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O. J. SWENSON

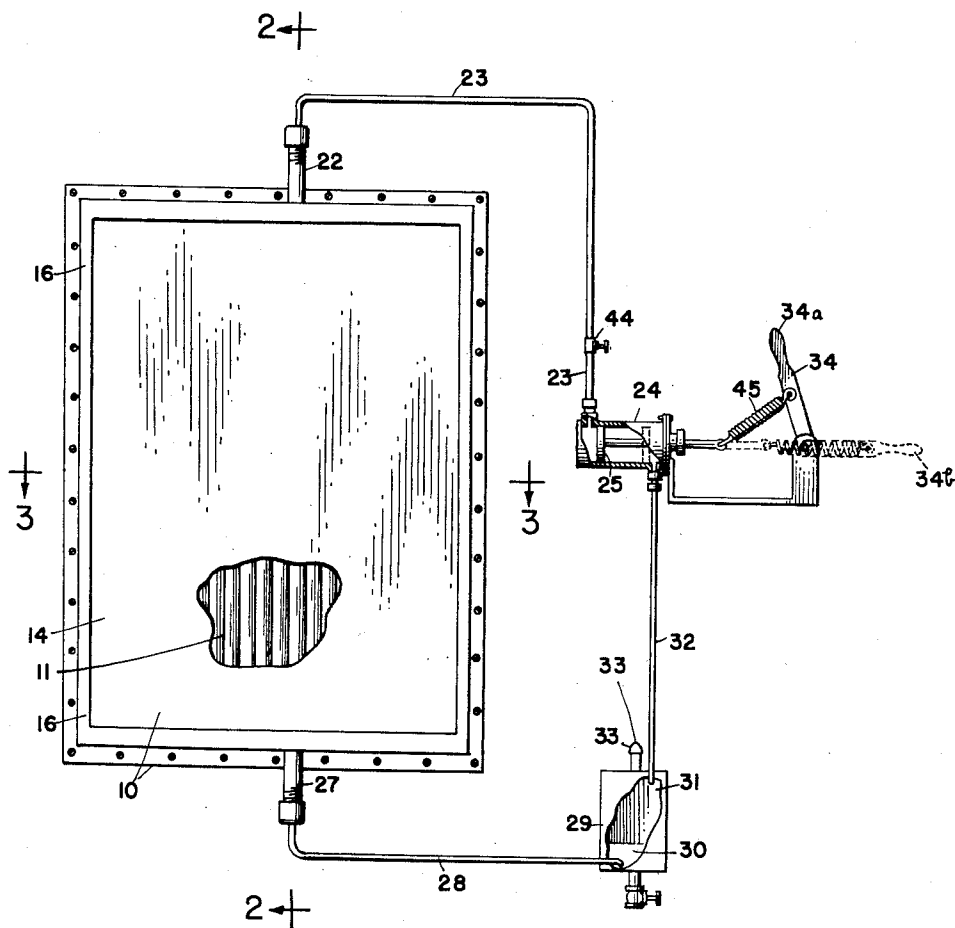
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TRANSLUCENT-TRANSPARENT WINDOW

