Dec. 22, 1959 B. H. BETTCHER 2,918,023

REINFORCED, THERMAL INSULATING, CONDENSATION-PROOF AND LIGHT ADMITTING MEMBER

Filed Jan. 27, 1955 2 Sheets-Sheet 1

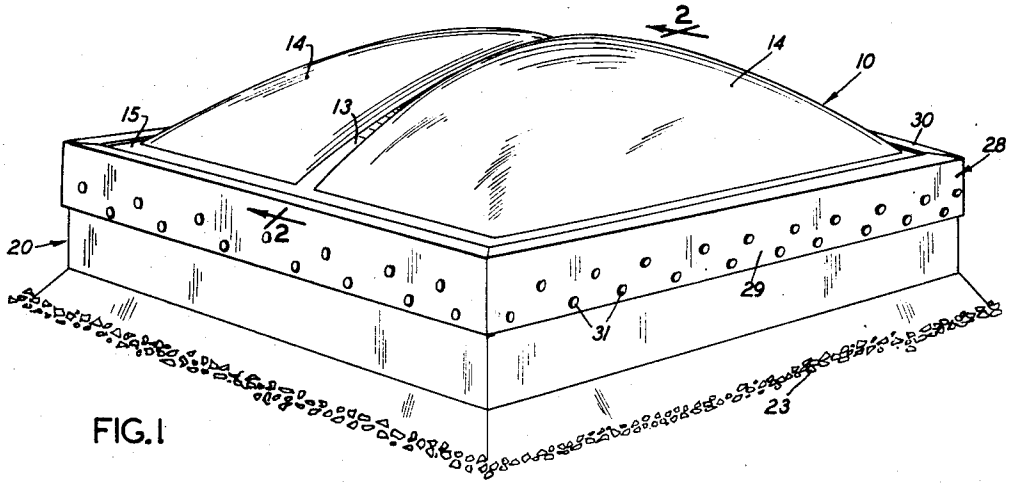


