



(72) ROMAINE, DOUGLAS J., US

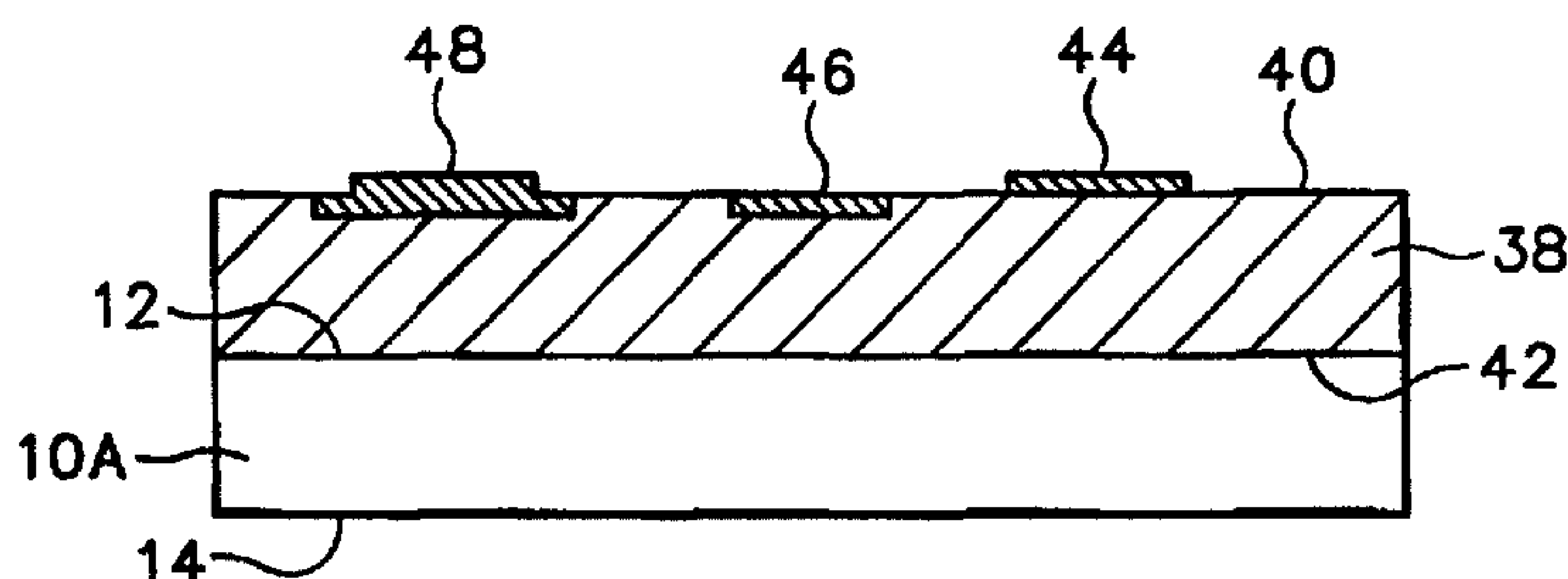
(71) SPENCER & ASSOCIATES, INC., US

(51) Int.Cl.⁷ B32B 5/02, B32B 31/26, B32B 31/00, B32B 27/00

(30) 1997/07/15 (60/052596) US

(54) **IMPRIMES AUTO-STRATIFIES ET RESISTANTS AUX
RAYURES ET LEURS PROCEDES DE FABRICATION**

(54) **SCRATCH-RESISTANT, SELF-LAMINATED PRINTED
MATERIALS AND METHODS FOR MAKING SAME**



(57) L'invention concerne un procédé permettant de produire un matériau (10B) structural composite multicouche imprimable unique, permettant d'obtenir à son tour un imprimé (10A) auto-stratifié résistant aux rayures. Un matériau structural composite multicouche imprimable est constitué d'un premier substrat (11) sous-jacent capable de passer dans un dispositif d'impression, d'une seconde couche (16), formée sur la première, liquéfiable lorsqu'on la chauffe à une température au moins équivalente à son point de fusion, et fusible aux températures inférieures à son point de fusion, et d'une troisième couche (22) imprimable formée sur la seconde couche. Cette troisième couche est également perméable de manière que lorsque la seconde couche est à l'état liquide, elle passe à travers et autour de la troisième couche. Le matériau structural composite multicouche imprimable peut constituer un imprimé auto-stratifié résistant aux rayures conformément au procédé suivant, à savoir (a) imprimer une image (26) prédéterminée sur la troisième couche, (b) chauffer la seconde couche jusqu'à ce qu'elle devienne liquide et qu'elle passe à travers et autour de la troisième couche et autour de l'image prédéterminée, et (c) faire fondre la seconde couche liquéfiable en abaissant sa température au-dessous de son point de fusion, ce qui permet d'encapsuler la troisième couche et l'image prédéterminée.

(57) A method is provided for producing a unique printable multi-layer composite structural material (10B), and in turn a unique scratch-resistant, self-laminated printed material (10A). A printable multi-layer composite structural material is formed which includes a first underlying substrate (11) capable of being transported through a printing device, a second layer (16) formed on the first layer which is flowable when heated to at least its melting point and being fusible below its melting point, and a third layer (22) formed on the second layer which is printable. The third layer is also permeable so that when the second layer is in a flowable state it permeates through and about said third layer. The printable multi-layer composite structural material is capable of forming a scratch-resistant, self-laminated printed material by (a) printing a predetermined image (26) onto the third layer, (b) heating the second layer until it is in a flowable state and permeates through and about the third layer and about the predetermined image, and (c) fusing the flowable second layer by lowering its temperature below its melting point thereby encapsulating said third layer and the predetermined image.



