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(54) **SCREEN ASSEMBLY AND METHOD OF ATTACHING A SCREEN CLOTH THEREIN USING A LIGHT CURABLE ADHESIVE**

(75) Inventors: **Robert C. Martineau**, Rice Lake, WI (US); **Jeff Sawyers**, Rice Lake, WI (US)

Correspondence Address:
HOWARD & HOWARD ATTORNEYS, P.C.
THE PINEHURST OFFICE CENTER, SUITE #101
39400 WOODWARD AVENUE
BLOOMFIELD HILLS, MI 48304-5151 (US)

(73) Assignee: **Quanex Corporation**

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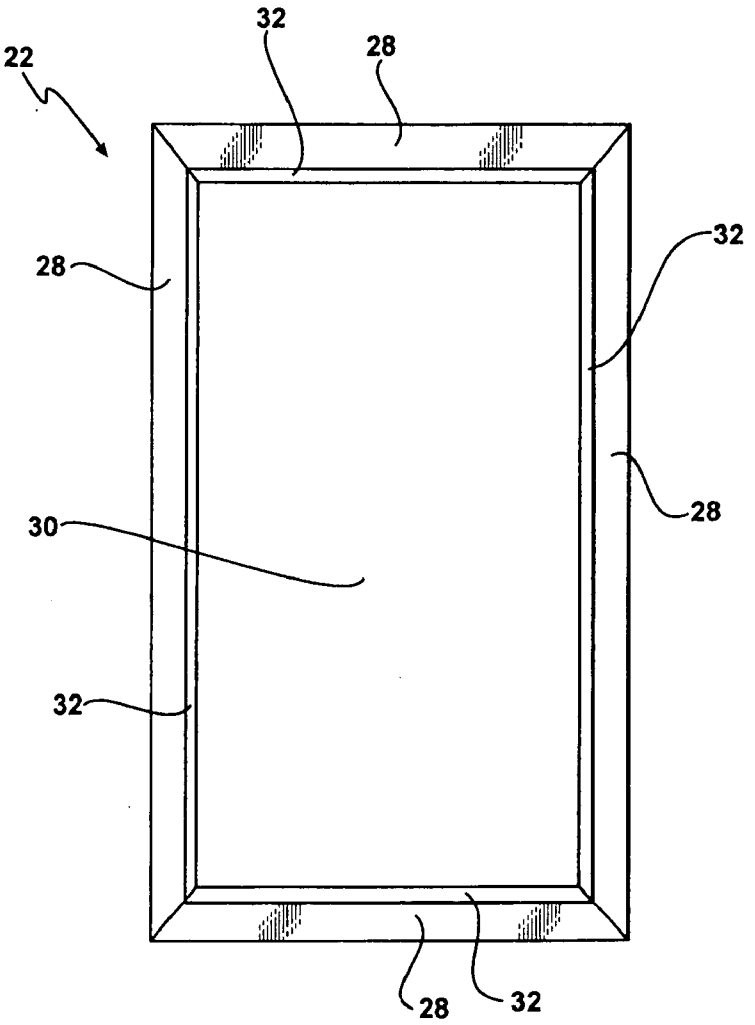
(57) **ABSTRACT**

A screen frame assembly (**20**) for a door or a window includes a frame (**22**), a screen cloth (**24**), and a light curable adhesive (LCA) (**26**). The LCA (**26**) cures upon exposure to light energy (**43**). The frame (**22**) defines an opening (**30**) and the screen cloth (**24**) covers the opening (**30**). The LCA (**26**) is disposed between the frame (**22**) and the screen cloth (**24**) to adhere the screen cloth (**24**) to the frame (**22**) once the LCA (**26**) has been cured.



