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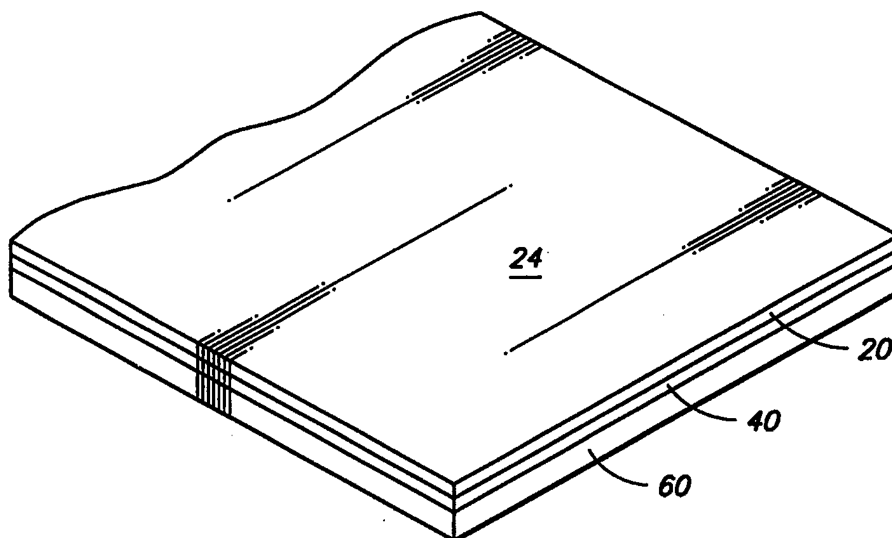

(57) Abstract

Methods of fixturing a flexible circuit substrate (20) to a processing carrier (60) are disclosed. In one implementation, the flexible circuit substrate (20) and processing carrier (60) are attached with an adhesive film (40) provided therebetween. The adhesive film (40) comprises acrylic, silicone or a silicone acrylic blend in a preferred embodiment of the present invention. Ideally, substantially the total surface area of a first surface (22) of the flexible circuit substrate (20) is attached to the processing carrier (60). The flexible circuit substrate (20) is removed from the adhesive film (40) following processing thereof. In a preferred embodiment of the present invention, the adhesive film (40) is monolithic. An electrical component (36) is attached to the flexible circuit substrate (20) and the flexible circuit substrate (20) is encapsulated in accordance with one implementation of the present invention.

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DESCRIPTION

METHODS OF FIXTURING FLEXIBLE CIRCUIT SUBSTRATES AND A PROCESSING CARRIER, AND PROCESSING A FLEXIBLE CIRCUIT

5

Technical Field

The present invention relates to methods of fixturing a flexible circuit substrate and a processing carrier, methods of processing a flexible circuit, and methods of processing a flexible circuit substrate relative to a processing carrier.

10 **Background Art**

Flexible printed wiring has been utilized for many years by numerous industries. At first, flexible printed wiring was utilized in aerospace applications, and more recently, the flexible printed wiring has been implemented in many consumer products. Flexible printed wiring applications range from digital watches 15 to commercial aircraft components, and from domestic appliances and automobiles to deep space hardware.

Flexible printed wiring provides inherent advantageous characteristics including: low weight and volume, increased reliability, flexibility and simplified assembly. Flexible printed wiring encompasses a random arrangement of printed 20 conductors using a flexible insulating base or substrate material. A plurality of cover layers may be provided on the flexible substrate material.

The random arrangement of conductors distinguishes flexible printed wiring from collated, flat flexible cable. The capacity of flexible printed wiring circuits to bend requires that the conductors, adhesive, and cover layer materials utilized 25 in the circuit be flexible similar to the base material.

Flexible printed wiring may comprise various combinations of base, conductor, and cover layers. For example, single-sided flexible printed wiring has conductors on one side of a base layer. Double-sided flexible printed wiring includes conductors on both sides of the base layer. Single access flexible 30 printed wiring includes a given conductor layer accessible from an external connection on one side. Double access flexible printed wiring includes a conductor layer accessible via an external connection from either the conductor side or the base side thereof.

Multi-layer flexible printed wiring includes more than two conductor layers 35 laminated together with insulating base layers between the conductive layers. Rigid-flex flexible printed wiring includes two or more rigid sections having one

or more flexible sections provided therebetween. Rigidized flexible printed wiring includes a plurality of rigid sheet material pieces selectively bonded to the flexible printed wiring.

The utilization of a single flexible printed wiring array reduces the number
5 of terminals and soldered joints required for combining component mounting areas with conventional interconnecting cables. Further, plated-through holes between conductored layers in flexible printed wiring are more reliable than the soldered joints and edge connectors which they can replace in conventional connection devices.

10 Beneficial characteristics of flexible printed wiring include inherent improved flexibility and lower mass per length which reduce strain on soldered joints. These characteristics of flexible printed wiring provide circuits of enhanced reliability compared to round wire when subjected to shocks and vibrations. Flexible printed wiring has increased resistance to damage and flexure
15 when compared with conventional round wire because the conductor material can be positioned closer to the neutral surface and because the bond between the conductors and insulation is uniformly distributed over a larger area.

Flexible printed wiring typically requires special pallets or fixtures, commonly referred to as processing carriers, which are utilized to position and
20 hold the flexible printed wiring terminals during component placement, mass soldering, and testing. These processing carriers essentially support the flexible sheets of material upon which the integrated circuitry is patterned, or traces are formed. The thin flexible sheets are subjected to various processing steps including large heating steps, air drying steps, and printing steps. The thin,
25 flexible nature of the polyester films, makes it extremely difficult, if not impossible, for the flexible sheets to be processed without being received upon a rigid temporary substrate during manufacture.

Various methods have been utilized to temporarily affix the flexible sheets to the processing carriers during the formation of the printed wiring thereon.
30 One prior art method of attachment employs vacuum suction-like cups which are used to temporarily grasp portions of the backside of the flexible circuit substrate.

Alternately, bent pins have been utilized to hold the flexible substrate to the processing carrier. For example, upward pins may be provided at the edges
35 of the flexible sheets. The upward pins may be bent over to grasp the outer surface of the flexible substrate to secure the flexible substrate for processing.

A plurality of holes may be provided within the flexible substrate for the sole purpose of facilitating the attachment of the flexible substrate to the processing carrier during the formation of the flexible printed wiring. Pins extend upwardly from the processing carrier through these holes. A plurality of securing devices, referred to as buttons, are positioned and pushed down upon the pins and onto the outer surface of the flexible substrate. The buttons are removed at the end of the processing of the flexible substrate.

Providing attachment through the use of such tooling pins makes certain processing steps impossible. For example, stencil printing of the flexible circuit is either difficult or impossible without damaging the stencil. Additionally, tooling is difficult to maintain when the tooling pins are utilized to secure the flexible circuit substrate.

In all of these prior art techniques, only some portion of the backside of the flexible sheet is actually retained or held fast to the processing carrier. Even where a screen is utilized as a support for a vacuum on the backside of the flexible substrate, an adhesive force is not provided at the portions where the screen physically touches the flexible substrate. In addition, the thin flexible circuits may "dimple" and stretch when vacuum is transmitted through a handling panel operating to hold the flexible circuit during processing.