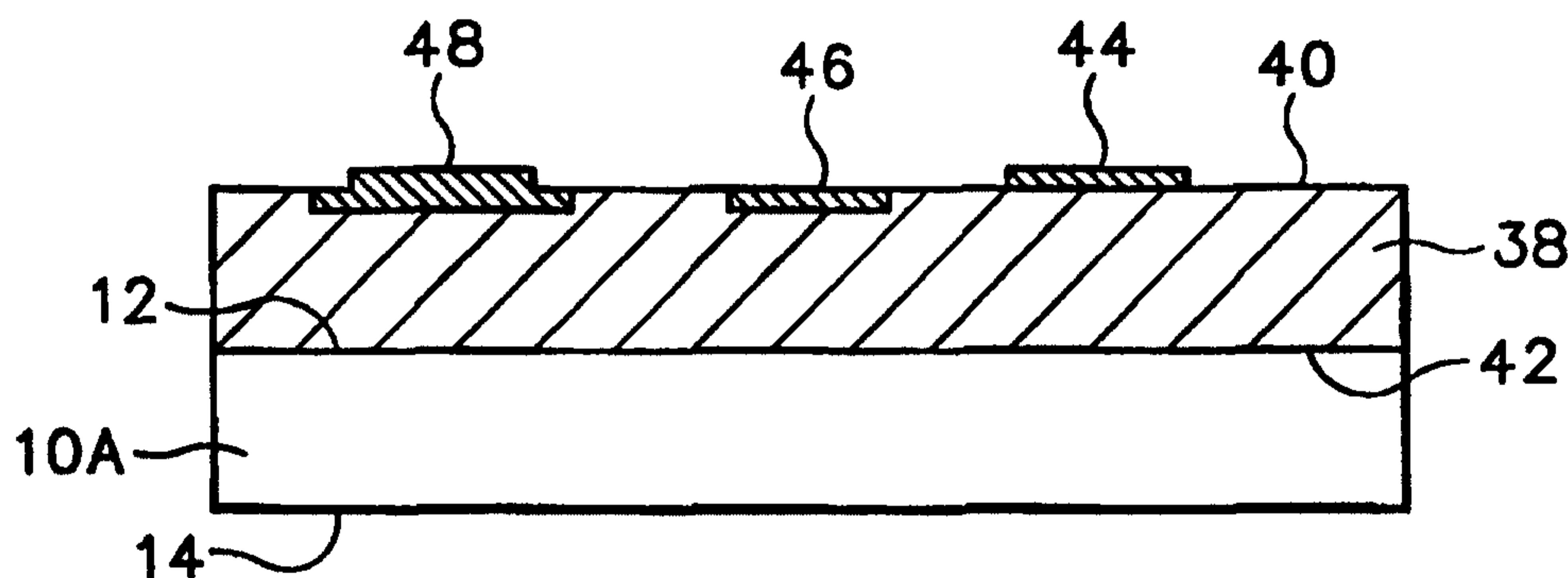
PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : B32B 5/02, 27/00, 31/00, 31/26	A1	(11) International Publication Number: WO 99/03674 (43) International Publication Date: 28 January 1999 (28.01.99)
<p>(21) International Application Number: PCT/US98/15000</p> <p>(22) International Filing Date: 15 July 1998 (15.07.98)</p> <p>(30) Priority Data: 60/052,596 15 July 1997 (15.07.97) US</p> <p>(71) Applicant (for all designated States except US): SPENCER & ASSOCIATES, INC. [US/US]; 16239 S.E. McLoughlin, Milwaukie, OR 97267-4654 (US).</p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only): ROMAINE, Douglas, J. [US/US]; 7911 12th Street #52, Vancouver, WA 98664 (US).</p> <p>(74) Agents: MARGER, Jerome, S. et al.; Marger Johnson McCollom & Stolowitz, P.C., 1030 S.W. Morrison Street, Portland, OR 97205 (US).</p>	<p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published With international search report.</p>	

(54) Title: SCRATCH-RESISTANT, SELF-LAMINATED PRINTED MATERIALS AND METHODS FOR MAKING SAME



(57) Abstract

A method is provided for producing a unique printable multi-layer composite structural material (10B), and in turn a unique scratch-resistant, self-laminated printed material (10A). A printable multi-layer composite structural material is formed which includes a first underlying substrate (11) capable of being transported through a printing device, a second layer (16) formed on the first layer which is flowable when heated to at least its melting point and being fusible below its melting point, and a third layer (22) formed on the second layer which is printable. The third layer is also permeable so that when the second layer is in a flowable state it permeates through and about said third layer. The printable multi-layer composite structural material is capable of forming a scratch-resistant, self-laminated printed material by (a) printing a predetermined image (26) onto the third layer, (b) heating the second layer until it is in a flowable state and permeates through and about the third layer and about the predetermined image, and (c) fusing the flowable second layer by lowering its temperature below its melting point thereby encapsulating said third layer and the predetermined image.

**SCRATCH-RESISTANT, SELF-LAMINATED PRINTED MATERIALS
AND METHODS FOR MAKING SAME**

5 **BACKGROUND OF THE INVENTION**

In the past few years computers and electronic
imaging has created the opportunity for individuals at
home and work to design colored graphics and print such
images in ink jet, electrographic, wax thermal
10 transfer, dye diffusion thermal transfer and
electrophotographic printers. The print media
substrate for each printing system is tailored to meet
basic imaging requirements. When imaged materials are
intended for outdoor exposure, additional processing
15 steps are necessary to make images robust enough to
withstand the adverse conditions associated with
indoor/outdoor use. Examples of these additional
process steps include laminating plastic films over the
printed image, or over-printing the printed image with
20 a clear protective covering such as varnish or the
like.

Ink jet, laser and electrographic transfer papers
are subject to a multiplicity of manufacturing steps
and specialized transfer equipment. Even so, they
25 still may require over laminating with plastic film
because the release coating is necessarily soft to
accommodate the transfer step operation.