Filed Aug. 25, 1950

2 Sheets-Sheet 1

FIG. 1



INVENTOR:
OSCAR J. SWENSON
BY *Spencer Johnston*
Cook & Root

ATTYS

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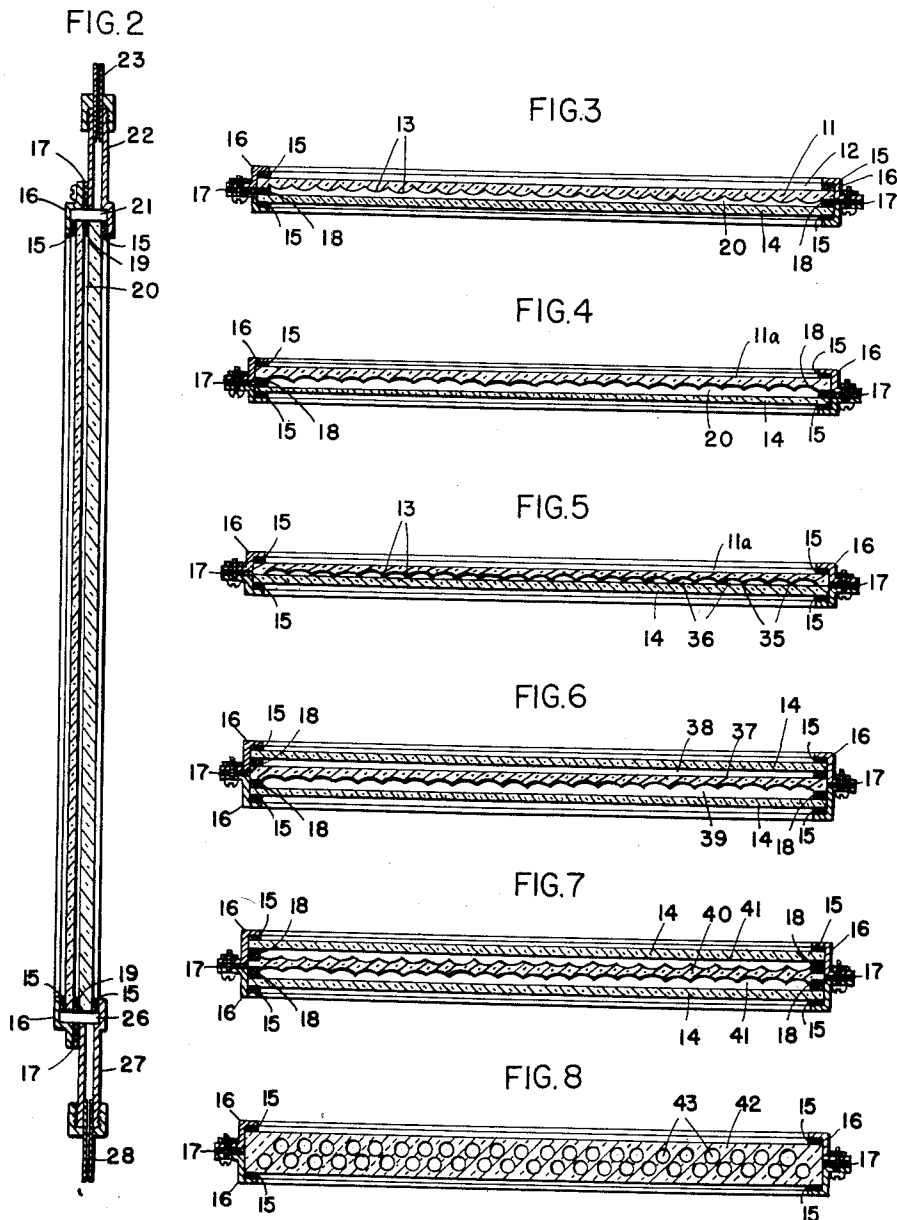
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INVENTOR:
OSCAR J. SWENSON
BY *Spencer Johnston,
Calk & Root*

ATT'YS

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TRANSLUCENT-TRANSPARENT WINDOW

Oscar J. Swenson, Crystal Lake, Ill.

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3 Claims. (Cl. 88—60)

This invention relates broadly to a method for rendering a translucent light transmitting system transparent and for rendering a transparent light transmitting system translucent. More particularly, it relates to a method for rendering a translucent light transmitting system transparent by filling void spaces within said system with a suitable liquid, and for returning said system, at will, to a condition of translucency by removing said liquid from said void spaces.

In the common use of transparent windows and walls in a building, it frequently becomes desirable or necessary to reduce their transparency to provide privacy for the occupants of the building. This change is usually accomplished by covering the transparent window or wall with shades, blinds, or drapes of opaque or semi-opaque materials. Thus the desired privacy is achieved, but only at the sacrifice of the light transmitting properties of the window or wall so covered.

Where the principal use of a window or wall requires privacy in addition to light transmission, a translucent window or wall is generally used. In many cases, however, clear visibility through these walls or windows would be highly desirable at certain times.