Further, the utilization of a vacuum to hold the flexible circuit substrate may only be utilized at a single piece of processing equipment and may not be utilized to hold the substrate when the holding panel is transferred between various pieces of processing equipment.

One conventional technique for affixing the flexible circuit substrate to the processing carrier includes the external taping of corners of the upper surface of the substrate to the holding panel. However, such a method prevents processing of the portions of the substrate which are beneath the external tape. Further, such a method fails to prevent airflows created by the processing equipment (e.g., curing oven) from lifting an unrestrained area of the flexible circuit. Still further, taping of the corners of the substrate during certain processing steps, such as screen printing, is undesirable inasmuch as the film has a tendency to stick to the screen or stencil and lift upwards away from the rigid processing carrier.

In addition, further processing steps may not be immediately performed when the prior art methods of attachment are utilized. In particular, the outer surface of the flexible substrate sheets cannot be encapsulated on the processing

carrier if prior art pins and\or external taping are utilized for affixing the flexible sheets. Specifically, the external tape attached to the top of the flexible substrate, or the pins protruding through the upper surface, or the buttons coupled with the pins, would be completely encapsulated precluding practical 5 removal from the processing carriers.

Therefore, there exists a need for providing improved methods for securing flexible circuit substrates against the processing carrier during the formation of flexible printed wiring circuits.

Brief Description of the Drawings

10 Preferred embodiments of the invention are described below with reference to the following accompanying drawings.

Fig. 1 is an isometric view of a flexible circuit having an integrated circuit chip mounted thereon.

Fig. 2 is an isometric view of a flexible circuit substrate fixtured to a 15 processing carrier with an adhesive film therebetween.

Fig. 3 is an exploded isometric view of Fig. 2.

Fig. 4 shows a processing step of forming a unitary adhesive film from a first film and second film.

Fig. 5 shows the unitary adhesive film formed by the processing step of 20 Fig. 4.

Fig. 6 shows a processing step in accordance with the present invention of removing a release liner from a first adherent surface of the adhesive film and applying the adhesive film to the processing carrier.

Fig. 7 shows a processing step in accordance with the present invention 25 of removing a second release liner from a second adherent surface of the adhesive film.

Fig. 8 shows a processing step in accordance with the present invention of adhering the flexible circuit substrate to the second adherent surface of the adhesive film.

30 Fig. 9 shows a processing step in accordance with the present invention of removing the flexible circuit substrate from the adhesive film.

Fig. 10 is a top plan view of the flexible circuit substrate having a plurality of discrete patterns, and which is fixtured to a processing carrier.

Fig. 11 is a top view of one of the individual patterns of Fig. 10.

35 Fig. 12 is a cross-sectional view which shows various elevational layers of the device shown in Fig. 11 at an intermediate processing step.

Best Modes for Carrying Out the Invention and Disclosure of Invention

Methods of fixturing a flexible circuit substrate to a processing carrier are disclosed. In one implementation, the flexible circuit substrate and processing carrier are attached with an adhesive film provided therebetween. The adhesive film comprises acrylic, silicone or a silicone acrylic blend in preferred embodiments of the present invention. Ideally, substantially the total surface area of a first surface of the flexible circuit substrate is attached to the processing carrier. The flexible circuit substrate is removed from the adhesive film and processing carrier following processing thereof. In a preferred embodiment of the present invention, the adhesive film is monolithic. An electrical component is attached to the flexible circuit substrate and the flexible circuit substrate is subsequently encapsulated in accordance with one implementation of the present invention.

Referring to Fig. 1, a processed flexible circuit 10 is shown. The flexible circuit 10 is a flexible printed wiring circuit. Although a preferred method is described herein with reference to a single-sided flexible circuit 10, the present invention is not limited to such circuits. The methods of the present invention may be utilized in the fabrication of any flexible circuit where fixturing of a flexible circuit substrate to a processing carrier is desired.

The flexible circuit 10 comprises a flexible circuit substrate 20 and a plurality of printed conductors 34 formed thereon for electrically coupling electrical components mounted thereto. The flexible circuit substrate 20 includes a first surface 22 (not specifically visible in Fig. 1) and a second surface 24 opposite thereto. The printed conductors 34 are formed on second surface 24. An exemplary integrated circuit chip 36 is mounted to the substrate 20 and operably connected with some of the conductors 34.

The flexible circuit substrate 20 preferably comprises a dielectric substrate which is the base film upon which the printed conductors 34 are formed providing electrical connections within the flexible circuit 10. The flexible circuit substrate 20 is operable to insulate printed conductors from one another, provide mechanical strength and permit flexing. The "flexible circuit substrate" as used herein refers to any flexible supporting or supportive structure, including, but not limited to, a supportive single layer of material or multiple layer constructions. For example, the flexible circuit substrate 20 may comprise polyester, polyimide, fluorocarbon, aramid paper, or a composite thereof. The flexible circuit substrate 20 preferably comprises a polyester film having a thickness of around 5 mils.

Referring to Figs. 2 and 3, the flexible circuit substrate 20 is shown at a processing step prior to that depicted by Fig. 1. Specifically, the flexible circuit substrate 20 is adhered to a processing carrier 60, in the form of a rigid plate, with an intervening adhesive film 40. Processing carrier 60 preferably comprises a flat, rigid material such as glass, metal plate, or a composite material panel. Processing carrier 60 includes an outer support surface 62.

The adhesive film 40 is preferably monolithic including a first adherent surface 42 and a second adherent surface 44. The first adherent surface 42 adheres to processing carrier support surface 62. The second adherent surface 44 adheres to the flexible substrate first surface 22. The first adherent surface 42 and second adherent surface 44 of the adhesive film 40 can be configured to provide equal degrees of adhesion force relative to the processing carrier 60 and relative to the flexible substrate 20. Alternately, the adhesive film 40 can be configured to provide different degrees of adhesion force relative to the processing carrier 60 and relative to the flexible substrate 20.

For example, the first adherent surface 42 may be a high tack surface which provides a first adhesion force which is greater than a second adhesion force provided by the second adherent surface 44 (i.e., low tack surface). Alternatively, the second adherent surface 44 may be a high tack surface which provides a first adhesion force which is greater than a second adhesion force provided by a low tack first adherent surface 42. The materials of the surfaces 22 and 62 also play a role in the ultimate adhesive force between the flexible substrate 20 and the adhesive film 40, and between the processing carrier 60 and the adhesive film 40, respectively.

An exemplary method of forming an adhesive film 40 having a high tack surface and low tack surface is described with reference to Fig. 4. A first film 31 is provided in the form of a first roll 50a. A second film 32 is provided in the form of a second roll 50b. The first film 31 includes first adherent surface 42 and a medial adherent surface 37 opposite thereto. The second film 32 includes second adherent surface 44 and a medial adherent surface 38. A protective release liner 46 covers the first adherent surface 42 and a second protective release liner 48 covers the second adherent surface 44.