Imaging media for digital ink jet printing is
divided into three primary groups. These groups are
30 typically differentiated based on the particular
substrate employed in the printing operation, i.e.,
paper or film or fabric. Each substrate within a

primary group can be further distinguished based on parameters such as its relative thickness and surface texture (ranging from glossy to matte for paper and film). The gross topography of certain surfaces such as fabric and canvas substrates, for example, add additional product distinctions.

Commercial providers of graphic media therefore must carry extensive inventories of various imaging media and laminating films to meet the range of requisite customers needs. Furthermore, most all of the above-described imaging media is very susceptible to damage from smearing, water, scratching and may be tacky to the touch. Even crosslinked vinyl films are easily scratched when wet.

Lamination of printed material is generally performed by post-laminating techniques subsequent to the formation of the subject printed material. This mode of operation is time consuming and expensive. Problems with the post-lamination process which also result include wrinkling, curl, delamination, bubbles and other defects which then requires additional printing and laminating steps to be performed.

SUMMARY OF THE INVENTION

The aforementioned problems which are present in prior art imaging media, and in methods for producing such imaging media, have been overcome by the scratch-resistant laminated printed materials of the present invention, and by the methods for producing such materials.

5 It is therefore an object of this invention to provide such printed materials having a robust image that is produced by a unique method which reduces overall image cost by eliminating a subsequent over laminate film step.

It is a further object of this invention to provide a unique method for producing the subject printed materials that are substantially scratch resistant.

10 It is a further object of this invention to provide a unique method for producing the subject printed materials that are water, oil and solvent resistant, without requiring the use of additional consumable laminating materials.

15 It is a further object of this invention to provide a unique method for producing the subject printed materials that can be printed in both large and small format ink jet printers.

20 It is a further object of this invention to provide a unique method for producing the subject printed materials which can be printed employing solvent coating systems.

25 It is a further object of this invention to provide a unique method for producing the subject printed materials which are bonded to foil, paper photographs and substantially all porous substrates.

30 It is a further object of this invention to provide a unique method for producing the subject printed materials that are capable of receiving handwritten indicia using common writing instruments.

It is a further object of this invention to provide a unique method for the subject printed materials that maintain the security of the image.

5 It is a further object of this invention to provide a unique method for producing the subject printed materials having various outer surface patterns and textures.

10 It is a further object of this invention to provide a unique method for producing the subject printed materials having a plurality of thicknesses depending on the particular end use.

15 It is a further object of this invention to provide a unique method for producing the subject printed materials on paper substrates with enhanced wet strength properties.

20 These and other objects and advantages result in a preferred method which permits the formation of an imaging media capable of accepting substantially all conventional printing techniques and yet so that it can be used either in the home or by commercial print houses in conjunction with existing printing equipment.

25 More specifically, a method for producing a unique scratch-resistant, self-laminated printed material is provided. The subject method comprises providing a first underlying substrate layer having at least one major surface which is capable of being transported through a printing device. Preferably, the first layer is selected from a group consisting of paper, a polymer film, and a nonwoven polymer fabric.

Next, a second layer is formed having at least one major surface. This second layer is formed on at least one of the major surfaces of the first layer. The second layer is flowable when heated to at least its melting point and is fusible below its melting point. Preferably, the second layer comprises a thermoplastic polymer. The second layer preferably has a melting point from about 70 to 80 °C.

A third layer is then formed on at least one of the major surfaces of the second layer. At least one of the major surfaces of the third layer is printable. The third layer is substantially permeable, so that when the second layer is in a flowable state, the second layer will permeate through and about the third layer.

The third layer preferably comprises a solvent-based material. Typically, the third material comprises a thermoplastic binder, an inorganic pigment, and a cationic polymer. In the case where a cationic polymer is employed, it preferably comprises a polyquarternary amine.

The thermoplastic binder generally serves as a binding resin for the inorganic pigment. The thermoplastic binder preferably is present in an amount from about 20 to 60 weight percent, more preferably from about 30 to 45 weight percent, and most preferably from about 35 to 50 weight percent, based on the total third layer weight. The thermoplastic binder is preferably a nylon multipolymer resin. The thermoplastic binder preferably has a melting point

from about 100 to 175 °C., more preferably a melting point from about 105 to 170 °C., and most preferably a melting point from about 110 to 165 °C. Preferably, the difference in the melting point temperatures
5 between the respective second and third layers is about 25°C, more preferably about 50°C, and most preferably about 75°C.

The material also contains a inorganic pigment which is present in an amount of from about 30 to 80
10 weight percent, more preferably from about 35 to 70 weight percent, and most preferably from about 30 to 60 weight percent, based on total layer weight. Moreover, the inorganic pigment has a particle size of up to about 25 microns, more preferably up to about 20
15 microns, and most preferably up to about 15 microns in particle size. In the most preferred case, the inorganic pigment is a mineral pigment. The mineral pigment can be metal-based particulate filler material such as a Si-based, SiO-based, Ti-based, Ca-based or
20 Mg-based filler material. In another preferred form, the inorganic pigment is treated with a wetting agent to facilitate dispersion in the third layer.

The printable multi-layer composite structural material formed as described above is capable of having
25 predetermined image printed onto at least one printable major surface of the third layer. Once the predetermined image is printed onto the printable multi-layer composite structural material, the second layer is heated above it's melting point until it is in
30 a flowable state. Then, the flowable second layer

permeates through and about the third layer and about the predetermined image. Finally, the flowable second layer is fused by lowering its temperature below its melting point thereby encapsulating the third layer and the predetermined image and forming the scratch-resistant, self-laminated fused printed material of the present invention.

The foregoing and other objects, features and advantages of the invention will become more readily apparent from the following detailed description of a preferred embodiment which proceeds with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic cross-sectional view of a multi-layer composite scratch-resistant, self-laminated printed material 10A of the present invention.