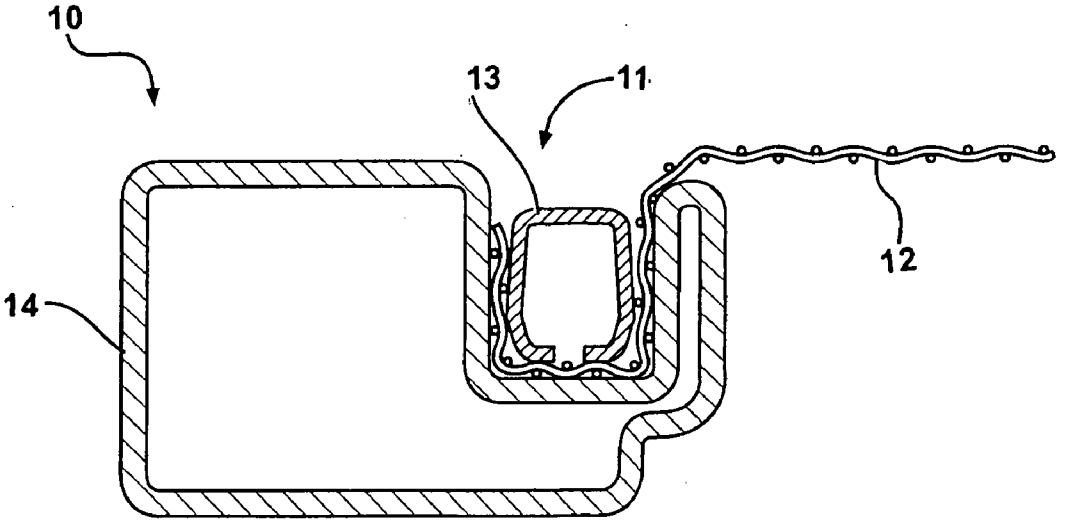


FIG - 1A
PRIOR ART

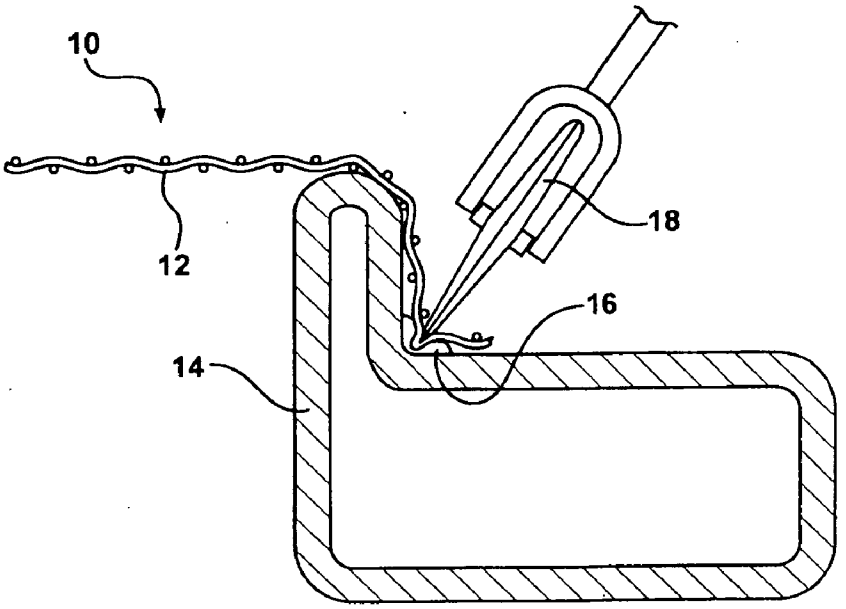


FIG - 1B
PRIOR ART

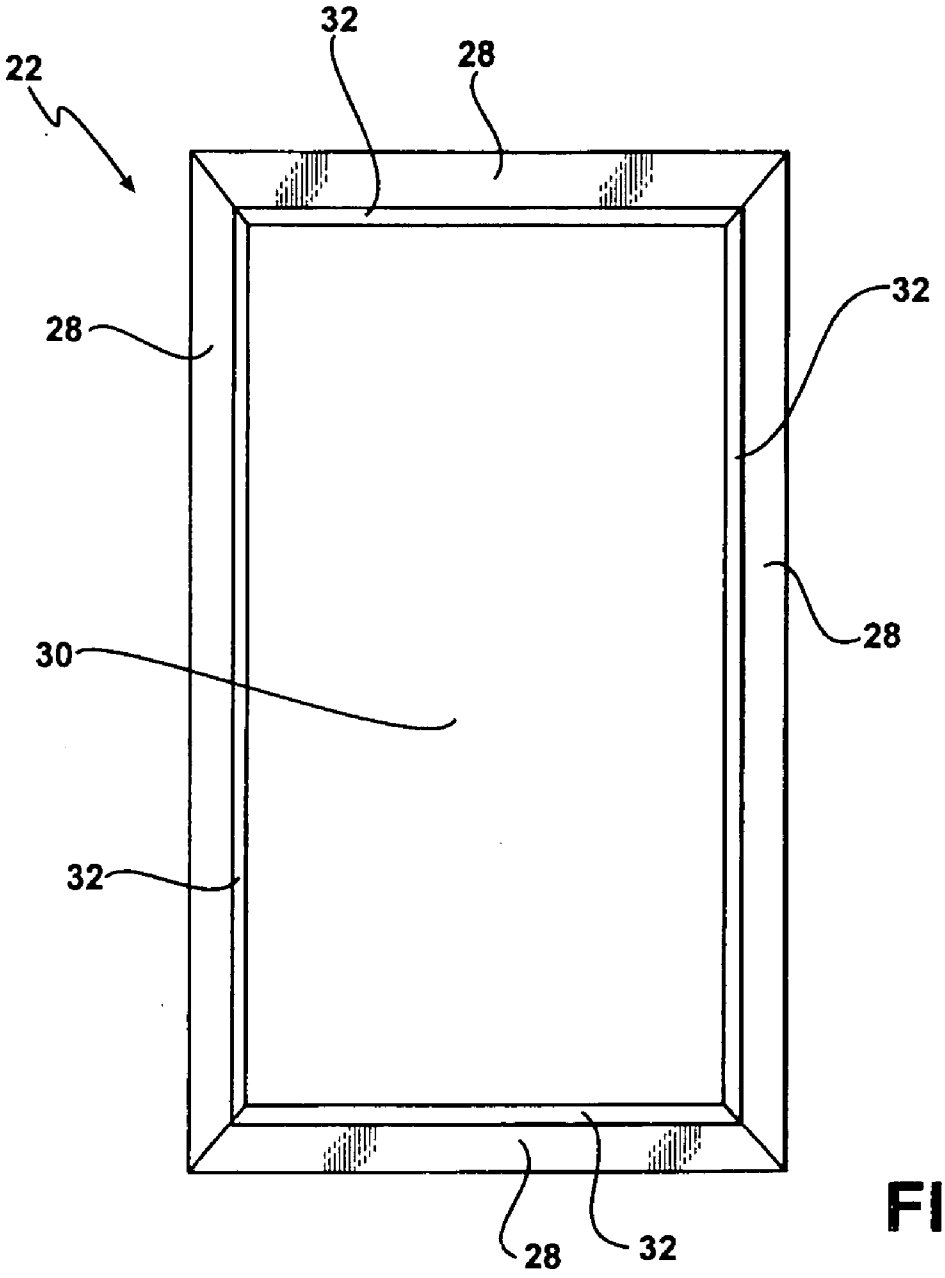


FIG - 2

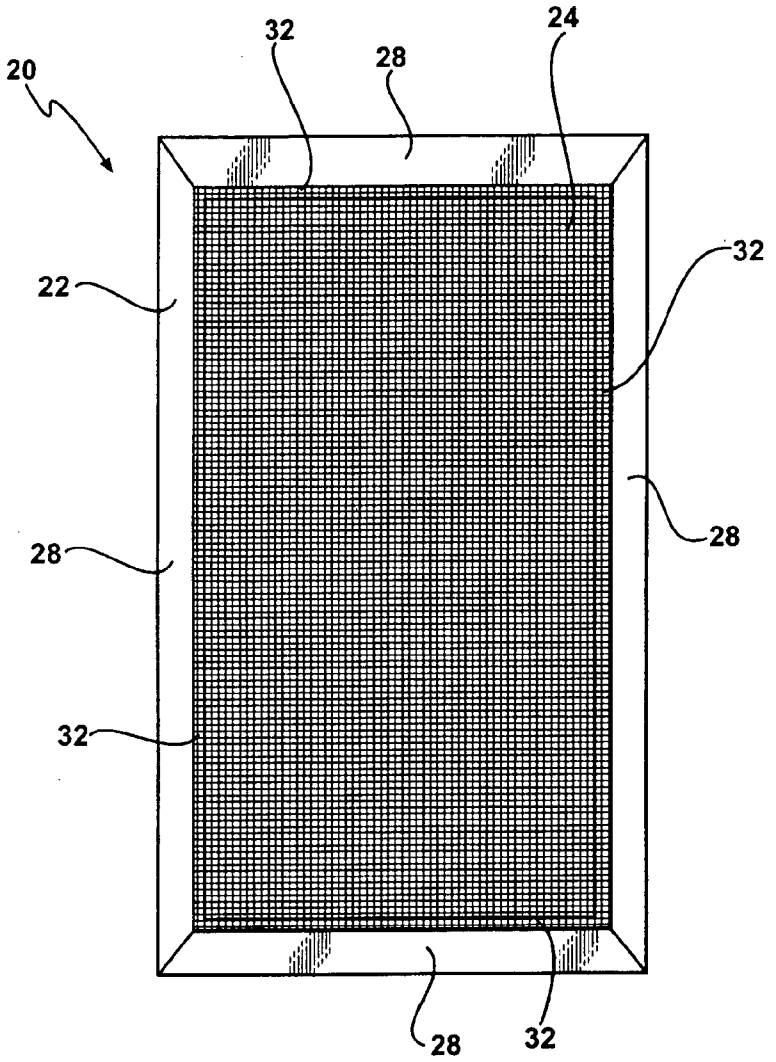


FIG - 3

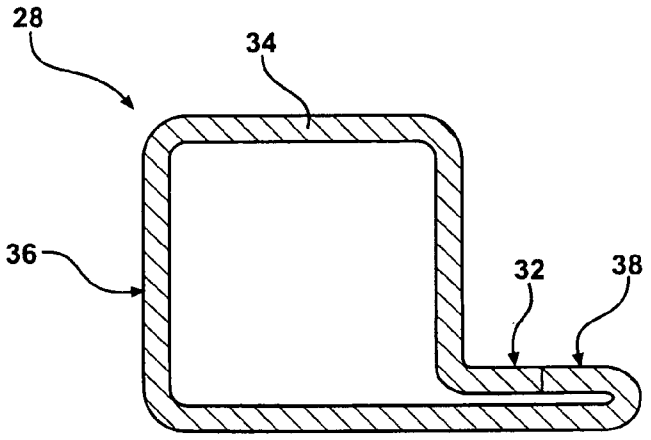


FIG - 4A

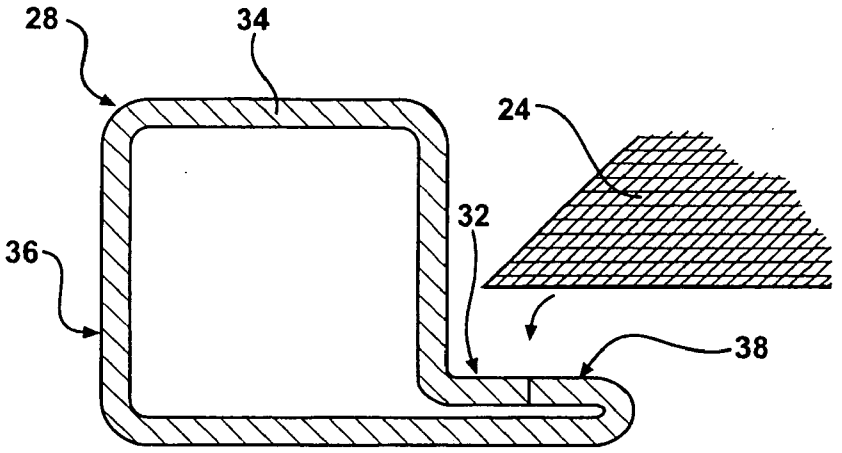


FIG - 4B

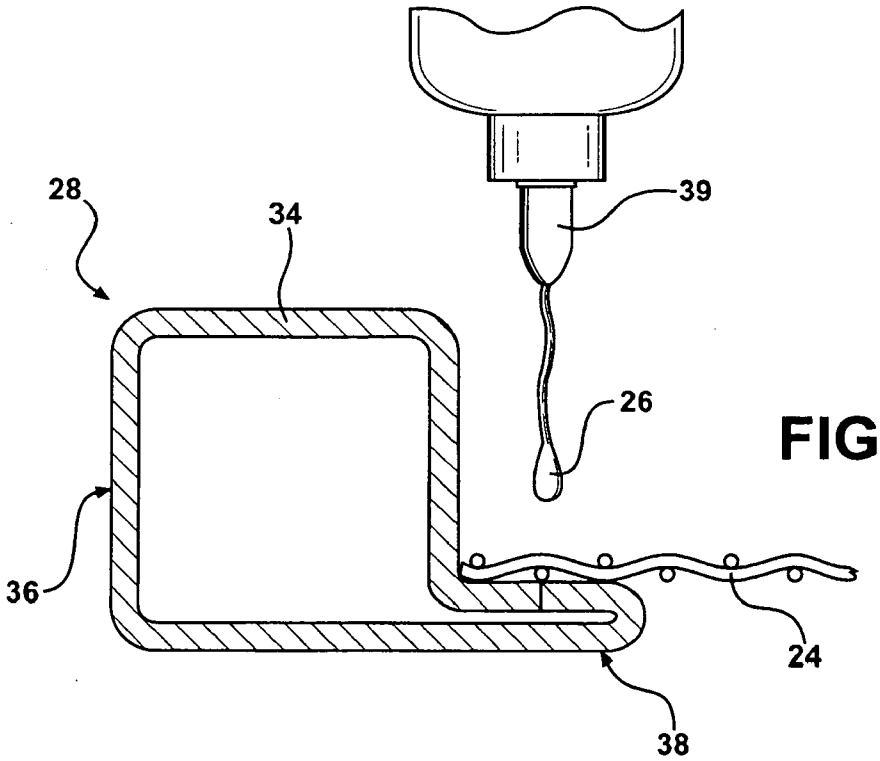


FIG - 4C

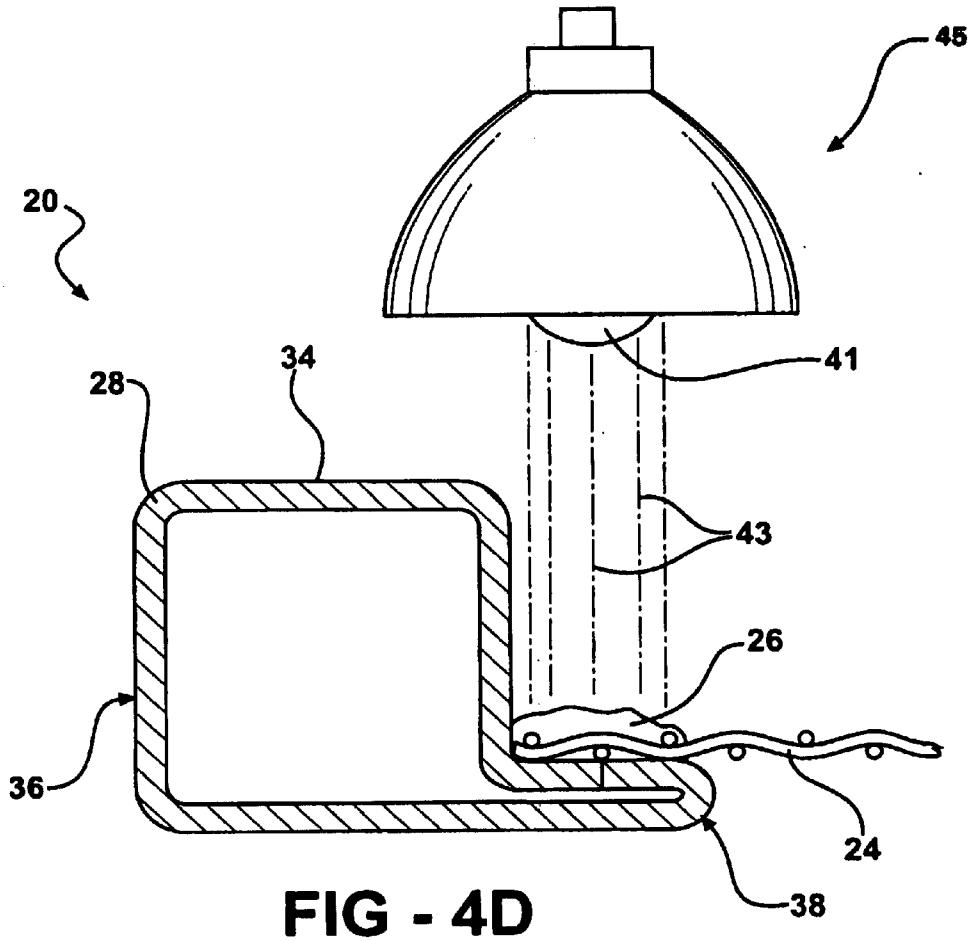


FIG - 4D