With the introduction of the so-called picture windows, the problem of providing for light transmission, privacy, and visibility in the use of these windows has become acute. These relatively large windows are not adapted to be readily covered by a curtain or blind, but rather the general practice today is to cover the window, when privacy is desired, with a large drape of fabric. Not only are these drapes expensive but when in the closed position, sometimes adversely affect the character of the room, and also often reduce the amount of light transmitted by the window below the amount desired.

Prior to my invention, no means were available to change a window from a condition of translucency to one of transparency, or vice versa, except by actually replacing the window in question with one having the desired property, a procedure obviously impractical for making changes for relatively short periods of use under either condition.

I have, therefore, developed a new and novel method for alternately, and at will, and in a very simple, practical, and expeditious manner, rendering a light transmitting system transparent or translucent, thus eliminating the basic objections, while retaining the advantages, of both types of fixed systems. I have also developed a translucent light transmitting system especially adapted for carrying out this method.

My invention, therefore is the method for rendering a translucent light transmitting system transparent, comprising introducing into the system, a liquid having substantially the same index of refraction as the translucent component of the system, and, conversely, to render the said transparent system translucent by removing said liquid from said system.

In addition, I have developed a novel translucent light transmitting system particularly adapted for carrying out

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this method, comprising a translucent component mounted in a sealed unit, a liquid having substantially the same index of refraction as the said translucent component, and means for introducing said liquid into said unit and for removing said liquid from said unit.

The invention will be understood by reference to the following description taken in connection with the accompanying drawing in which is shown a translucent light transmitting system adapted for carrying out this invention. While I have developed the system illustrated in the drawing and described below for carrying out my novel method, it is to be understood that the method is not limited to this particular system alone.

The same reference numerals have been used for the designation of like parts throughout and in the drawing.

Figure 1 is a front elevational, diagrammatic view of the translucent light transmitting system, with a portion broken away to show the translucent component of the system.

Figure 2 is a view in section taken along the line 2—2 of Figure 1.

Figure 3 is a view in section taken along the line 3—3 of Figure 1.

Figure 4 is a view in section of a modification of the system shown in Figures 1, 2 and 3, taken along the line 3—3 of Figure 1, wherein one pane of glass is plane and the other plane-corrugated.

Figure 5 is another modification of Figure 4, wherein one pane of glass is plane and the other plane-corrugated with the high points of the corrugations in contact with the plane surface of the other pane.

Figure 6 is another modification of Figure 4 wherein one pane of glass is plane-corrugated and is positioned between two panes of plane glass, with spaces on both sides of said plane-corrugated pane.

Figure 7 is another modification of Figure 4 wherein a corrugated-corrugated pane of glass is positioned between two panes of plane glass, with spaces on both sides of said corrugated-corrugated pane.

Figure 8 is another modification of Figure 4 showing a monolithic structure of glass with interconnected interior voids positioned in a vertical path.

Referring to the drawings a translucent light transmitting system is illustrated which consists of a unit 10 in which a pane of translucent glass 11 having one smooth surface 12 and the other a contoured or scalloped surface 13 is arranged in spaced and substantially parallel relation to and with a pane of plane transparent glass 14. The panes of translucent glass 11 and transparent glass 14 are joined into a unit 10 by sealing them together around the edges by suitable mechanical means so as to produce a liquid tight joint between the two panes. In Figure 3 is shown one method of forming a mechanical seal wherein gaskets 15 are positioned between the vertical edges of the panes 11 and 14 and a sheet metal frame 16, the frame members being connected by a gasketed joint 17 to permit assembly of the unit. If desired, the panes may be cemented in the frame with a suitable cement such as litharge and glycerine. Low melting solders recently developed for attaching metal to glass can also be used for sealing the glass panes in a suitable frame.

The panes 11 and 14 are mounted in a vertical position and are separated by spacers 18 and 19 to form space 20 between the panes 11 and 14. Spacers 19 are longitudinally discontinuous to prevent sealing the space between panes 11 and 14 at their top and bottom. The top of the frame members 16 is extended sufficiently to form a header space 21 which serves to connect the space 20 and all the void spaces in the contoured surface 13 to a vacuum tube connection 22 at the top of the unit 10. The vacuum connection 22 is connected by vacuum tube 23

to a source of vacuum such as a vacuum pump 24, having a piston 25.

