procédé selon l'une quelconque des revendications précédentes, dans lequel la surface de la première couche portant le colorant ou les colorants transférés est en contact avec la seconde couche.

13. Procédé selon l'une quelconque des revendications précédentes, dans lequel les première et seconde couches sont mises en contact après l'étape de transfert.

14. Procédé selon l'une quelconque des revendications précédentes, dans lequel le ou chaque colorant diffuse dans au moins la première couche jusqu'à une profondeur supérieure à 5 µm.

15. Procédé selon la revendication 14, dans lequel le ou chaque colorant diffuse jusqu'à une profondeur d'au moins à 10 µm.

16. Procédé selon la revendication 15, dans lequel le ou chaque colorant diffuse jusqu'à une profondeur d'au moins à 50 µm.

17. Procédé selon au moins la revendication 5, dans lequel l'article comprend en outre une troisième couche en matière plastique, la seconde couche étant disposée entre les première et troisième couches, dans lequel on fait diffuser le ou chaque colorant dans toutes les trois couches.

18. Procédé selon l'une quelconque des revendications précédentes, dans lequel le ou chaque colorant est transféré sur la première couche à partir d'un véhiculeur.

19. Procédé selon la revendication 18, dans lequel on utilise un faisceau de rayonnement pour faire en sorte que les parties de colorant soient transférées sur la première couche.

20. Procédé selon la revendication 19, dans lequel le faisceau de rayonnement est un rayon laser.

21. Procédé selon la revendication 18, dans lequel le ou chaque colorant est transféré en utilisant une tête thermique.

22. Procédé selon l'une quelconque des revendications précédentes, dans lequel des parties de plus d'un colorant sont transférées sur la première couche afin de produire une image multicolore.

23. Procédé selon l'une quelconque des revendications précédentes, dans lequel le ou chaque colorant est intimement associé avec un colorant absorbant un rayonnement thermique, dans lequel l'étape de diffusion comprend l'activation du colorant absorbant de la chaleur pour faire diffuser le colorant diffusible.

24. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'image de l'article de sécurité définit une identification individuelle.

25. Procédé selon la revendication 24, dans lequel l'image est caractéristique du porteur de l'article.

26. Procédé selon la revendication 24 ou la revendication 25, dans lequel l'image est un matricule.

27. Article de sécurité comprenant deux couches en contact et liées ensemble, au moins une des couches comprenant une première couche en matière plastique qui contient une image formée par un colorant diffusible, l'autre couche ayant été marquée avec le colorant diffusible.

28. Article de sécurité selon la revendication 27 qui a été fabriqué par un procédé selon l'une quelconque des revendications 1 à 26.