First film 31 and second film 32 are unwound from respective rolls 50a, 50b and aligned such that the medial adherent surfaces 37, 38 are opposite one another as shown in Fig. 4. First film 31 and second film 32 are inserted intermediate a pair of mating rollers which includes an upper roller 80 and lower

roller 81. The films 31, 32 are drawn therebetween to join and form a unitary adhesive film 40. Drawing first film 31 and second film 32 through rollers 80, 81 bonds the medial adherent surfaces 37, 38 and forms adhesive film 40.

Referring to Fig. 5, the unitary adhesive film 40 includes opposing outer
5 sides 33, 35. The unitary adhesive film 40 has the first adherent surface 42 and second adherent surface 44 on respective outer sides 33, 35. The first adherent surface 42 is covered by protective release liner 46, and the second adherent surface 44 is covered by protective release liner 48. First film 31 and second film 32 may be high tack and low tack adhesives, respectively. In such a
10 configuration, the first adhesion force of first adherent surface 42 is greater than the second adhesion force of second adherent surface 44. Alternately, first film 31 and second film 32 may be low tack and high tack adhesives, respectively. In this configuration, the first adhesion force of first adherent surface 42 is less than the second adhesion force of second adherent surface 44.

15 Adhesive film 40 preferably comprises a monolithic pressure sensitive silicone, acrylic or silicone acrylic blend adhesive tape. Adhesive film 40 is preferably 1-4 mils thick and is available under the designation SIL-XX from Systems Division Incorporated of Tustin, California.

An exemplary preferred method of adhering the processing carrier 60,
20 adhesive film 40 and flexible substrate 20 together is described with reference to Figs. 6-8. Adhesive film 40 is provided in the form of a roll 50 having a protective release liner 46 provided over first adherent surface 42 and a protective release liner 48 provided over second adherent surface 44. Providing an adhesive film 40 having two liners 46, 48 is preferred but not necessary.

25 The adhesive film roll 50 is provided adjacent first upper roller 80 and first lower roller 81. Adhesive film 42 includes a leading end 49 and processing carrier 60 a leading end 64. Release liner 46 is peeled away from adherent surface 42 at leading end 49, with leading end 49 then being aligned with processing carrier leading end 64. The processing carrier 60 and the adhesive
30 film 40 are then driven between rolls 80 and 81, while peeling away release liner 46, to uniformly adhere adherent surface 42 to all of processing carrier support surface 62.

Referring to Fig. 7, the adhesive film 40 is shown laminated to the processing carrier 60 following passage thereof through the pair of first rollers
35 80, 81. The second release liner 48 is now removed from the adhesive film 40.

The removal of the second release liner 48 exposes the second adherent surface 44 of the adhesive film 40.

Referring to Fig. 8, the flexible circuit substrate 20 is then applied to the processing carrier 60. Specifically, the flexible circuit substrate 20 is provided in an orientation such that the first surface 22 is opposite to the second adherent surface 44 of the adhesive film 40. Flexible circuit substrate 20 includes a leading end 28 which is aligned with the leading end 64 of the processing carrier 60 and the leading end 49 of the adhesive film 40, and is then inserted intermediate the rollers 80, 81, with the spacing therebetween being adjusted if necessary.

The flexible circuit substrate surface 22 is then pressed onto the second adherent surface 44 of the adhesive film 40 as the processing carrier 60 and flexible circuit substrate 20 are drawn between the pair of rollers 80, 81. Such provides one implementation whereby the total substantial surface area of the first surface 22 of the flexible circuit substrate 20 is attached to the support surface 62 of the processing carrier 60. Such a complete attachment facilitates processing of the flexible circuit substrate 20. Alternately, but less preferred, strips of adhesive film could be provided intermediate the processing carrier 60 and flexible circuit substrate 20. In addition, by way of example only, adhesive film 40 can be provided in the form of cut sheets corresponding in size to that of the processing carrier 60.

Alternately, by way of example only, the adhesive film 40 could be provided pre-applied to the flexible substrate 20 prior to joining with processing carrier 60, or pre-applied to processing carrier 60 prior to joining with the flexible substrate 20. Regardless, the fixtured flexible substrate is then subjected to various processing, such as the printing of circuit wiring 34 thereon and adhering electronic devices thereto. Such can ultimately include application of encapsulating material (described below) outwardly of flexible substrate surface 24 while fixtured to processing carrier 60 in the preferred embodiment, something heretofore not practically achievable. In the exemplary embodiment, no temporary fixturing materials or components are received over or project outwardly of substrate surface 24, enabling such encapsulation.

Referring to Fig. 9, the flexible circuit substrate 20 is subsequently removed from the processing carrier 60 following the processing of the flexible circuit 10. Depending upon the degrees of adhesion, the adhesive film 40 will either stay with processing carrier 60 or be removed with flexible substrate 20.

Preferably, the adhesive film 40 remains attached to the processing carrier 60 (as shown in Fig. 9), enabling possible reuse of the adhesive film 40 with another flexible circuit substrate 20.

The methods of fixturing the flexible circuit substrate 20 to the processing carrier 60 in accordance with the preferred embodiment provide numerous benefits. First, the processing carrier 60 may be transferred from one piece of process equipment to another without having to remove the flexible circuit substrate 20 attached thereto. Fixturing of the flexible circuit substrate 20 to the processing carrier 60 with the adhesive film 40 prevents dimple or stretch of the flexible circuit substrate 20. Further, the adhesive film 40 affixes substantially the total surface area of the first surface 22 of the flexible circuit substrate 20 to the processing carrier 60. The adhesive film 40 ideally holds the flexible circuit substrate 20 uniformly across substantially the entire first surface 22 thereof.

Attachment of the total surface of the flexible circuit substrate 20 to the processing carrier 60 during processing prevents the flexible circuit substrate 20 from being raised during certain processing steps, including blowing of air against the flexible circuit substrate 20. Additionally, attaching substantially the total surface area of the flexible circuit substrate 20 to the processing carrier 60 eliminates the tendency of the flexible circuit 10 to attach to the stencil or screen and lift apart from the processing carrier 60 during stencil or screen printing.

Fixturing of the flexible circuit substrate 20 to the processing carrier 60 by the disclosed methods permits unobstructed processing of the unattached surface (i.e., the second surface 24) of the flexible circuit substrate 20. Such methods may be tailored for compatibility with the specific processing carrier 60 being utilized, the flexible circuit 10 materials, and the processing environment.

Further exemplary utilization of the above technology is described with reference to Figs. 10-12. The flexible circuit substrate 20 is processed to define a plurality of individual devices 21, which will ultimately be singulated from substrate 20. Example devices include RFID cards. The flexible circuit substrate 20 is placed in a stencil or other printer in which conductive epoxy is applied thereover following the fixturing of the flexible circuit substrate 20 to the processing carrier 60.

Fig. 11 illustrates exemplary circuitry of an individual RFID device 21. Such includes circuitry in the form of a first battery connection terminal 71, a

second battery connection terminal 73 and an antenna 75. A thin profile/button-type battery 70 is mounted on each of the individual substrates 21 with conductive epoxy.