The bottom of the frame members 16 is extended below the bottom edges of panes 11 and 14 to form a header space 26 which connects the space 20 and all the void spaces of the contoured surface 13 to a liquid tube connection 27 at the bottom of unit 10. The liquid tube connection 27 is connected by a tube 28 to the bottom of a liquid reservoir 29, positioned below the panes 11 and 14 in such a manner that there is an unobstructed path for liquid to pass from the reservoir 29 into the space 20 and the voids of the contoured surface 13. The vapor space 31 in the reservoir 29 is connected by tube 32 to vacuum pump 24 at a point on the opposite side of the piston 25 from the point of attachment of vacuum tube 23. A vent from the vapor space 31 to the atmosphere is provided in cap 33, the latter also serving to permit addition of liquid to the reservoir 29. The vent consists of a small hole 33a in cap 33.

The liquid 30 is contained in reservoir 29 and is desirably of low viscosity, and has an optical index of refraction substantially the same as that of the glass having the contoured surface 13. A liquid consisting of 45 parts by volume of carbon tetrachloride and 100 parts by volume of ortho-dichlorobenzene is particularly suitable for one of the specific glass compositions used in pane 11. In the case of the two liquids cited, carbon tetrachloride has an index of refraction lower than most common glass compositions and ortho-dichlorobenzene has an index of refraction higher than most common glass. Since glass with different composition and different indices of refraction can be used for constructing pane 11 and its contoured surface 13, it is desirable and in some cases necessary to vary the liquid composition from that cited to give it a refractive index substantially the same as that of the glass in the contoured surface 13. The exact proportions of carbon tetrachloride and ortho-dichlorobenzene to use in combination with a specific type of glass can be determined readily by placing a small sample of the glass in a test tube containing a measured amount of one of the two pure liquid cited, and adding the other in measured small increments, such as from a burette, until the submerged portion of the glass sample is no longer visible. The proportion of the two liquids present in the test tube at the time this condition is reached is the proportion of the two liquids which it is desirable to use to carry out the method with a unit containing a pane 11 constructed of glass having the same composition as the sample tested in the manner described.

In addition to having the optical properties required for the method, carbon tetrachloride and ortho-dichlorobenzene are also non-flammable in character, and thus their use as described minimizes any possible fire hazard which could result from a broken or leaking window if a flammable liquid were used instead. It is obvious that there are a large number of other liquids than those cited from which mixtures having the necessary optical and desirable other properties can be made. There are also possible cases where the glass composition in the contoured surface 13 could be sufficiently well matched in optical index by a pure liquid. Various solutions of solids in liquids could also be used. It is therefore not intended that the method described should be limited to the use of a liquid composed of carbon tetrachloride and ortho-dichlorobenzene.

The vacuum source 24 must be capable of reducing the pressure in the interior space 20 between the panes 11 and 14 sufficiently to draw the liquid 30 from the reservoir 29 into said space and up to the header space 22.

To operate the above-described unit in order to carry out my novel method, the piston 25 of vacuum pump 24 is pulled to the right, as viewed in Figure 1, by moving

handle 34 from its position at 34a, indicated by the solid outline, to its position at 34b, as indicated by the dotted outline. The spring 45 is provided as a linkage between handle 34 and piston 25 to permit the handle 25 to move at a rate determined by the rate that liquid is drawn into the space 20. The movement of the piston 25, under the impetus imparted manually to the handle 34 and in turn by spring 45, causes a reduction in pressure within the space 20 sufficient to cause liquid 30 to flow from the reservoir 29 through liquid tube 28 into space 20. The liquid 30 fills the space 20 and the voids or depressions and irregularities of the contoured surface 13 which cause the properties of translucency of pane 11. Since the liquid 30 has substantially the same refractive index as the glass with the contoured surface 13, the diffractive effect of the contoured surface 13 is neutralized or eliminated, so the light path through the unit 10 becomes optically homogeneous, thus rendering the unit transparent.

The function of the transparent glass pane 14 in the above-described drawing is merely to create a chamber which permits flooding of the contoured surface 13 of the opposing pane 11 with the liquid 30.