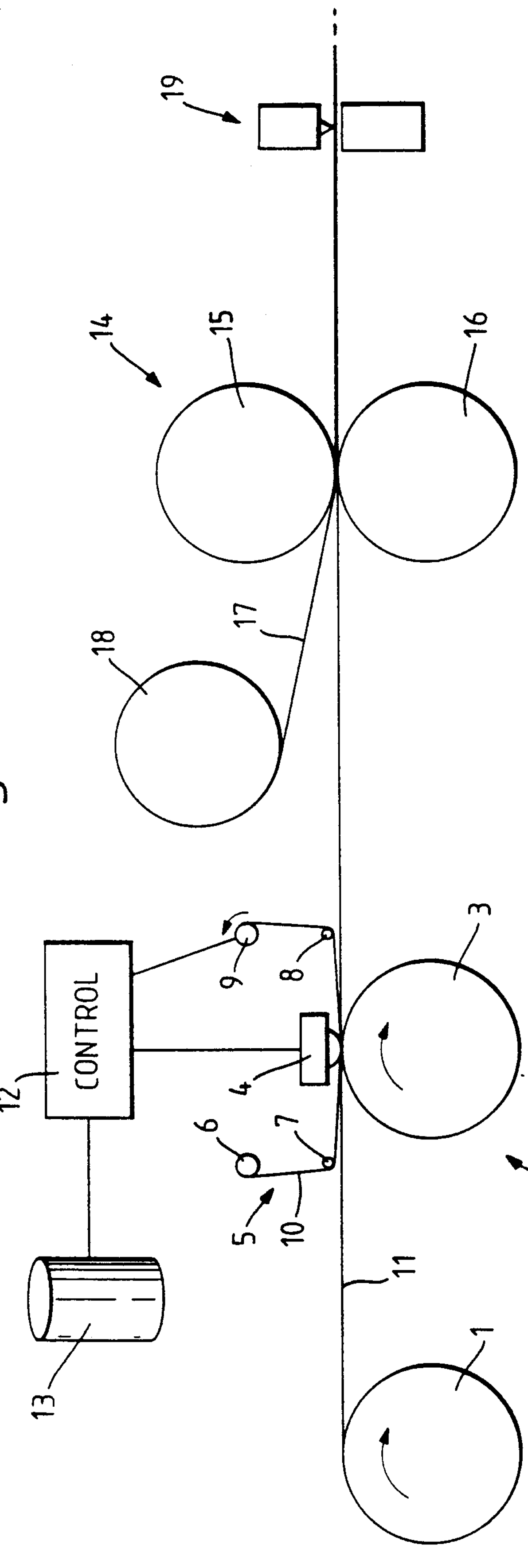

Fig. 1.

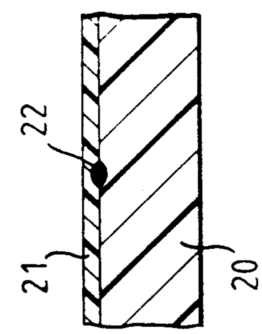

Fig. 2(A)

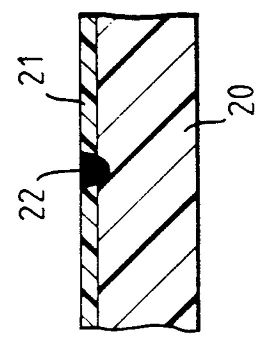

Fig. 2(B)

Fig.3.

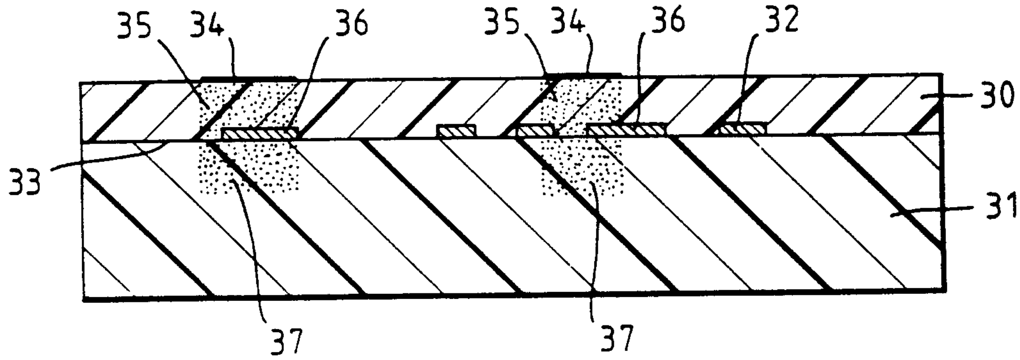

Fig.4.

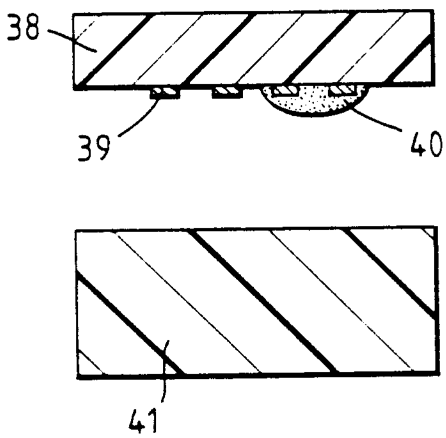

Fig.5.

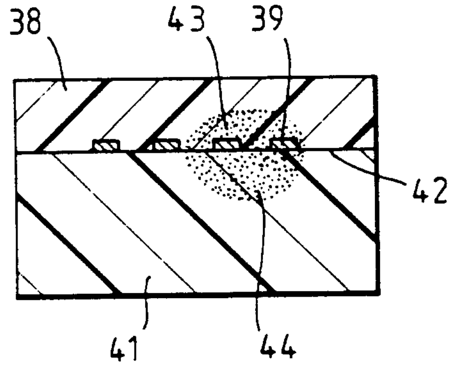

Fig.6.