FIG. 1

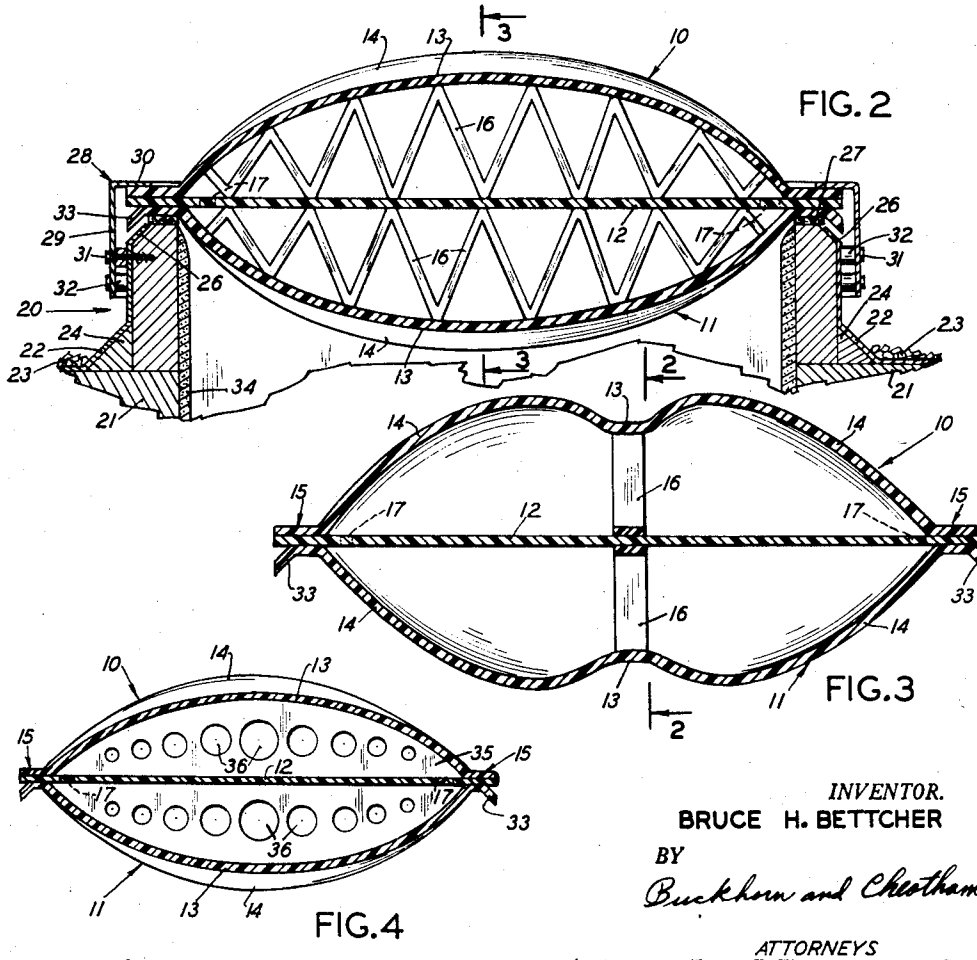


FIG. 2

FIG. 3

FIG. 4

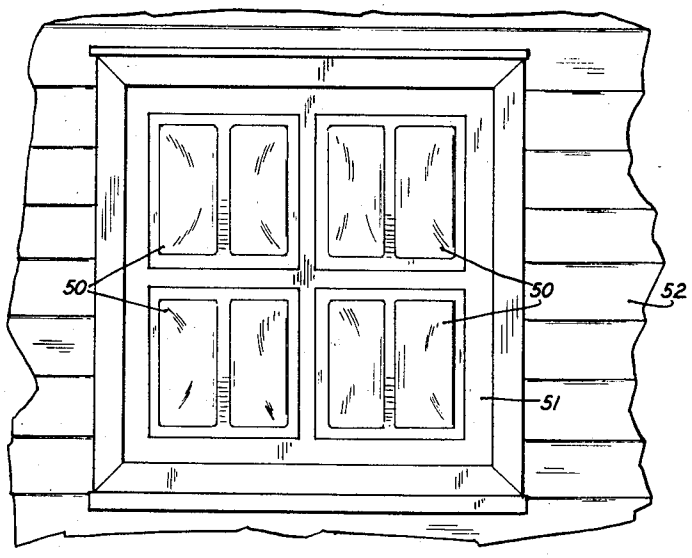
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FIG.5