An integrated circuit 36 is provided and includes suitable circuitry including
5 transponder circuitry for receiving, processing, transmitting and/or otherwise operating upon electronic signals. Integrated circuit 36 is preferably in the form of a semiconductor chip which is operatively mounted relative to the individual substrate 21 and in electrical contact with battery 70 via a conductive ink as described in a U.S. Patent Application entitled "Methods Of Enhancing
10 Electromagnetic Radiation Properties Of Encapsulated Circuit, And Related Device", filed the same day as the present application by Mark E. Tuttle and Rickie C. Lake as named inventors, and commonly assigned to the assignee hereof, and incorporated herein by reference. An exemplary and preferred integrated circuit 36 is described in U.S. Patent Application Serial No. 08/705,043,
15 which names James O'Toole, John R. Tuttle, Mark E. Tuttle, Tyler Lowrey, Kevin Devereaux, George Pax, Brian Higgins, Shu-Sun Yu, David Ovard and Robert Rotzoll as inventors, which was filed on August 29, 1996, is assigned to the assignee of this patent application, and is incorporated herein by reference.

Referring to Fig. 10, flexible circuit substrate 20 undergoes further
20 processing in which an amount of adhesive material 74 is applied around a perimeter edge of the sheet or panel. Such applied adhesive material forms a dam relative to and inside of which encapsulating epoxy material is to be formed.

Subsequently, encapsulating epoxy material 89 (Fig. 12) is formed over
25 flexible circuit substrate surface 24 to cover/encapsulate each of individual devices 21 while processing carrier 60 is in place. Preferably, such epoxy constitutes a two-part epoxy having a resin and a hardener which are sufficient to provide desired degrees of flex and rigidity. After application and curing of such epoxy, the processing carrier 60 and adhesive film 40 are removed and the flexible
30 circuit substrate 20 is subjected to suitable separation or singulation processing in which individual devices 21 are cut and separated from one another.

CLAIMS:

1. A method of fixturing a flexible circuit substrate and a processing carrier, comprising:

providing an adhesive film;

5 providing a flexible circuit substrate;

providing a processing carrier; and

attaching the flexible circuit substrate and the processing carrier together with the adhesive film therebetween.

10 2. The method according to claim 1 wherein the adhesive film includes a first adherent surface and a second adherent surface providing equal degrees of adhesion force.

3. The method according to claim 1 wherein the adhesive film 15 comprises silicone or acrylic.

4. The method according to claim 1 wherein the adhesive film comprises a blend of silicone and acrylic.

20 5. The method according to claim 1 wherein the adhesive film is pressure sensitive.

6. The method according to claim 1 wherein the attaching step comprises the steps of applying the adhesive film to the processing carrier and 25 then pressing the flexible circuit substrate onto the adhesive film.

7. The method according to claim 1 wherein the flexible circuit substrate includes a first surface, and the attaching step comprises attaching substantially the total surface area of the first surface to the adhesive film.

30

8. The method according to claim 1 further comprising the step of separating the flexible circuit substrate and the adhesive film.

9. The method according to claim 1 wherein the processing carrier 35 comprises a rigid plate.

10. A method of processing a flexible circuit, comprising:

providing a processing carrier having a support surface;

providing a flexible circuit substrate having a first surface and a second surface;

5 providing an adhesive film having a first adherent surface and a second adherent surface;

adhering the first adherent surface of the adhesive film with the support surface of the processing carrier;

adhering the second adherent surface of the adhesive film with the first

10 surface of the flexible circuit substrate; and

processing the second surface of the flexible circuit substrate with the first adherent surface of the adhesive film being adhered to the support surface of the processing carrier and the second adherent surface thereof being adhered to the first surface of the flexible circuit substrate.

15

11. The method according to claim 10 further comprising the step of separating the flexible circuit substrate and the adhesive film.

12. The method according to claim 10 wherein the processing step

20 includes at least one of attaching an electronic component and the flexible circuit substrate, and encapsulating the flexible circuit substrate.

13. The method according to claim 10 wherein the adhering of the second adherent surface comprises adhering substantially the total surface area

25 of the first surface of the flexible circuit substrate to the adhesive film.

14. A method of processing a flexible circuit substrate relative to a processing carrier, comprising:

providing an adhesive film having a first adherent surface and a second

30 adherent surface;

adhering the processing carrier and the first adherent surface of the adhesive film;

adhering the flexible circuit substrate and the second adherent surface of the adhesive film; and

after the adherings, separating the flexible circuit substrate and the second adherent surface of the adhesive film with the first adherent surface and the processing carrier remaining adhered.

5 15. The method according to claim 14 further comprising the step of separating the adhesive film and the processing carrier.

16. A method of fixturing a flexible circuit substrate and a processing carrier, comprising:

10 providing a flexible circuit substrate having a first surface;

providing a processing carrier having a support surface;

applying a first adhesion force against the support surface of the processing carrier; and

applying a second adhesion force against substantially the total surface area

15 of the first surface of the flexible circuit substrate.

17. The method according to claim 16 wherein the second adhesion force is uniformly applied against the first surface of the flexible circuit substrate.

20 18. The method according to claim 16 wherein the first adhesion force and the second adhesion force are provided by an adhesive film.

19. The method according to claim 16 wherein the first adhesion force and the second adhesion force are substantially equal.

25

20. The method according to claim 16 wherein the first adhesion force is greater than the second adhesion force.

21. The method according to claim 16 wherein the second adhesion

30 force is greater than the first adhesion force.

22. A method of fixturing a flexible circuit substrate and a processing carrier, comprising:

providing a flexible circuit substrate having a first surface;

35 providing a processing carrier having a support surface; and

attaching substantially the total surface area of the first surface of the flexible circuit substrate and the support surface of the processing carrier.

23. A method of fixturing a flexible circuit substrate and a processing carrier, comprising:

providing a flexible circuit substrate having a first surface and an adhesive film attached thereto;

providing a processing carrier having a support surface; and

attaching the adhesive film and the support surface of the processing carrier.

24. A method of processing a flexible circuit, comprising:

providing a processing carrier having a support surface;

providing a flexible circuit substrate having a first surface and a second surface;

fixturing the first surface of the flexible circuit substrate to the support surface of the processing carrier; and

covering the second surface of the flexible circuit substrate with an encapsulating material.

25. The method according to claim 24 wherein the fixturing comprises:

providing an adhesive film having a first adherent surface and a second adherent surface;

adhering the first adherent surface of the adhesive film with the support surface of the processing carrier; and

adhering the second adherent surface of the adhesive film with the first surface of the flexible circuit substrate.

26. The method according to claim 24 wherein the fixturing comprises attaching substantially the total surface area of the first surface to the adhesive film.

27. The method according to claim 24 further comprising the step of curing the encapsulating material into a hardened coating with the flexible circuit substrate fixtured to the processing carrier.

28. The method according to claim 24 further comprising the step of attaching an electronic component and the flexible circuit substrate.