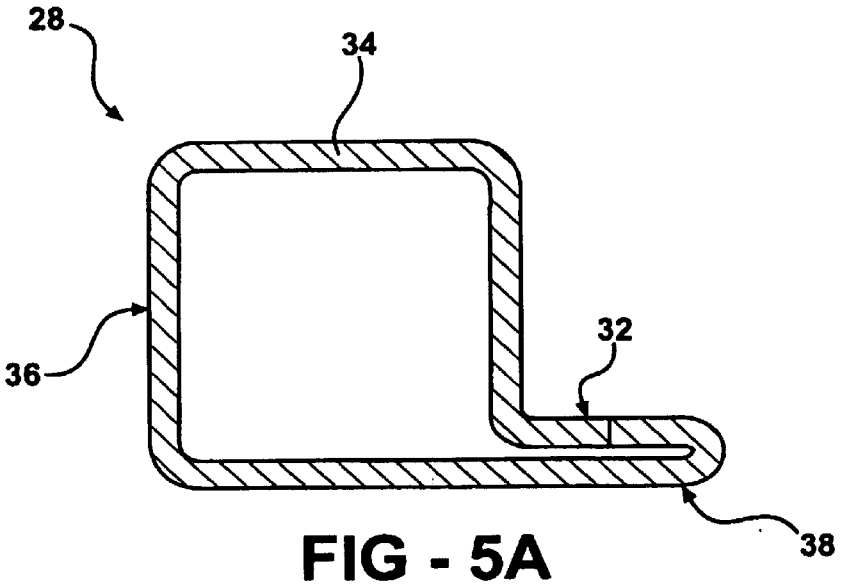


FIG - 5A

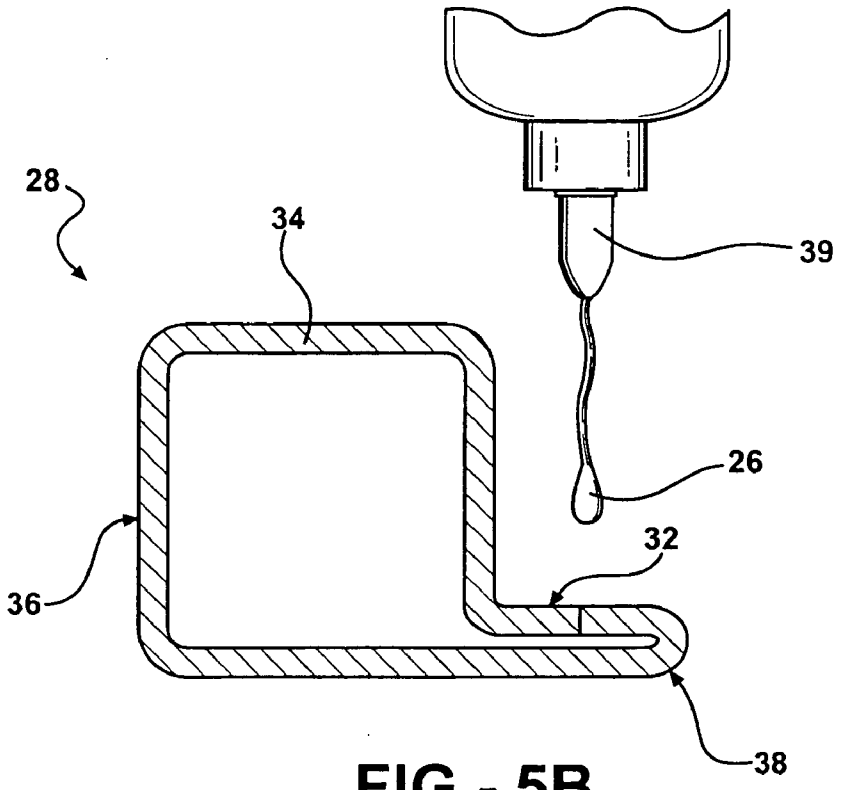


FIG - 5B

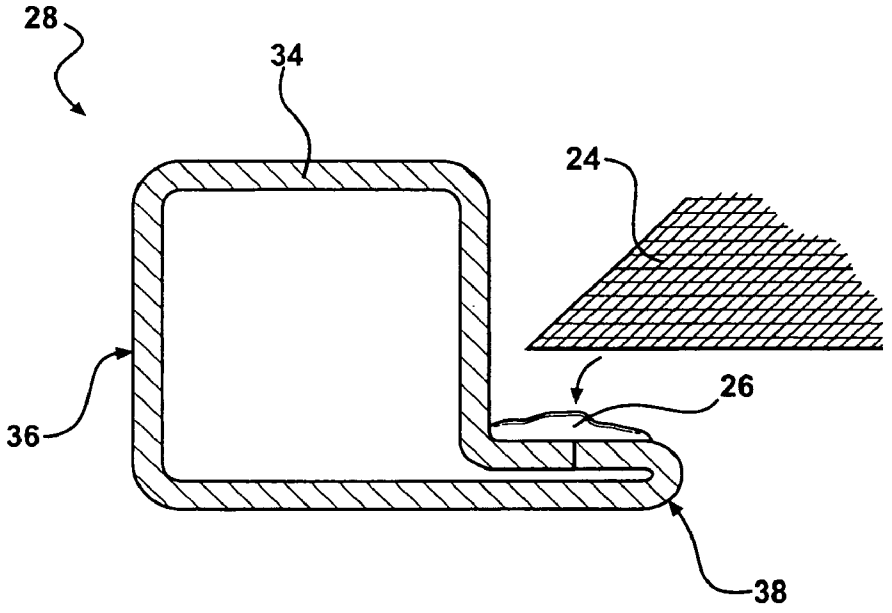


FIG - 5C

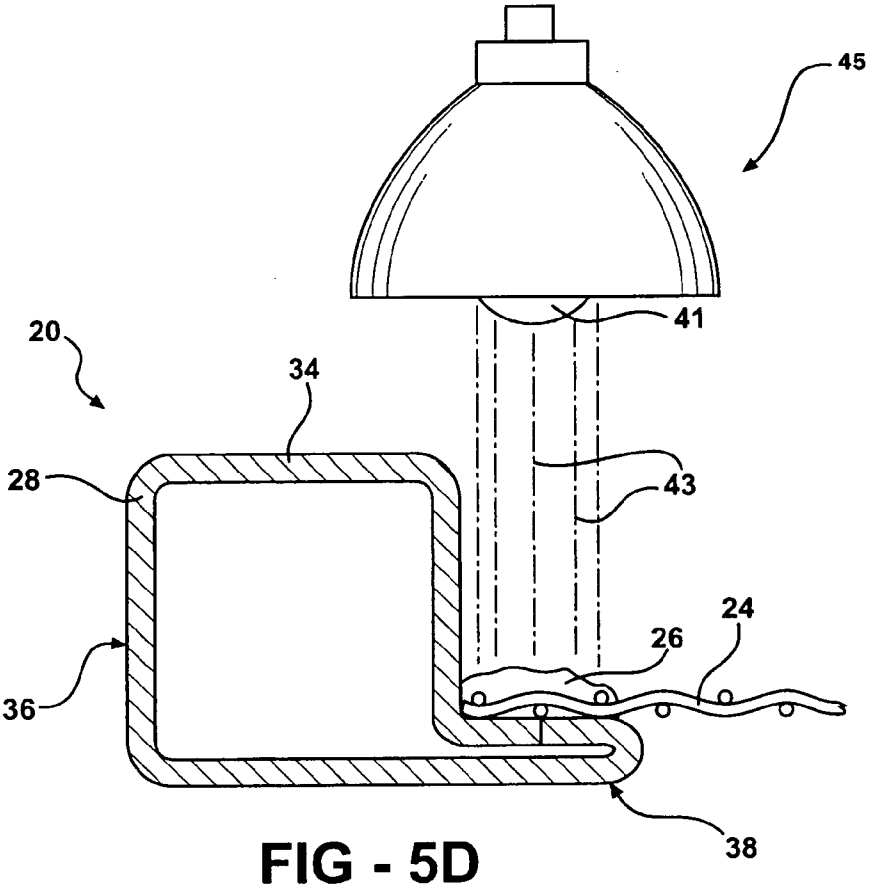


FIG - 5D

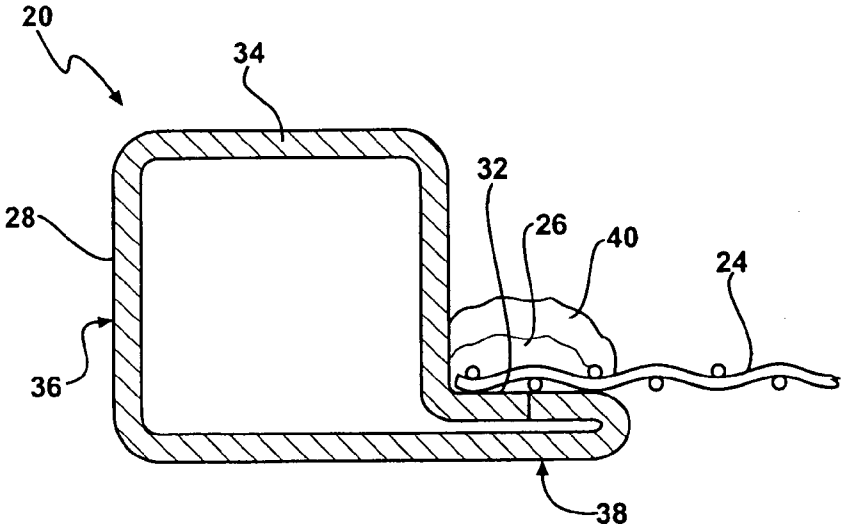


FIG - 6

SCREEN ASSEMBLY AND METHOD OF ATTACHING A SCREEN CLOTH THEREIN USING A LIGHT CURABLE ADHESIVE

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. provisional patent application Ser. No. 60/572,545 filed on May 19, 2004.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention generally relates to screen assemblies for a window or a door. More specifically, the invention uses a light curable adhesive to adhere a screen cloth to a screen frame for the window or the door.

[0004] 2. Description of the Related Art

[0005] Traditional screen assemblies for windows or doors retain a screen cloth to a screen frame utilizing a mechanical fit. A cross section of this type of screen assembly is shown in **FIG. 1A**. Here, a screen frame **10** is formed to define a spline channel **11**. The screen assembly **10** is formed by stretching a screen cloth **12** over at least a portion of the spline channel **11** and pressing a spline **13** into the spline channel **11**, thereby trapping the screen cloth **12** in the spline channel **11**.