FIG. 2 is a schematic cross-sectional view of a printable multi-layer composite structural material 10B of the present invention fusible to product material 10A of Fig. 1.

FIG. 3 is a schematic cross-sectional view of the release sheet 28.

Fig 4 is a ternary diagram which shows the optimized proportional amounts in a preferred formulation for each component of a third layer comprising an inorganic pigment, a cationic polymer and a thermoplastic binder.

Fig. 5 is a schematic cross-sectional view of embossing material 29.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

As depicted in FIG. 1, a scratch-resistant, self-laminated printed material 10A formed according to the teaching of the present invention, comprising a printed media construction as hereinafter described, is provided. Material 10A is formed by printing a robust predetermined image 26 onto the surface of a printable multi-layer composite structural material 10B (see FIG 2), and then self-laminating and encapsulating the image 26 thereon.

Referring now to FIG. 2, material 10B comprises an underlying based substrate, such as a film, paper or plastic nonwoven sheet, which is denoted first layer 11. First layer 11, which has a top surface 12 and a bottom surface 14, has formed thereon an encapsulating fused layer, denoted second layer 16. Second layer 16, which has a top surface 18 and a bottom surface 20, surrounds a permeable printable layer, denoted third layer 22. The third layer 22 has a top surface 24 and a bottom surface 25. A robust predetermined image 26 is printed onto third layer 22. The encapsulating fused layer 16, when subjected to the requisite heat with or without pressure, forms the outer scratch-proof protective layer of material 10A for the predetermined image indicia 26, and in turn for the third layer 22.

The underlying substrates 11 of this invention are chosen by criteria defined by the properties of the finished product, such as brightness, caliper stiffness, and wet strength for papers to other porous

substrates. Other materials include foil and other flexible films. The substrate 11 of the present invention is not an interactive part of the image formation process but instead serves as the underlying base structure for materials 10A and 10B. Therefore, this allows for a wide choice of substrates limited only by their being of a caliper and flexibility that will permit a given material 10B to be transported through a given printer. For example, papers such double side coated publication grades, bond copy papers, and single side coated label paper are suitable as a substrate 11. Film substrates such as opaque polyvinylidene fluoride and white polyester are also among those that are suitable for this purpose.

The second layer 16, which serves as an "encapsulating" layer for the third layer 22, typically comprises a meltable, flowable polymeric material, preferably a thermoplastic polymeric material. The second layer 16 can be applied onto substrate 11, for example, out of a water dispersion or extruded onto the top surface 12 of first layer 11. Criteria for selection of the second layer 16 is a relatively low melting point, substantially insoluble good adhesive properties, lack of color development when heated, and a melt flow index which is compatible with that of the predetermined image indicia 26, which are typically imaging inks.

Printable, permeable third layer 22 is typically applied to the second layer 18 using conventional coating methods such as a wire wound rod coater, a

10

three roll contra coater, or a gravure coater. The third layer 22 is preferably composed of a high melting point thermoplastic binder, a mineral pigment, and a cationic polymer. Important criteria for the use of the thermoplastic binder in third layer 22 is solvent, water and petroleum resistance, and a melt temperature. The preferred criteria for the use of the mineral pigment in third layer 22 is a coating pigment particle size (as previously described), and a minimum image quality. Cationic polymer selection is primarily based on image quality.

A robust predetermined image 26 can be printed onto the surface of material 10B by a printer (not shown), for example, an ink jet printer or the like, such as an Encad Nova Jet II. For purposes of this invention, the term "robust" means that the resultant image 26 absorbed into the printable third layer 22 and has sufficient strength and sturdiness properties to pass through the printer during the printing operations described above without substantially adversely affecting the resultant image 26 without substantially displacing the top surface 24.

The graphic image encapsulating process for forming material 10B comprises typically heating the material 10A, or heating and pressing material 10B, so that the second layer 16 becomes meltable and flowable and permeates through and about permeable third layer 22 forming a fused, scratch-proof protective layer 38 for the image 26.

30

To facilitate the graphic image encapsulating process, a silicone release sheet 28 is provided (see FIG. 3). The sheet 28 has a top surface 32 and bottom surface 30 which can have either a patterned or non-patterned configuration. As shown in FIG. 3, bottom surface 30 is patterned, including positive embossing segments 36 and negative embossing segments 34. Sheet 28 is placed over outer top surface 24 to provide an easy separation thereof from surfaces 30, 34 and 36, when removed from a heated press, such as clam shell hot press, for instance, a Seal Hot Nip Laminator Model No. IP 6000, after being cooled to room temperature. The embossed release sheet 28 is intended to produce mirror topographical molded surfaces 40, 44, 46, and 48. Sheet 28 can be textured as shown or flat with an elevation of surface 30. For example, using a glossy film, such as biaxially-oriented polypropylene (BOPP) coated with a silicone coating on surface 36 as release sheet 28, a glossy surface will result on surface 40. Glossy surface 40 can in turn be textured, by opening the press at the end of the graphic encapsulating image process, and placing embossing material 29, having upper and lower embossing surfaces 31 and 33, over the release sheet 28 for 5 to 15 second additional hot pressing. The resulting sheet will exhibit a glossy/textured surface. Common materials which can be used for embossing sheet 29 include canvas, plastic window screen, and embossed papers and films.

During the graphic encapsulating image process, the surface of fused layer 38 has properties of a hot

melt adhesive which allows for a number of unique properties that are usually not found with prior art. Metal foils, paper, paper board, leather, and glass can be bonded to heated surface 40. Other bondable materials include natural products such as dried botanical specimens. Bonding the above materials to surface 38 can be accomplished by placing them between top surfaces 24 and 32 during the graphic encapsulating image process. In another simple approach, a heated metal object, such as a hand iron, will complete the graphic encapsulating image process. This method is suitable for small format craft use, but lacks the uniformity of a commercial hot press.