From an understanding of the principles involved in the above-described method, it will be apparent to those skilled in the art, that the extent and shape of the space or spaces within the unit for carrying out the method can be varied considerably and that a large number of alternative constructions can be used. Without intending to limit the method to only those illustrations given herein, a few of them are cited below merely as examples.

In Figure 4 the unit 10 is composed of a pane of plane transparent glass 14 and a pane of plane-corrugated glass 11a, which panes are spaced apart by spacers 18 and 19 to form space 20.

In Figure 5, the panes 14 and 11a are so positioned that the high points of the corrugations or scallops 35 are in contact with the surface of pane 14 forming a multiplicity of vertically disposed spaces or troughs 36 which are interconnected at their upper and lower extremities by header spaces 21 and 26 respectively. The arrangement depicted in Figure 5 has a particular advantage, as will be described later.

In Figure 6 a pane of plane-corrugated glass 37 is positioned in spaced relationship between two panes of plane transparent glass 14, forming two spaces 38 and 39 for liquid.

In Figure 7 is shown a corrugated-corrugated pane of glass 40 positioned in spaced relationship between two panes of plane transparent glass 14 forming spaces 41, 41.

In Figure 8 is shown a monolithic glass structure 42 with interior voids 43 vertically disposed and interconnected at their upper and lower extremities by header spaces 21 and 26, respectively.

While the above description covers only the step whereby a translucent light transmitting system is rendered transparent, it is also possible with the system described to return said system to a condition of translucency. This is accomplished by causing the liquid 30 to drain from the interior space 20 of the unit 10 back into the reservoir 29 by releasing the vacuum held on the said space by the vacuum source 24. The said vacuum is released by moving the handle 34 from its position at 34b back to its original position at 34a. By proper adjustment of the valve 44, the rate at which the vacuum is released and thus the rate at which the liquid 30 drains from the space 20 can be so controlled that a partial vacuum is maintained in space 20 throughout the draining period. This possibility has an important practical purpose in connection with the construction of the system for carrying out my novel method as will be explained below.

When the space between the panes of glass or other

light transmitting material used in applying my invention is filled with a liquid as described above, a hydrostatic pressure is created which tends to separate the said two panes confining the liquid. For this reason, it is desirable to cause the liquid 30 to flow into the space 20 by connecting the top of said space to a source of vacuum as described above, rather than to resort to the alternative procedure of introducing the said liquid under pressure at the bottom of space 20. The vacuum causes the pressure on the exterior surfaces of the said panes to be greater than on their interior surfaces, and, as a result, the two panes deflect toward one another. In relatively small panes this deflection is not serious. In larger panes, however, this deflection and resulting stress may be so great as to cause the panes to rupture. To solve this problem of deflection of the liquid-confining panes, I particularly recommend the structure shown in Figure 5 wherein the high points of the contoured surface 13 of the translucent pane 11 contact the surface of the opposing pane 14, to be used in combination with the procedure for introducing the liquid 30 into the space 20 whereby a source of vacuum is connected to the top of said space, together with the procedure of controlling the rate of draining liquid 30 from the space 20 so as to always maintain a partial vacuum within said space during the draining period. By following this procedure with the construction indicated in Figure 5, the panes will always tend to deflect inwardly toward one another, but will be prevented from actually doing so by the reaction of the high points of the contoured surface 13 against the surface of the opposing pane 14, with which they are in contact. Obviously, it would be much more difficult to prevent deflection of the said panes if the forces acting on them caused them to deflect outwardly instead of inwardly. The advantage of the above-described procedure which always results in a tendency of the said panes to deflect inwardly towards one another, to permit the prevention of actual deflection in the simple and practical manner described, thus becomes apparent.

The problem of deflection of the panes as described above can be solved in another manner by using a monolithic structure of the type illustrated in Figure 8 to carry out the said novel method, since the void spaces therein can be made sufficiently small and the structure sufficiently strong to eliminate deflection of the surfaces of the structure as a practical problem. In using the said type of structure the liquid 30 can be introduced into the said void spaces either by the application of vacuum to the top of unit 10 as described above, or the liquid 30 can be introduced into the said void spaces under pressure through tube 28 at the bottom of unit 10.