[0006] Some screen assemblies have been constructed to eliminate the need for a spline channel and a spline to trap the screen cloth into place. These screen assemblies are manufactured instead with a cured adhesive. A cross section of this type of screen assembly is shown in **FIG. 1B**. A process, which utilizes an adhesive to secure the screen cloth to the frame is disclosed in U.S. Pat. No. 6,279,644 to Wylie (the '644 patent). The '644 patent discloses a screen assembly **10**, generally shown in **FIG. 1**, where the screen cloth **12** is adhered to a frame **14** using a hot melt adhesive **16**. The hot melt adhesive **16** is applied to the frame **14** in the molten form as the frame **14** is formed. The hot melt adhesive **16** on the frame **14** is subsequently cooled to harden for storage. The frame **14** is then moved to storage. When needed, the cooled frame **14** can then be removed from storage where the hardened hot melt adhesive **16** and the frame **14** are placed in a conventional oven and heated to reliquify the hot melt adhesive **16**. The screen cloth **12** is placed on both the heated frame **14** and the reliquified hot melt adhesive **16**. Pressure is applied to the screen cloth **12**, with a roller **18** for example, to encapsulate fibers of the screen cloth **12** with the hot melt adhesive **16**. The hot melt adhesive **16** is subsequently cured by cooling the hot melt adhesive **16** to adhere the screen cloth **12** to the frame **14**. Cooling can expedited by using external cooling devices (e.g. air cooling, a chilled roller, etc.).

[0007] Although the type of screen assemblies of the '644 patent have eliminated the requirement of a spline channel to secure the screen cloth to the screen frame, their assembly requires many steps. These additional steps add complexity and time to the manufacture of screen assemblies. This complexity and time translate into an increased manufacturing cost of the screen assemblies.

SUMMARY OF THE INVENTION AND ADVANTAGES

[0008] The present invention relates to a screen assembly for a window or a door. The assembly comprises a frame and a screen cloth. The frame defines an opening and includes a mounting surface surrounding the opening. The screen cloth is disposed on the mounting surface and covers the opening. A light curable adhesive is disposed between the mounting surface and the screen cloth. The light curable adhesive is responsive to light energy for adhering the screen cloth to the mounting surface of the frame.

[0009] The subject invention also provides a method of attaching the screen cloth to the mounting surface of the frame. The method comprises the steps of, placing the screen cloth onto the mounting surface of the frame, disposing the light curable adhesive between the screen cloth and the mounting surface of the frame, and applying light energy to the light curable adhesive to adhere the screen cloth to the mounting surface of the frame.

[0010] By using a light curable adhesive to adhere the screen cloth to the screen frame, only light energy is required to cure the adhesive. The light energy cures the light curable adhesive in less time than conventional adhesives and in less time than it takes a hot melt adhesive to cure during cooling. Therefore, once the light curable adhesive cures upon exposure to light energy, no additional steps (e.g. cooling steps, removal from storage, etc.) are required. This saves complexity, time, and cost in the manufacture of the screen assemblies.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Other advantages of the present invention will be readily appreciated, as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0012] **FIG. 1A** is a partial cross-sectional view of a prior art screen frame assembly utilizing a spline;

[0013] **FIG. 1B** is a partial cross-sectional view of a prior art screen frame assembly utilizing a hot melt adhesive;

[0014] **FIG. 2** is a front view of frame sections connected to form a frame;

[0015] **FIG. 3** is a front view of a screen frame assembly from **FIG. 2** with a screen cloth adhered thereto;

[0016] **FIG. 4A** is a partial cross-sectional view of the frame of the screen frame assembly;

[0017] **FIG. 4B** is a partial cross-sectional view illustrating the frame of the screen frame assembly and the screen cloth placement on the frame;

[0018] **FIG. 4C** is a partial cross-sectional view illustrating disposition of a light curable adhesive onto the frame;

[0019] **FIG. 4D** is a partial cross-sectional view illustrating application of light energy on the light curable adhesive;

[0020] **FIG. 5A** is a partial cross-sectional view of the frame of the screen frame assembly;

[0021] **FIG. 5B** is a partial cross-sectional view illustrating disposition of the light curable adhesive onto the frame in an alternative embodiment;

[0022] **FIG. 5C** is a partial cross-sectional view of the frame illustrating the frame having the light curable adhe-

sive disposed on the frame and placement of the screen cloth on to both the frame and the light curable adhesive in the alternative embodiment;

[0023] **FIG. 5D** is a partial cross-sectional view of the frame illustrating application of light energy on the light curable adhesive in the alternative embodiment; and

[0024] **FIG. 6** is a partial cross-sectional view of the frame including the screen cloth, the light curable adhesive, and a cover layer disposed over the light curable adhesive.

DETAILED DESCRIPTION OF THE INVENTION

[0025] The present invention relates to a screen assembly **20** for a window or a door. The assembly is shown generally at **20**. The assembly **20** comprises a frame **22**, a screen cloth **24**, and a light curable adhesive (LCA) **26** that cures upon exposure to light energy. The frame **22** includes frame sections **28** that define an opening **30**. The frame sections **28** include a mounting surface **32** that surrounds the opening **30**. The screen cloth **24** is disposed on the mounting surface **32** and covers the opening **30**. Furthermore, the LCA **26** is disposed between the screen cloth **24** and the mounting surface **32**. The LCA **26** is responsive to light energy to cure and adhere the screen cloth **24** to the mounting surface **32** of the frame **22**. Preferably, the LCA **26** is Ultra Light-Weld® 3069 series from Dymax®. The LCA **26** is described additionally below.

[0026] Although the frame sections **28** surround the opening **30**, it should be understood that "surrounding" does not require complete enclosure of the perimeter of the opening **30**. While the frame **22** can include four frame sections **28** that are connected to form an enclosed rectangular shape surrounding the opening **30**, it should be understood that the frame **22** can also include more or less frame sections **28** such as three frame sections **28** that are connected to form a triangular shape, for example, or even three sides of a rectangular shape that surrounds the opening **30**. Other configurations of frame sections **28** are also possible. Additionally, the perimeter is not limited to the rectangular shape, but can be any shape that is desired (e.g. triangular, octagonal, etc.).

[0027] Each frame section **28** is preferably formed from aluminum. However, other materials for forming the frame sections **28** are also possible. The frame sections **28** are typically pre-painted, although painting is not required. A preferred type of paint is a polyester-based paint. The only requirement with respect to the material used for forming the frame sections **28** and/or the type of paint used is that an adequate bond between the LCA **26** and the frame section **28** can be established once the LCA **26** is cured.

[0028] Each frame section **28** is formed into a cross-section **34**. The cross-section **34** can be any shape. A preferred shape for the cross-section is shown generally at **34** in **FIGS. 4A and 5A** which includes a rectangle, preferably a square **36**, having a flange **38** extending from one side of the square **36**. Preferably, the mounting surface **32** is formed from the flange **38**. However, the flange **38** is not required and the mounting surface **32** can be formed from any portion of the frame section **28**.