Other methods of conducting the graphic encapsulating image process include either (I) by heating material 10B in an oven, for instance at temperature of about 160 °C for about two minutes, with surface 14 not touching the hot surface, or, (II) by slowly transporting roll media with surface 14 over a heated bar. Both of these methods will produce a robust matte surface 40.

For example, in a conventional coating process, a 89 g/m² publication grade paper is coated with a clay dispersion on each of its outer surfaces. The substrate 11 is coated on surface 12 with about a 0.75 mil thickness dry clay layer using a 25% water dispersion in ethylene acrylic acid (Primacor® 5980, produced by Dow Plastics) using a #40 wire wound rod. Prior art processes depend to a great extent upon water-based coating materials to adsorb water

associated with ink jet printing. As a result, contact with water will degrade image quality of the printed product unless the sheet material is substantially post laminated with a protective film.

5 In a preferred method of the present invention, the preferred 3rd layer comprises an alcohol soluble binder resin (Elvamide® 8063, a nylon multipolymer manufactured by du Pont Engineering Polymers) a coating pigment (Silcron G-130, manufactured by SCM
10 Chemicals) which is a treated clay pigment with a mean particle size of about 3 microns and a cationic polymer (Agefloc A-50HV manufactured by CPS Chemical Co.), which is a polyquaternary amine.

The above materials were evaluated using the
15 subject graphic image encapsulating process in an Encad Nova Jet II® color ink jet printer. The mixture formulations using the graphic image encapsulating process of the present invention and expressed in percent solids content of materials totaling one
20 hundred percent. For example, a product was formulated for the Encad Wide Format Printer using the following range percentage levels: Binder 8963 (50% to 30%) Pigment G-130 (80% to 50%) Cationic A-50HV (10% to 0%) All coatings were prepared at 13% total non volatile
25 solids, using methyl alcohol as the solvent.

Twenty samples of varying formulation combinations of the subject scratch-resistant, self-laminated printed material 10A were produced coating with three wire wound rods (# 10, # 25, and # 40) to vary coating
30 weights. Experimental papers were printed in an Encad

Nova Jet II using pigmented GO™ inks and tested for image quality after the graphic image encapsulating process was completed in an oven for a period of two minutes, at 160 °C.

5 Formulation responses of the scratch-resistant, self-laminated printed materials 10A were compared to a commercial ink jet sheet (P-124 produced by Permalite Repromedia Corporation®). Key image quality parameters are image density for black and primary colors,
10 diameter dot size measured in millimeters, "feathering" or image colors running together before drying, and dry time which is the amount of time for a wet image out of the printer to dry. The data is summarized in Table 1 below.

15

Table 1

	<u>Material 10A</u>	<u>P-124</u>
20	<u>IMAGE DENSITY</u>	
	Black	1.40 >1.31
	Cyan	1.37 >1.38
	Magenta	1.01 >1.02
	Yellow	0.96 >0.86
25	-----	
	<u>DOT SIZE (mm)</u>	
	Black	.15 <.19
	Cyan	.12 <.15
	Magenta	.13 <.15
30	Yellow	.13 <.14

Material 10A P-124

FEATHERING

0 = Poor 5 = Good

5	Black-White	5	5
	Black-Color	5	2
	Color-White	5	5
	Color-Color	4	0

10 -----

DRY TIME

0 = Poor 5 = Good

15	Black	5,0	4.5
	Primary Colors	4.5	4.5
	Secondary Colors	2.5	0

20 As can be seen from the results for the key quality parameters, most all results for the scratch-resistant, self-laminated printed material of the present invention meet or exceed the P-124 commercial ink jet paper. The Material 10A exhibited all of the objects and advantages previously mentioned above.

25 Based on the results regarding the method of present invention, which was conducted employing fusing of a printable multi-layer composite structural material 10B in an oven, the optimum weight %

16

formulation and coating weight, based on the ternary diagram denoted FIG. 4, is as follows:

	Silcron G-130 inorganic pigment	50%
5	Elvamide 8963 thermoplastic binder	40%
	Agefloc A-50hv cationic polymer	10%
	Coating Weight #40 rod	18 g/m ²

10 Having described and illustrated the principles
the invention in a preferred embodiment thereof, it
should be apparent that the invention can be modified
in arrangement and detail without departing from such
principles. We claim all modifications and variations
coming within the spirit and scope of the following
15 claims.

Claims:

1. A method for producing a scratch-resistant, self-laminated printed material, which comprises

5 providing a first underlying substrate layer having at least one major surface which is capable of being transported through a printing device,

forming a second layer having at least one major surface on at least one of said major surfaces of said first layer, said second layer being flowable when heated to at least its melting point and being fusible below its melting point;

10 forming a third layer on at least one of said major surfaces of said second layer, at least one of said major surfaces of said third layer being printable, said third layer being permeable so that when said second layer is in a flowable state it will permeate through and about said third layer;

15 printing a predetermined image onto at least one printable major surface of said third layer;

20 heating said second layer above its melting point until it is in a flowable state, said flowable second layer permeating through and about said third layer and about said predetermined image; and

25 fusing said flowable second layer by lowering its temperature below its melting point thereby encapsulating said third layer and said predetermined image and forming said scratch-resistant, self-laminated fused printed material

2. The method of claim 1, in which said second layer comprises a thermoplastic polymer.

3. The method of claim 1, wherein said third layer comprises a thermoplastic binder, an inorganic pigment, and a cationic polymer.

4. The method of claim 3, wherein said thermoplastic binder is from about 20 to 60 percent of total layer weight.

5. The method of claim 3, wherein said thermoplastic binder is selected from the group consisting of a nylon multipolymer resin.