29. A method of fixturing a flexible circuit substrate and a processing
5 carrier, comprising:

providing a first film having a first adherent surface;

providing a second film having a second adherent surface;

joining the first and second films to form a unitary adhesive film having the first adherent surface and the second adherent surface on opposing outer
10 sides thereof;

providing a flexible circuit substrate;

providing a processing carrier; and

attaching the flexible circuit substrate and the processing carrier together with the adhesive film therebetween.

15

30. The method according to claim 29 further comprising the steps of:

adhering the first adherent surface with the support surface of the processing carrier; and

adhering the second adherent surface with the first surface of the flexible
20 circuit substrate.

31. The method according to claim 30 wherein the first adherent surface provides a first adhesion force and the second adherent surface provides a second adhesion force; and the first adhesion force being greater than the
25 second adhesion force.

32. The method according to claim 30 wherein the first adherent surface provides a first adhesion force and the second adherent surface provides a second adhesion force; and the first adhesion force being less than the second
30 adhesion force.

33. A method of fixturing a flexible circuit substrate and a processing carrier, comprising:

providing a monolithic adhesive film having a first adherent surface and
35 a second adherent surface;

providing a flexible circuit substrate having a first surface;

providing a processing carrier having a support surface; and

attaching the flexible circuit substrate and the processing carrier together, with the support surface of the processing carrier attached to the first adherent surface of the monolithic adhesive film and the first surface of the flexible circuit substrate attached to the second adherent surface of the monolithic adhesive film.

34. The method according to claim 33 wherein the attaching step comprises attaching substantially the total surface area of the first surface of the flexible circuit substrate to the monolithic adhesive film.

35. The method according to claim 33 further comprising the step of separating the flexible circuit substrate and the monolithic adhesive film.

36. A method of processing a flexible circuit, comprising:

providing a processing carrier having a support surface;

providing a flexible circuit substrate having a first surface and a second surface;

providing a monolithic adhesive film having a first adherent surface and a second adherent surface;

adhering the first adherent surface of the monolithic adhesive film with the support surface of the processing carrier;

adhering the second adherent surface of the monolithic adhesive film with the first surface of the flexible circuit substrate; and

processing the second surface of the flexible circuit substrate with the first adherent surface being adhered to the support surface of the processing carrier and the second adherent surface being adhered to the first surface of the flexible circuit substrate.

37. The method according to claim 36 further comprising the step of separating the flexible circuit substrate and the monolithic adhesive film.

38. The method according to claim 36 wherein the processing step includes at least one of attaching an electronic component and the flexible circuit substrate, and encapsulating the flexible circuit substrate.

39. The method according to claim 36 wherein substantially the total surface area of the first surface of the flexible circuit substrate is adhered to the monolithic adhesive film.

5 40. A method of fixturing a flexible circuit substrate and a processing carrier, comprising:

providing a flexible circuit substrate having a first surface;

providing a processing carrier having a support surface;

providing a monolithic adhesive film having a first adherent surface and 10 a second adherent surface;

applying a first adhesion force against the support surface of the processing carrier, the first adhesion force being provided by the first adherent surface of the monolithic adhesive film; and

applying a second adhesion force against substantially the total surface area 15 of the first surface of the flexible circuit substrate, the second adhesion force being provided by the second adherent surface of the monolithic adhesive film.

41. The method according to claim 40 wherein the second adhesion force is uniformly applied against the first surface of the flexible circuit substrate.

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42. The method according to claim 40 further comprising the step of separating the flexible circuit substrate and the monolithic adhesive film.

43. A method of processing a flexible circuit, comprising:

25 providing a monolithic adhesive tape including a first adherent surface and a second adherent surface;

providing a processing carrier having a support surface;

providing a flexible circuit substrate having a first surface and a second surface;

30 first adhering the first adherent surface of the adhesive tape and the support surface of the processing carrier;

after the first adhering, second adhering the second adherent surface of the adhesive tape and substantially the total surface area of the first surface of the flexible circuit substrate, and the second adhering of the second adherent 35 surface of the adhesive tape and the first surface of the flexible circuit substrate being substantially uniform;

processing the second surface of the flexible circuit substrate with the first adherent surface of the adhesive tape being adhered to the support surface of the processing carrier and the second adherent surface thereof being adhered to the first surface of the flexible circuit substrate;

5 first separating the flexible circuit substrate and the adhesive tape; and

after the first separating, second separating the adhesive tape and the processing carrier.