[0029] The screen cloth **24**, i.e., screen, is disposed on the mounting surface **32** to cover the opening **30** and prevent the ingress of insects or debris, for example, while providing ventilation through the opening **30**. The screen cloth **24** is preferably formed from fiberglass and coated with polyvinylchloride (PVC). However, the screen cloth **24** can be formed from other types of material as well (e.g. aluminum, stainless steel, etc.) and a coating is not necessarily required. Additionally, the screen cloth **24** does not have to be a "cloth". For example, the screen cloth **24** can appear solid with minute holes. The only requirement with respect to the material and/or the coating of the screen cloth **24** is that a bond between the LCA **26** and the screen cloth **24** can be established once the LCA **26** is cured. Additionally, the screen cloth **24** can be cut to any preferred size and shape.

[0030] The LCA **26** is disposed onto the mounting surface **32** either before or after the screen cloth **24** is placed on the mounting surface **32**. Preferably, the screen cloth **24** is placed on the mounting surface **32** prior to disposing the LCA **26** onto the mounting surface **32**. When this happens, the LCA **26** is applied to the screen cloth **24**, over the mounting surface **32**, where the adhesive permeates through the screen cloth **24** to dispose the adhesive between the screen cloth **24** and the mounting surface **32** of the frame **22**. Preferably, as the LCA **26** is applied, a light source **45** simultaneously applies a concentrated beam of light energy to the LCA **26**. Of course, simultaneous application of the LCA **26** and the beam of light energy is not required. The light source **45** is operatively connected to a metering head **39**. Like the metering head **39**, the concentrated beam preferably remains stationary. This particular light energy is a tacking light energy that is sufficient to tack the screen cloth **24** to the mounting surface **32**. However, the light energy can also be sufficient to input a full cure to the LCA **26**.

[0031] Once the frame **22** is assembled, the screen cloth **24** and the LCA **26** are applied to the mounting surface **32**. The screen cloth **24** and the LCA **26** can be applied to the mounting surface **32** in either order. Referring to **FIGS. 4A-4D**, when the screen cloth **24** is applied to the mounting surface **32** prior to the application of the LCA **26**, the frame **22** is placed on a face of an X-Y table (not shown). Next, the screen cloth **24** is placed onto the mounting surface **32** of the frame **22**. An X-Y table includes two linear positioners that function to move the face, and any object placed on the face, in an X-Y plane. Accordingly, coordinates are programmed into the X-Y table to dictate the position in the X-Y plane the table is to move. The metering head **39** is located above the X-Y table in a stationary position for applying the LCA **26** onto the mounting surface **32** of the frame **22** as the X-Y table moves in the X-Y plane according to the programmed coordinates. While the X-Y table moves, the metering head **39** communicates with the X-Y table to dispense the LCA **26** over mounting surface **32** of the frame **22** and permeate through the screen cloth **24**. The programming of the X-Y table provides flexibility in manufacturing the assemblies. This is because the X-Y table is programmed to know the coordinates of the mounting surface **32** for various frame **22** dimensions and/or combination of frame sections **28**. If the assemblies are made on an automated assembly line, the X-Y table is notified as to which frame **22** is on the X-Y table. The notification is accomplished through a programmed sequence of frame size and frame section **28** combinations or through the scanning of a bar code that corresponds to the particular frame **22** size and frame section **28** combination. However, other methods of notification are

also possible. The ability to sequence allows the assemblies to be made in any order because the X-Y table knows which frame **22** is in place on the table. For example, the X-Y table can apply the LCA **26** to the mounting surface **32** of a frame **22** having four sides and shaped as a square **36** and next apply the LCA **26** to the mounting surface **32** of a frame **22** having eight sides and shaped as an octagon.

[**0032**] Alternatively, referring to **FIGS. 5A-5D**, when the LCA **26** is applied to the mounting surface **32** prior to the application of the screen cloth **24**, the frame **22** is placed on the face of the X-Y table. Coordinates are programmed into the X-Y table to dictate the position in the X-Y plane the table is to move. The metering head **39** is located above the X-Y table in a stationary position for dispensing the LCA **26** onto the mounting surface **32** of the frame **22** as the X-Y table moves in the X-Y plane according to the programmed coordinates. While the X-Y table moves, the metering head **39** communicates with the X-Y table to dispense the LCA **26** over the mounting surface **32** of the frame **22**. The metering head **39** and the light source **45**, which provides the beam of light energy, can be on a common Z-axis, which is typically normal to the X-Y plane. After the LCA **26** is applied to the mounting surface **32**, the screen cloth **24** is placed over the LCA **26** where the LCA **26** permeates the screen cloth **24**. If it is desired, the screen cloth **24** can be pressed into the LCA **26** to ensure the LCA **26** permeates the screen cloth **24**. It is to be appreciated that the LCA **26** is preferably interwoven within and about the screen cloth **24**, i.e., on both sides of the screen cloth **24**, to establish both chemical and mechanical bonds.

[**0033**] Although an X-Y table is described as preferred, other methods of disposing LCA **26** onto the mounting surface **32** can also be used. For example, once the frame **22** is assembled, it can be placed onto a table where and the metering head **39** is programmed to move in an X-Y plane above the mounting surface **32** and dispense the LCA **26** onto the mounting surface **32** in the appropriate locations. Likewise, other methods can also be used to dispense the LCA **26** onto the mounting surface **32**.

[**0034**] After the LCA **26** is disposed onto the mounting surface **32** and the screen cloth **24**, the screen assembly **20** is positioned under a UV lamp **41** which is mounted in and powered by a UV light source **45**. Generally, the UV lamp **41** applies a curing light energy **43** to cure the LCA **26**. To cure, the UV lamp **41** preferably applies UV energy **43** to cure the LCA **26**. The LCA **26** cures in response to light energy **43** in the range of 0.5 to 700 nanometers (nm). This is the range for all visible light. However, the LCA **26** preferably comprises a UV curable adhesive **26** which cures in response to UV energy **43** in the range of 4 to 400 nm. This range includes UVA, UVB, and UVC energy. The UV curable adhesive **26** is formulated to react optimally with UVA energy **43** in the range of 320 to 400 nm. The UVA energy **43** has long wavelengths which allow the deep penetration of the wavelengths into the UV curable adhesive **26**. The deep penetration of the wavelengths of the UVA energy into the UV curable adhesive **26** helps to cure the UV curable adhesive **26** from the inside out which accelerates the time to cure. The time to cure the UV curable adhesive **26** is preferably less than ten seconds. However, it should be understood that although the UV curable adhesive **26** is formulated for optimal reaction to energy **43** in the range of 320 to 400 nm to cure in ten seconds or less, the UV curable adhesive **26** will cure in response to any light energy **43** applied over a longer period of time. It is to be understood that in addition to the wavelength range described above, appropriate cure of the UV curable adhesive **26** to the mounting surface **32** and the screen cloth **24** depends on other factors including, but not limited to, the thickness of the UV curable adhesive **26**, the temperature, the time and intensity of exposure to the UV energy **43**, and other like factors.