6. The method of claim 1, wherein said material includes an inorganic pigment in an amount of between about 30 to 80 percent based on total third layer weight.

7. The method of claim 6, wherein said inorganic pigment has a particle size of up to about 25 microns in particle size.

8. The method of claim 6, wherein said inorganic pigment is a mineral pigment.

9. The method of claim 6, wherein said inorganic pigment is treated with a wetting agent to facilitate dispersion in said third layer.

10. The method of claim 3, wherein said cationic polymer comprises a polyquarternary amine.

11. The method of claim 1, wherein the first layer is selected from a group consisting of paper, a polymer film, and a nonwoven polymer fabric.

12. The method of claim 1, in which said second layer has a melting point from about 70 to 80 °C.

13. The method of claim 1, wherein said third layer contains a thermoplastic binder that have a melting point from about 105 to 165 °C.

5 14. The method of claim 1, wherein said third layer is formed of a solvent-based material.

15. The method of claim 1, wherein the difference in the melting point temperatures between the respective second and third layers is about 25°C

10 16. The method of claim 1, wherein the inorganic pigment is a metal-based particulate filler material

17. The method of claim 15, wherein the solvent is an alcohol.

15 18. A method for producing a printable multi-layer composite structural material, which comprises providing a first underlying substrate layer having at least one major surface which is capable of being transported through a printing device,

20 forming a second layer having at least one major surface, formed on at least one of said major surfaces of said first layer, said second layer being flowable when heated to at least it's melting point and being fusible below it's melting point; and

25 forming a third layer on at least one of said major surfaces of said second layer, at least one of said major surfaces being printable, said third layer being permeable so that when said second layer is in a flowable state it will permeate through and about said second layer;

30 said printable multi-layer composite structural material being capable of forming a scratch-resistant,

self-laminated printed material by employing a method comprising (a) printing a predetermined image onto at least one printable major surface of said third layer, (b) heating said second layer until it is in a flowable state, said flowable second layer permeating through and about said third layer and about said predetermined image, and (c) fusing said flowable second layer by lowering its temperature below its melting point thereby encapsulating said third layer and said robust predetermined image and forming said scratch-resistant, self-laminated printed material.

19. A printable multi-layer composite structural material, which comprises

a first underlying substrate layer having at least one major surface which is capable of being transported through a printing device,