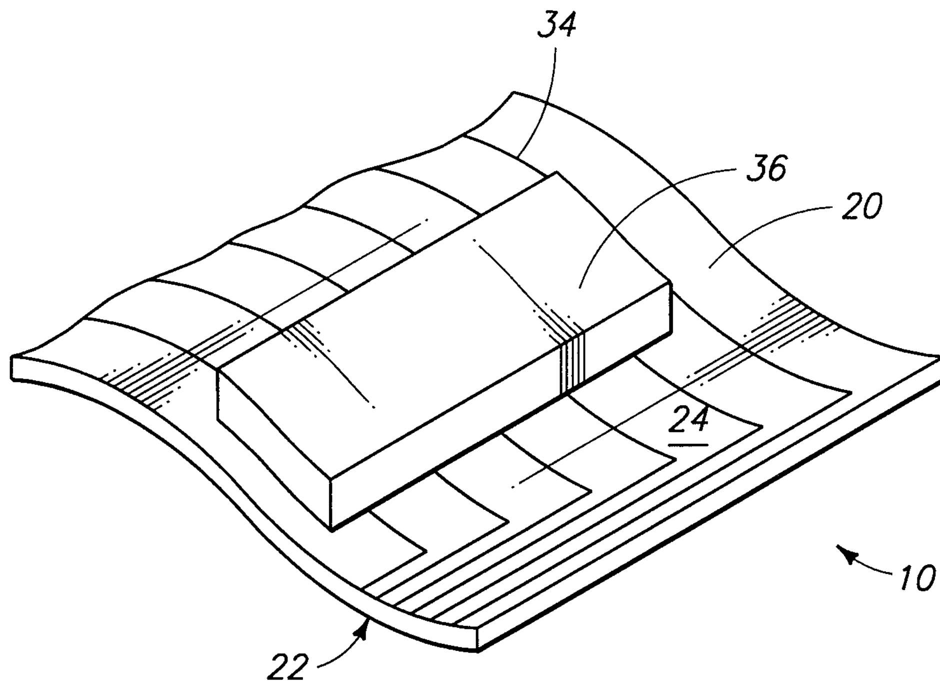

Fig 1

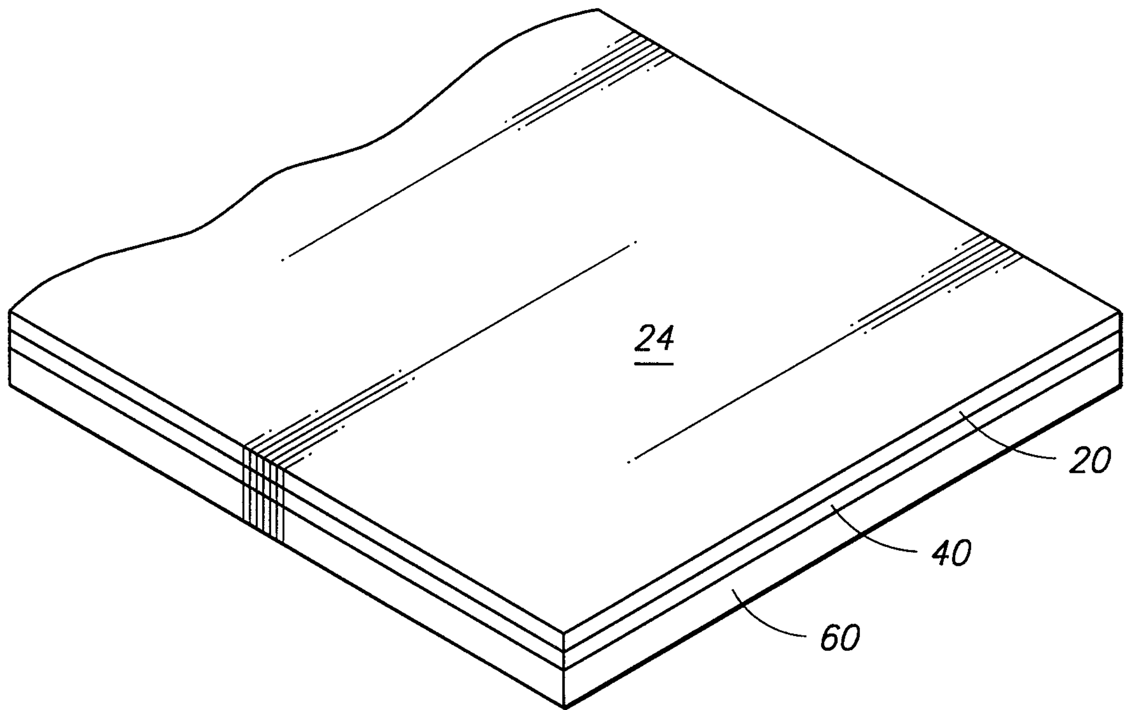
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Fig 2

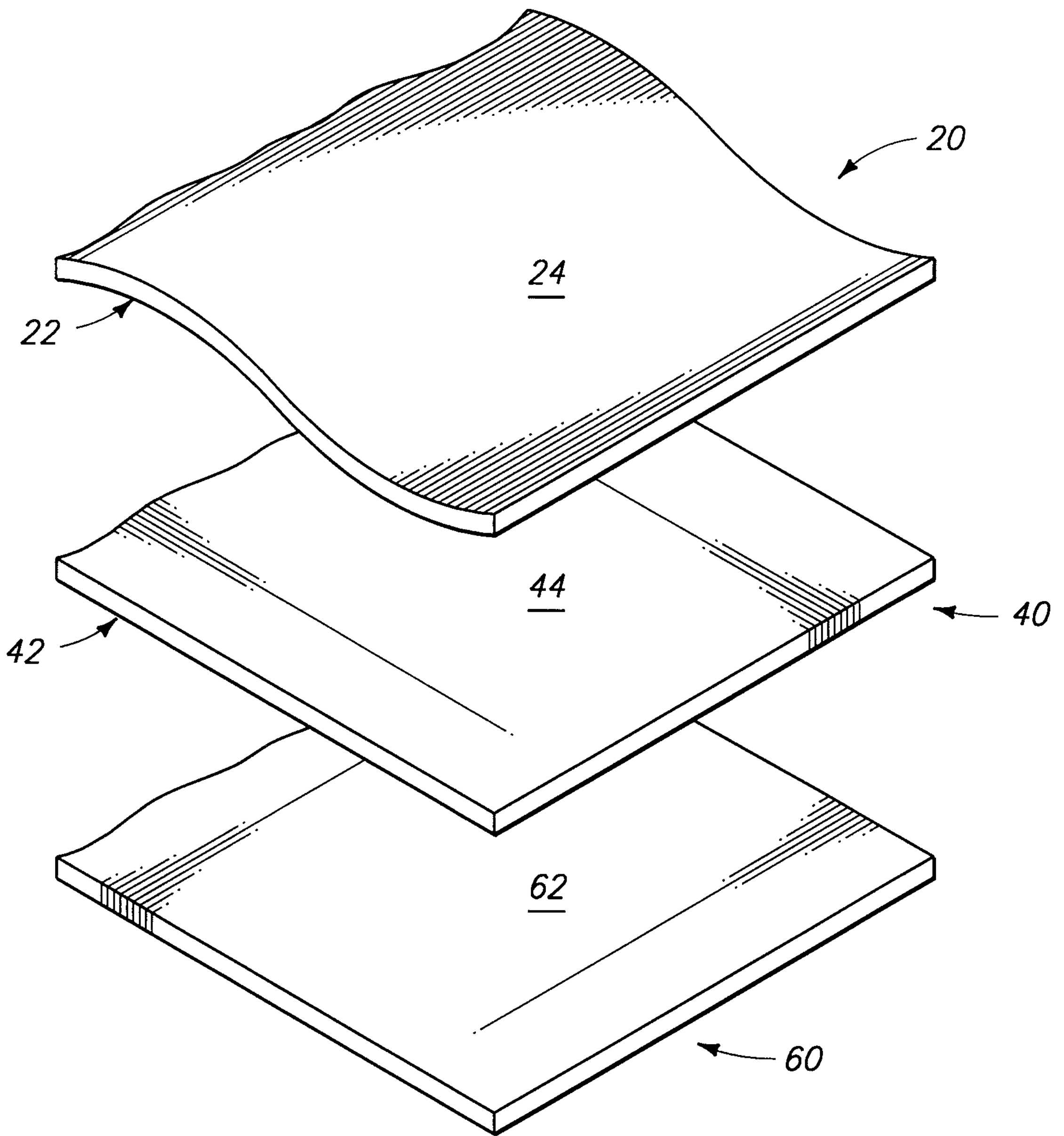
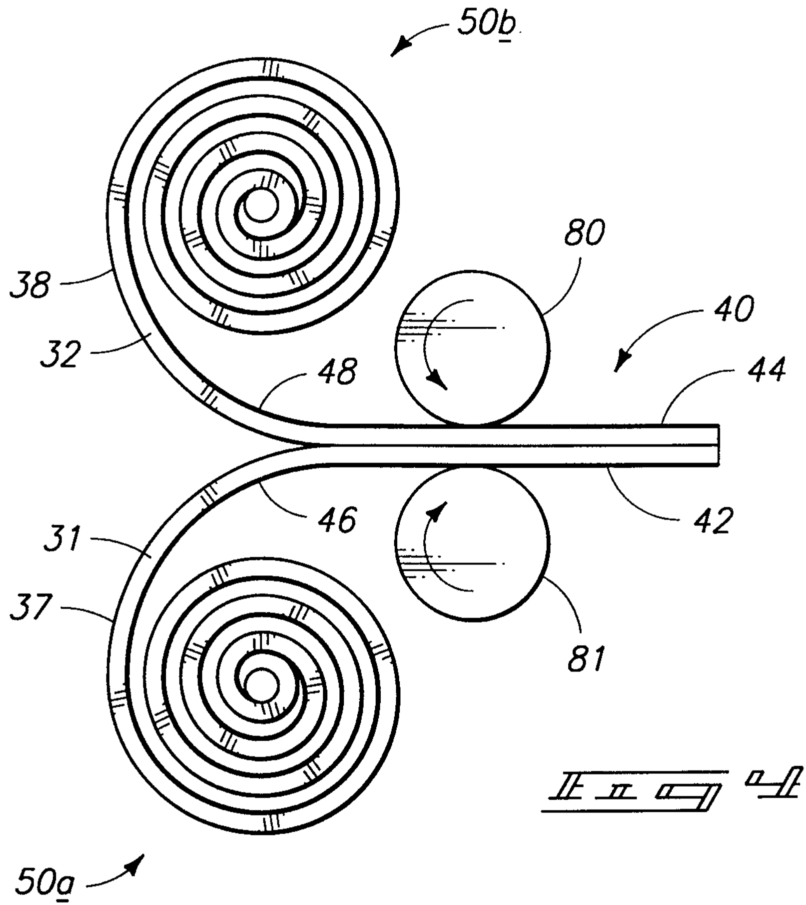