[**0035**] Additionally, the UV curable adhesive **26** comprises a resin, an ethylenically unsaturated monomer, and a curing initiator. The UV curable adhesive **26** may also include additives to enhance the processibility and the physical properties of the UV curable adhesive **26**. Furthermore, the UV curable adhesive **26** is preferably 100% solids, i.e., free of solvent. Preferred resins include, but are not limited to, urethane resins, acrylic resins, polyester resins, epoxy resins, and combinations thereof. Preferred ethylenically unsaturated monomers include acrylate-based monomers such as a methacrylate monomer. The curing initiator is important because it is a photo-initiator reactive with the resin and/or the monomer upon exposure to UV energy in the range of 4 to 400 nm. Preferably, the curing initiator is 1-hydroxycyclohexyl phenyl ketone, empirical formula $C_{13}H_{16}O_2$, but other curing initiators are suitable for use in the UV curable adhesive **26**. The resin is typically present in an amount of from 40 to 55 parts by weight, the monomer is typically present in an amount of from 20 to 40 parts by weight, and the photo-initiator is typically present in an amount of from 1 to 9 parts by weight, all based on 100 parts by weight of the light curable adhesive. The preferred viscosity of the LCA **26** at 20 RPM is in the range of 5,700 to 14,000 cP, as determined by ASTM D2556, prior to being cured. This viscosity range is preferred because the LCA **26** can permeate the screen cloth **24** and flow onto the mounting surface **32**. Additionally, this viscosity range prevents the LCA **26** from flowing such that the LCA **26** runs off of the mounting surface **32**.

[**0036**] After the UV curable adhesive **26** has cured, it is possible to dispose a cover layer **40** over the adhesive. This cover layer **40** protects the adhesive from subsequent exposure to light energy because it is possible that subsequent exposure to light energy may degrade the UV curable adhesive **26** over time such that the bond between the mounting surface **32** and the screen cloth **24** degrades. Various cover layers **40** can be used, so long as they do not degrade in the presence of light energy **43**. The cover layer **40** does not degrade in the presence of light energy. The cover layer **40** can be, but is not limited to, caulk or paint, preferably black paint.

[**0037**] The invention has been described in an illustrative manner, and it is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation. Obviously, many modifications and variations of the present invention are possible in light of the above teachings, and the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A screen assembly for a window or a door, said assembly comprising;

a frame defining an opening and including a mounting surface surrounding said opening,

a screen cloth disposed on said mounting surface and covering said opening, and

a light curable adhesive disposed between said mounting surface and said screen cloth and responsive to light energy for adhering said screen cloth to said mounting surface of said frame.

2. A screen assembly as set forth in claim 1 wherein said light curable adhesive is responsive to light energy in the range of 0.5 nm to 700 nm.

3. A screen assembly as set forth in claim 1 wherein said light curable adhesive comprises a UV curable adhesive.

4. A screen assembly as set forth in claim 3 wherein said UV curable adhesive is responsive to UV energy in the range of 4 to 400 nm.

5. A screen assembly as set forth in claim 4 wherein said UV curable adhesive is responsive to UV energy in the range of 320 to 400 nm.

6. A screen assembly as set forth in claim 1 wherein said light curable adhesive has a viscosity in the range of 5,700 to 14,000 cP, as determined by ASTM D2556, before being cured.

7. A screen assembly as set forth in claim 1 wherein said light curable adhesive comprises a resin, an ethylenically unsaturated monomer, and a curing initiator.

8. A screen assembly as set forth in claim 7 wherein said curing initiator is a photo-initiator reactive with said monomer upon exposure to UV energy in the range of 4 to 400 nm.

9. A screen assembly as set forth in claim 8 wherein said resin is present in an amount of from 40 to 55 parts by weight, said monomer is present in an amount of from 20 to 40 parts by weight, and said photo-initiator is present in an amount of from 1 to 9 parts by weight, all based on 100 parts by weight of said light curable adhesive.

10. A method of attaching a screen cloth to a mounting surface of a frame, said method comprising the steps of;

placing the screen cloth onto the mounting surface of the frame,

disposing a light curable adhesive between the screen cloth and the mounting surface of the frame, and

applying light energy to the light curable adhesive to adhere the screen cloth to the mounting surface of the frame.

11. A method as set forth in claim 10 wherein the step of applying light energy to the adhesive is further defined as the steps of first applying only sufficient light energy to tack the screen cloth onto the mounting surface of the frame and thereafter applying sufficient light energy to cure the adhesive.

12. A method as set forth in claim 11 further defined as applying tacking light energy at a first station and applying curing light energy at a second station spaced from the first station.

13. A method as set forth in claim 12 wherein the step of applying tacking energy occurs simultaneously with the step of disposing the adhesive on the mounting surface.

14. A method as set forth in claim 12 wherein the step of applying curing energy is further defined as applying curing energy for less than ten seconds.

15. A method as set forth in claim 10 wherein the step of applying light energy is further defined as applying curing energy for less than ten seconds.

16. A method as set forth in claim 10 wherein the step of placing the screen on the mounting surface of the frame occurs prior to the step of disposing the adhesive between the screen cloth and the mounting surface of the frame.

17. A method as set forth in claim 16 wherein the step of disposing the adhesive further includes the step of permeating the adhesive through the screen cloth to dispose the adhesive between the screen cloth and the mounting surface of the frame.

18. A method as set forth in claim 10 wherein the step of applying the light energy is further defined as applying light energy in a range of **0.5** to **700** nm to cure the adhesive.

19. A method as set forth in claim 18 wherein the step of applying the light energy is further defined as applying light energy in a range of 4 to 400 nm to cure the adhesive.

20. A method as set forth in claim 19 wherein the step of applying the light energy is further defined as applying light energy in a range of 320 to 400 nm to cure the adhesive.

21. A method as set forth in claim 10 wherein the step of disposing a light curable adhesive is further defined as disposing a light curable adhesive having a viscosity in a range of 5,700 to 14,000 cP, as determined by ASTM D2556.

22. A method as set forth in claim 10 further including the step of disposing a cover layer over the adhesive after application of the light energy to the adhesive to protect the adhesive from subsequent exposure to light energy.

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