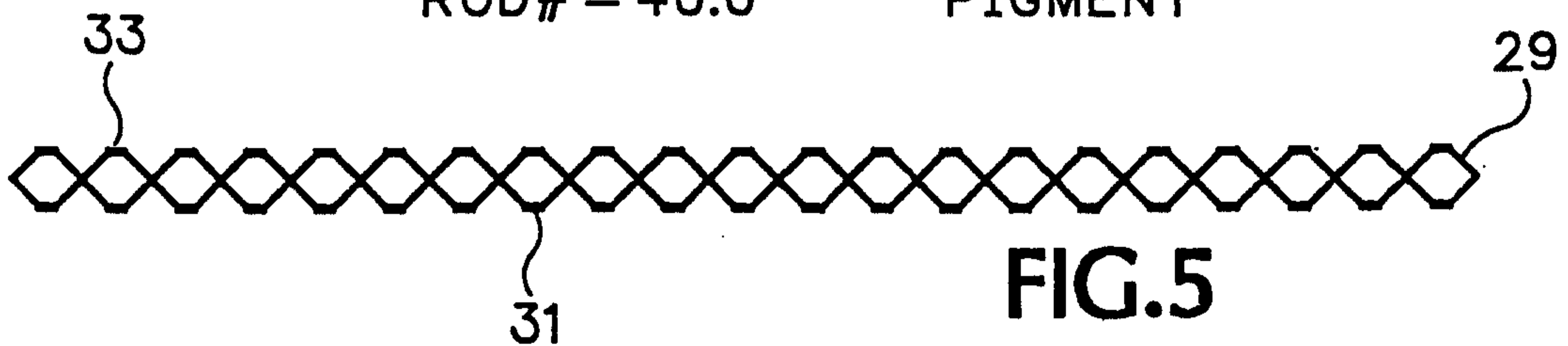
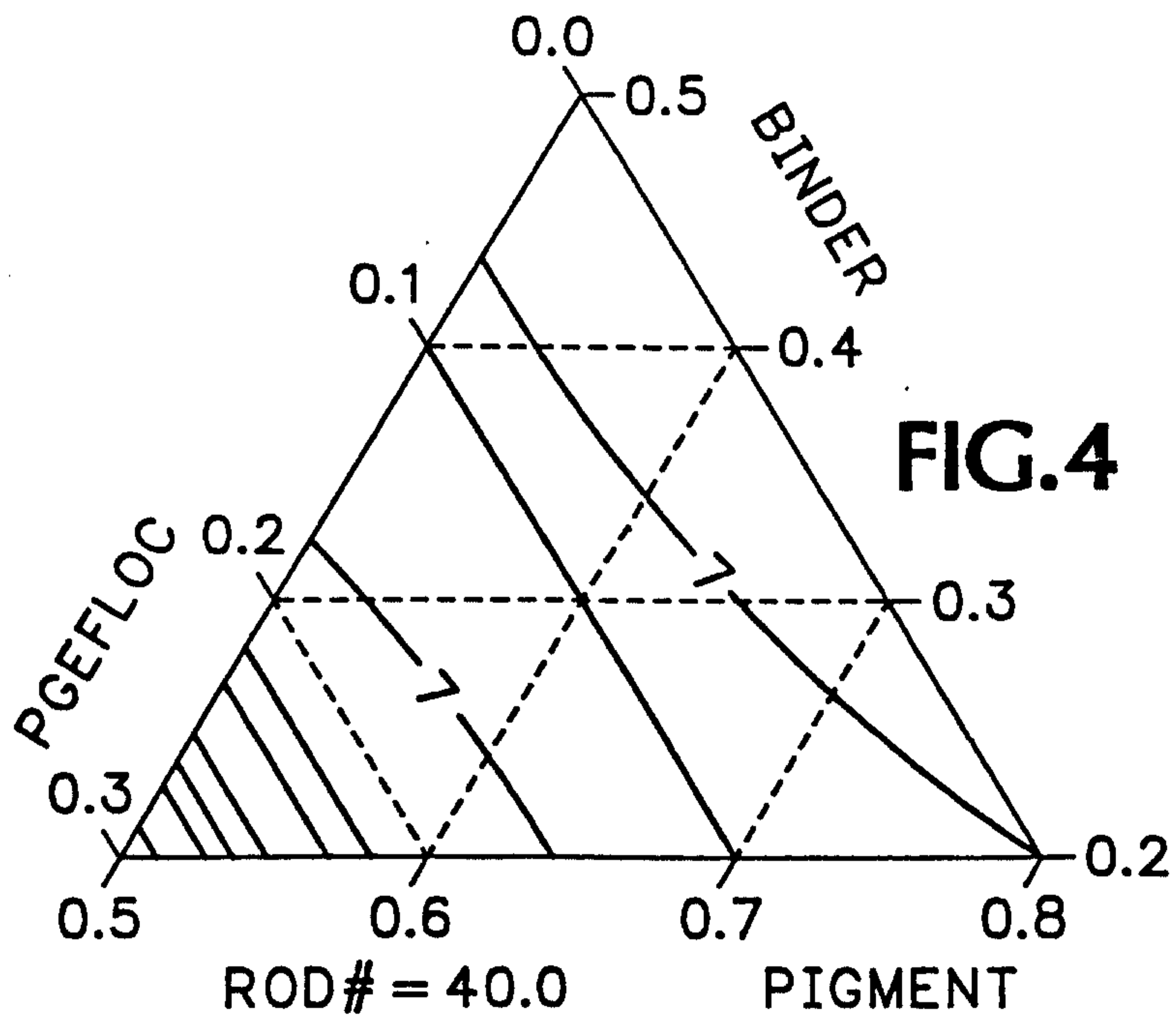
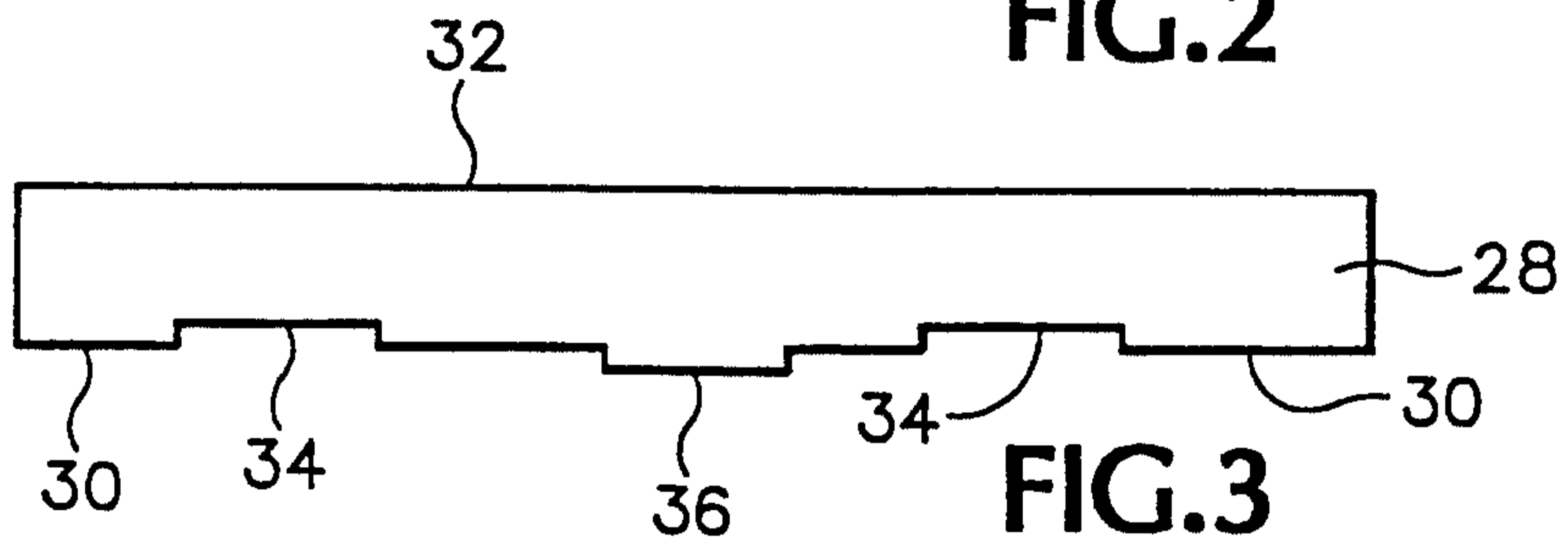
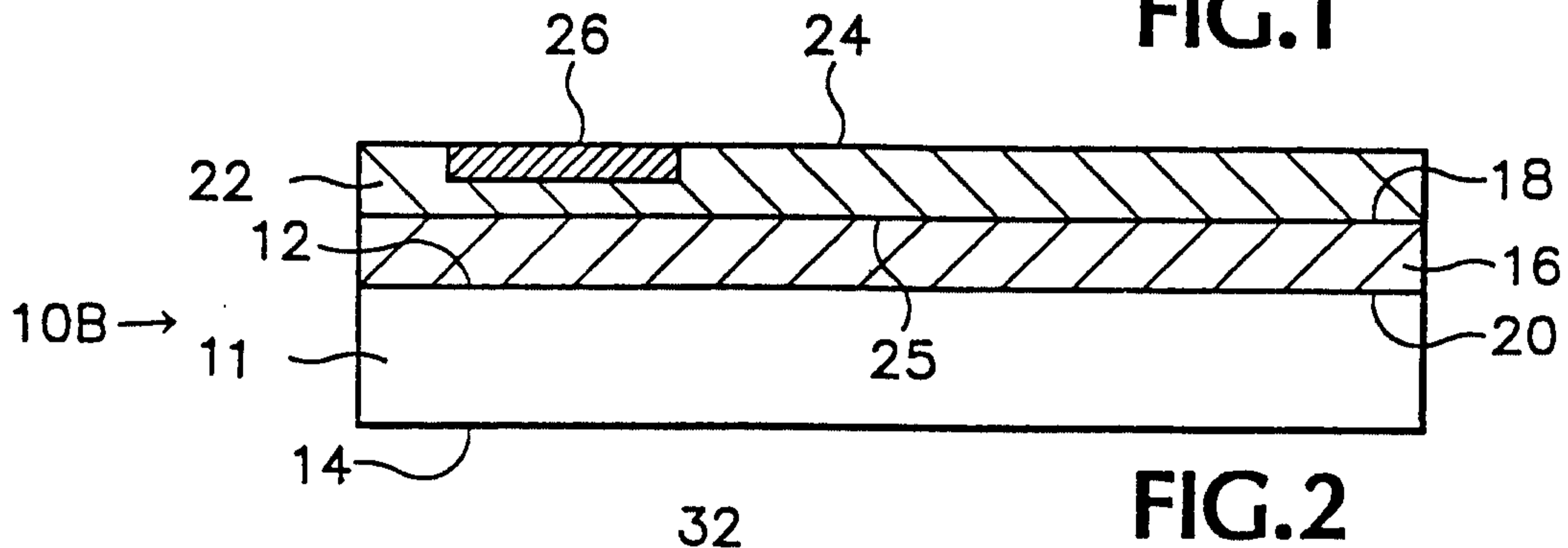
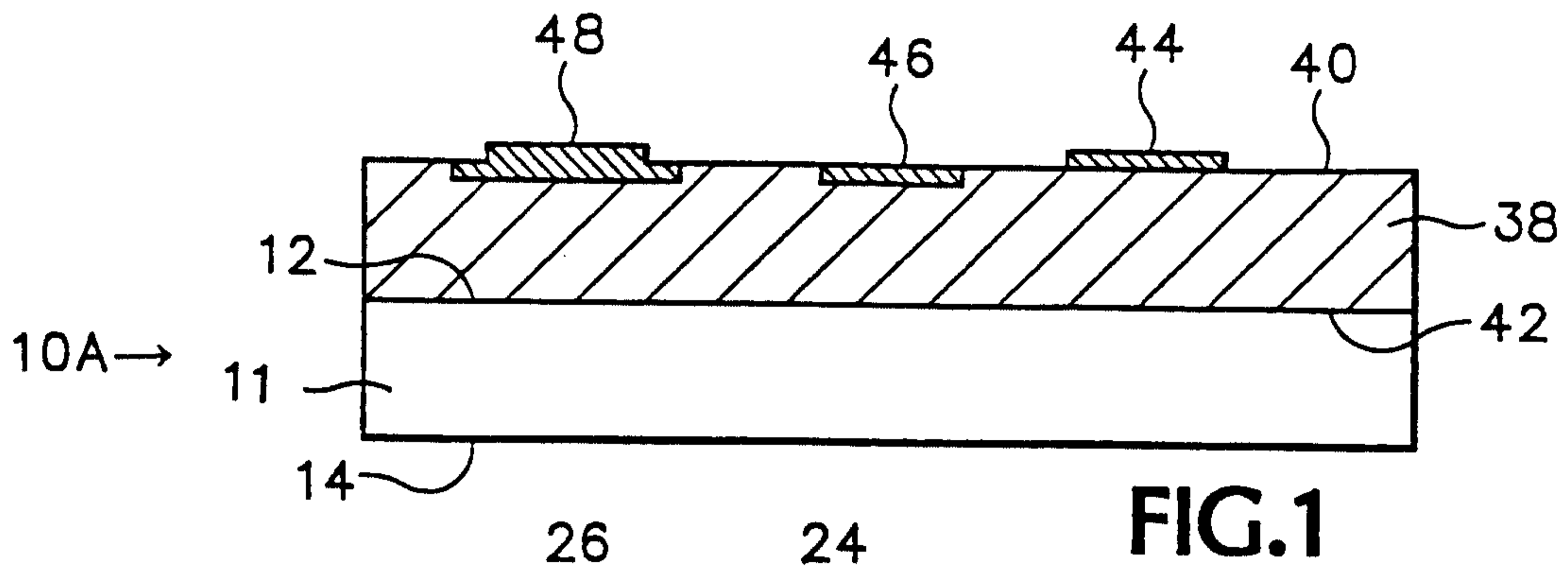
a second layer having at least one major surface, formed on at least one of said major surfaces of said first layer, said second layer being flowable when heated to at least its melting point and being fusible below its melting point; and

a third layer formed on at least one of said major surfaces of said second layer, at least one of said major surfaces being printable, said third layer being permeable so that when said second layer is in a flowable state it will permeate through and about said second layer;

said printable multi-layer composite structural material being capable of forming a scratch-resistant, self-laminated printed material by employing a method

comprising (a) printing a predetermined image onto at least one printable major surface of said third layer, (b) heating said second layer until it is in a flowable state, said flowable second layer permeating through and about said third layer and about said predetermined image, and (c) fusing said flowable second layer by lowering its temperature below its melting point thereby encapsulating said third layer and said robust predetermined image and forming said scratch-resistant, self-laminated printed material

PCT/US 98/15000
IPREVUS 20 JUL 1999



AMENDED SHEET