FIG 3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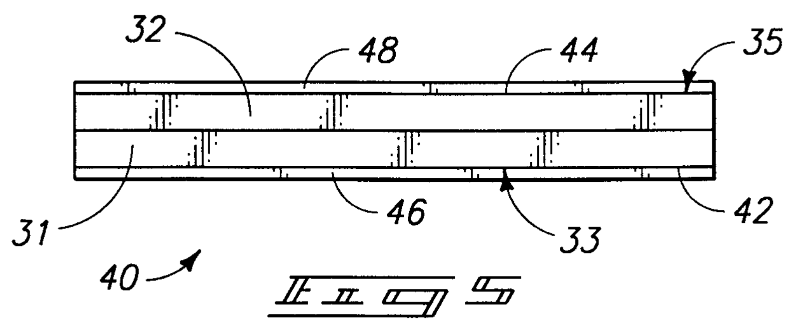
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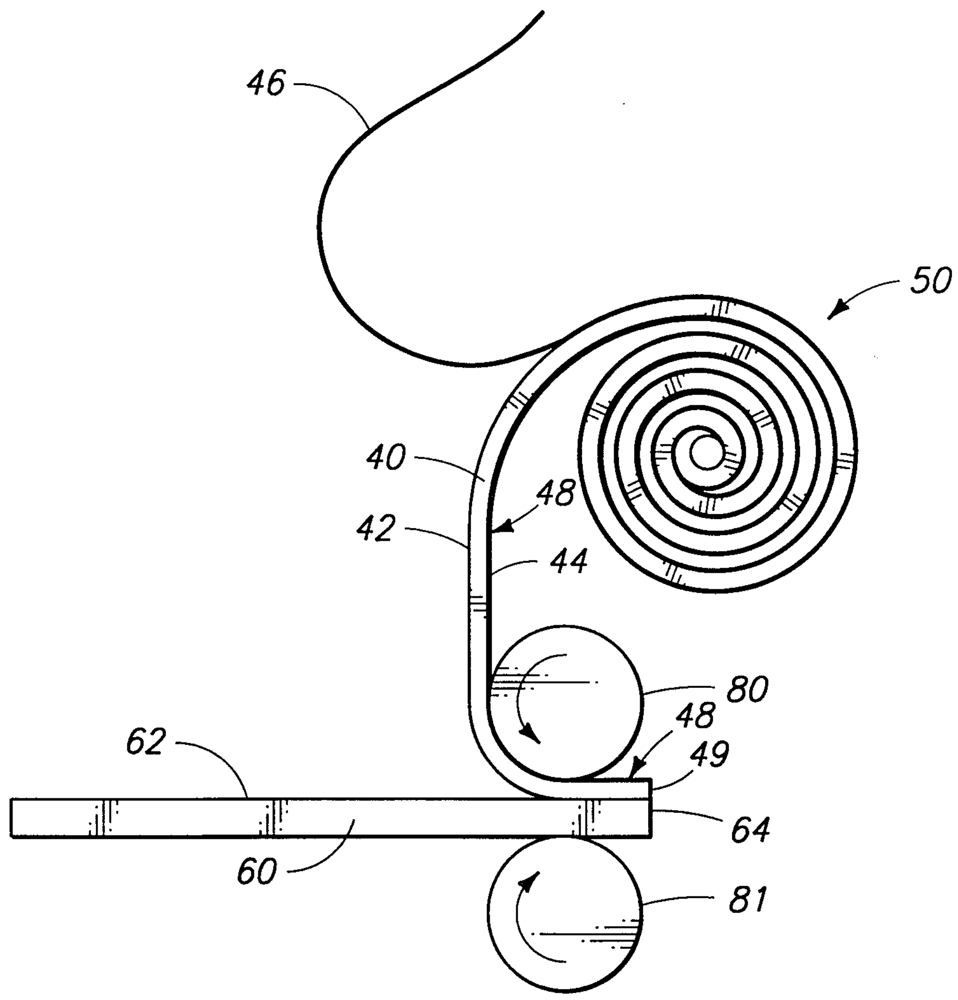


Fig 6

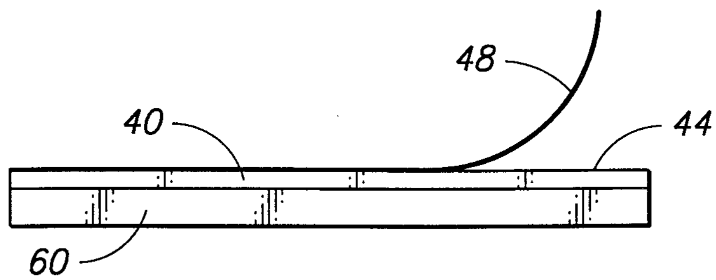
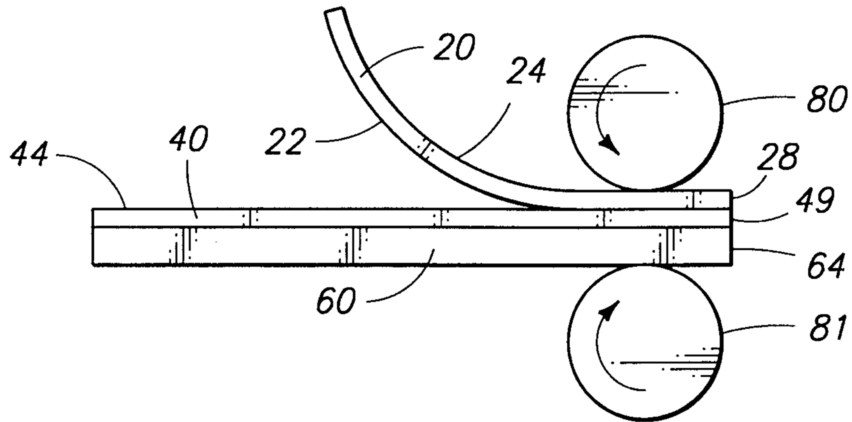