Having thus indicated a number of specific examples of constructions for carrying out my novel method, the broad range of possibilities in this connection can be indicated by the statement that the said method can be carried out in connection with any translucent light transmitting system in which the non-planar surfaces, whose diffractive effect causes the system to be translucent rather than transparent, are so arranged that they can be flooded with a liquid having substantially the same index of refraction as the said non-planar surfaces, thus neutralizing the said diffractive effect to render the said system transparent, and, conversely, are so arranged that the said liquid can subsequently be removed from said surfaces to restore the said system to its original condition of translucency. Thus the method is not limited to the use of panes or structures as illustrated, nor to structures of glass alone as illustrated and described, but rather can be carried out in systems constructed in a large number of configurations as well as from a large number of clear light transmitting materials, another example other than glass being the various organic chemical plastics now available.

From the above description, it will readily be appreciated that my novel method now makes it possible to

repeatedly and expeditiously render a translucent light transmitting system transparent and alternately at will to return the said system to its original translucent condition in an entirely practical manner, thus serving an important and useful purpose.

Because of the increasing usage of light transmitting structures, such as picture windows, in external construction of buildings, and light transmitting walls in interior construction, both with inherent disadvantages eliminated by my invention, my novel method becomes particularly important and useful, and in addition offers opportunities for application of light transmitting systems in a manner heretofore not possible.

The invention is hereby claimed as follows:

1. A light-transmitting structural window unit comprising at least two opposed substantially parallel sheets of a light-transmitting material arranged to form a window and mounted in a unit sealed along the edges of the sheets, the outer said sheets each having a smooth planar transparent outer surface, one of said sheets having at least one inner surface which is continuously scalloped throughout the light-transmitting area of said window to alone render the window normally translucent and incapable of transmitting a clear image, the high points of said scalloped surface contacting the sheet opposite thereto but the latter and the scalloped sheet not being united in the light-transmitting area of said window, thereby preventing deflection of said scalloped sheet and said opposite sheet towards each other, spaces being formed between said scalloped sheet and said opposite sheet corresponding to the troughs on said scalloped surface and between said high points, means for applying a vacuum to said spaces to introduce thereinto a transparent liquid having substantially the same index of refraction as the material from which said scalloped surface is composed, whereby said window is rendered transparent, and means for removing said liquid from said spaces, whereby said window becomes translucent.

2. A light-transmitting structural window unit comprising two opposed substantially parallel sheets of a light-transmitting material arranged to form a window and mounted in a unit sealed along the edges of the sheets, each said sheet having a smooth planar transparent outer surface, the inner surface of one of said sheets being continuously scalloped throughout the light-transmitting area of said window to alone render the window normally translucent and incapable of transmitting a clear image, the high points of said scalloped surface contacting the other said sheet but the sheets not being united in the light-transmitting area of said window, thereby preventing deflection of said sheets towards each other, spaces being formed between said sheets corresponding to the troughs on said scalloped surface and between said high points, means for applying a vacuum to said spaces to introduce thereinto a transparent liquid having substantially the same index of refraction as the material from which said scalloped surface is composed, whereby said window is rendered transparent, and means for removing said liquid from said spaces, whereby said window becomes translucent.

3. A light-transmitting structural window unit comprising a plane transparent glass window pane in opposed contacting substantially parallel relationship with a plane-corrugated translucent glass window pane, said panes being arranged to form a window and mounted in a unit sealed along the edges of the panes, the inner surface of said plane-corrugated window pane being continuously corrugated throughout the light-transmitting area of said window to alone render the window normally translucent and incapable of transmitting a clear image, the high points of said corrugated surface contacting said plane window pane but the panes not being united in the light-transmitting area of said window, thereby preventing deflection of said panes towards each other, spaces being formed between said panes corresponding to the troughs

on said corrugated surface and between said high points, a transparent liquid in said spaces having substantially the same index of refraction as said plane-corrugated window pane, means for applying a vacuum to said spaces to introduce said liquid therein, whereby said window is rendered transparent, and means for removing said liquid from said spaces, whereby said window becomes translucent.

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