Fig 7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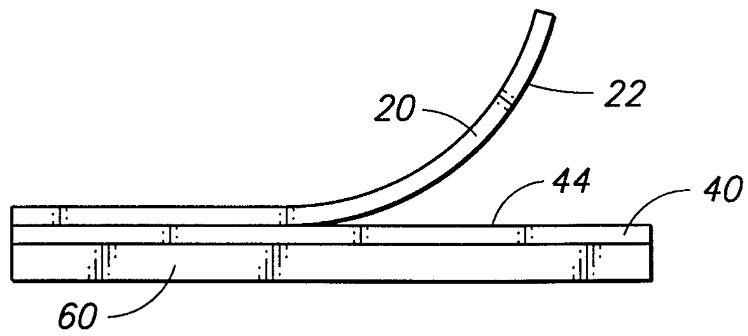
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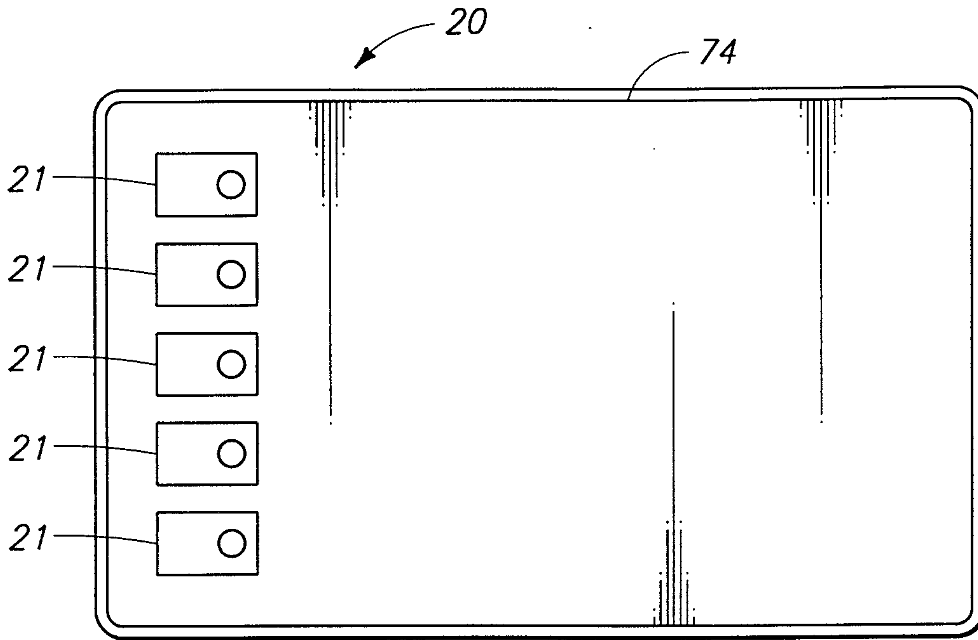

Fig 10

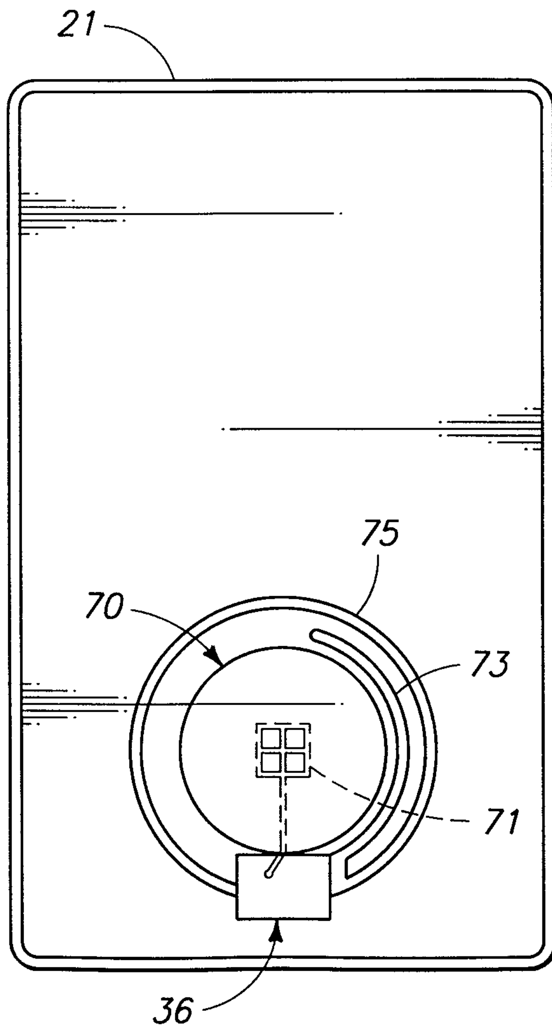

Fig 11

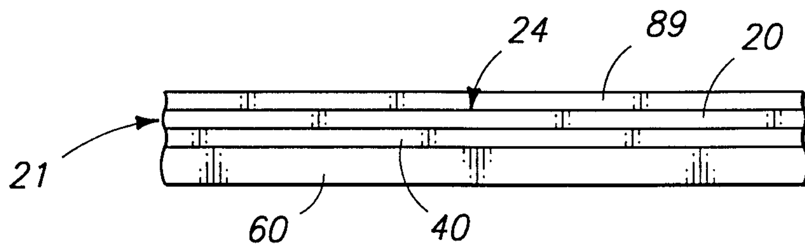
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Fig 12

INTERNATIONAL SEARCH REPORT

Inte ...ional Application No
PCT/US 98/10044

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H05K3/00 C09J7/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H05K C09J H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 030 779 A (THE MARCONI COMPANY) 10 April 1980	1,2, 6-11, 13-19, 22, 33-37, 39-43
Y	see the whole document	3-5,20, 21,23, 29-32

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search: 17 July 1998

Date of mailing of the international search report: 29/07/1998

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Inte ...ional Application No
PCT/US 98/10044

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	DATABASE WPI Week 9538 Derwent Publications Ltd., London, GB; AN 95-290638 XP002070342 & JP 07 188 621 A (TOYO INK MFG CO) , 25 July 1995 see abstract	3-5
Y	PATENT ABSTRACTS OF JAPAN vol. 17, no. 291 (C-1067), 4 June 1993 & JP 05 017725 A (SEKISUI CHEM CO), 26 January 1993, see abstract	20,21, 29-32
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Y	see claims	23
X	PATENT ABSTRACTS OF JAPAN vol. 95, no. 4, 31 May 1995 & JP 07 022795 A (SHIN ETSU CHEM CO), 24 January 1995, see abstract	1,3, 6-11,13, 14, 16-19, 22, 33-37, 39-42
X	DE 41 23 370 A (ROBOCK) 21 January 1993 see the whole document	1,7-9, 16-19,22
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Information on patent family members

International Application No
PCT/US 98/10044

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DE 19549354 A	09-01-1997	AU 5996096 A	05-02-1997
		WO 9702723 A	23-01-1997
DE 4123370 A	21-01-1993	NONE	