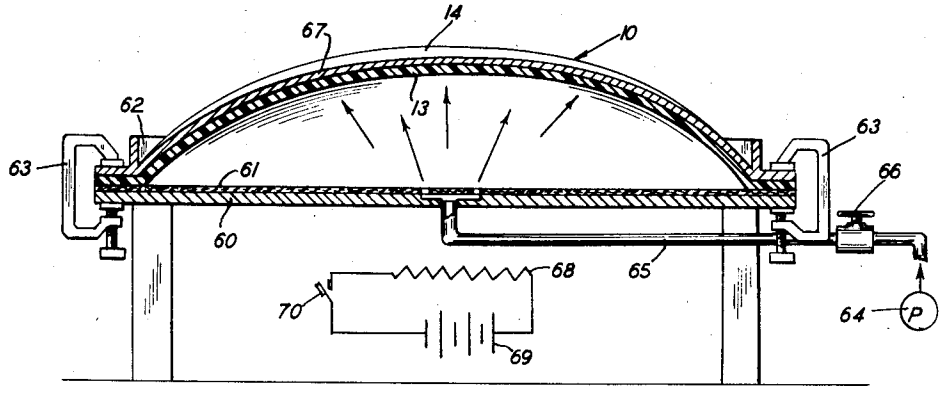


FIG.6

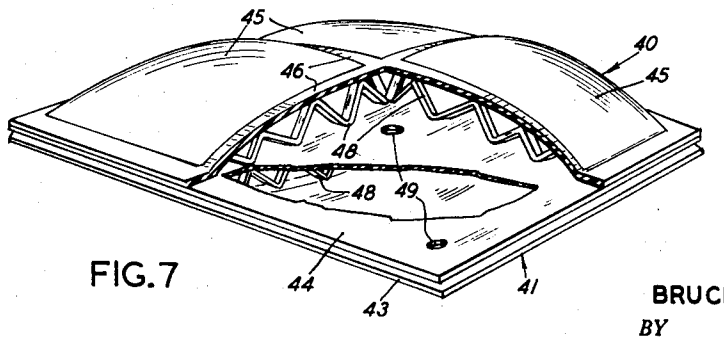


FIG.7

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2,918,023

REINFORCED, THERMAL INSULATING, CONDENSATION-PROOF AND LIGHT ADMITTING MEMBER

Bruce H. Bettcher, Portland, Oreg.

Application January 27, 1955, Serial No. 484,488

2 Claims. (Cl. 108—16)

My present invention comprises an improvement upon the skylight disclosed and claimed in my copending application, Serial No. 461,066, filed October 8, 1954.

The skylight of the present invention is one which may be easily fabricated of readily obtainable light transmitting thermoplastic sheet material and easily installed by unskilled workmen, which is thermally insulating, soundproof, leakproof and condensation-proof. The principal object of the present invention is to provide a skylight of the foregoing character which may be made in large sizes, and yet will withstand extreme temperature and pressure changes. A further object of the present invention is to make a skylight which may be made in any size, large or small, and which may be evacuated to a higher degree than possible with the skylight of my previous application, so as to render the same more effective as an insulator and sound barrier.

A further object of the present invention is to provide skylights of the foregoing character which may be made of sheet material of the same thickness throughout, whereas with the skylight disclosed in my preceding application it was necessary to increase the thickness of one or more sheets of the plastic material employed as the dimensions of the skylight were increased. With the present invention large, economical purchases of a single thickness of plastic sheet may be made since all sizes of skylights may be made of the same thickness material.

Further objects and advantages of the present invention will be more readily apparent from inspection of the following specification taken in connection with the accompanying drawings and wherein like numerals refer to like parts throughout.

In the drawings,

Fig. 1 is a view, in perspective, of an installed skylight construction;

Fig. 2 is a vertical section taken substantially along line 2—2 of Figs. 1 and 3;

Fig. 3 is a transverse section through the skylight itself, taken substantially along line 3—3 of Fig. 2;

Fig. 4 is a vertical section through a modified form of skylight, taken along the same plane as Fig. 2;

Fig. 5 is a partial view of the side of a building showing the skylight installed as a window light;

Fig. 6 is a vertical section, in somewhat schematic representation, through apparatus employed in the manufacture of elements of the skylight; and

Fig. 7 is a partially broken view, in perspective, of a further modification of the present invention.

The skylight disclosed in Figs. 1, 2 and 3 comprises three rigid, translucent, thermoplastic sheet members **10**, **11** and **12**, which are provided with marginal areas lying in planes and adhered to each other throughout to form an hermetically sealed, hollow body. Each of the sheets is composed of a translucent, thermoplastic material, such as methyl-methacrylate, known commercially as Plexiglas. Such sheet material may be obtained in sheets of standard width and length, such as twenty-four inches by twenty-four inches, and on up to forty-eight inches by seventy-

two inches, and in thicknesses of one-eighth inch up to one-quarter of an inch or thicker, and may be clear, or clouded, either type being available in various tints. All three sheets employed in a single skylight are preferably of the same thickness, and may be as thin as one-eighth of an inch for small skylights, and may be up to three-eighths of an inch, or more, in thickness for large sizes. A feature of my invention is that most skylights, ranging in maximum dimensions from twenty-four inches up to the largest dimension for which standard sheets are available, such as seventy-two inches, may be made of one-quarter inch sheet material. The skylight may be formed to have any convenient outline, but the preferred forms are square and rectangular since this eliminates cutting the commercially obtainable sheets, simplifies fabrication of skylight curbs, and eliminates any necessity for building curved wooden shapes such as would be necessary for installing round, oval or other shapes of skylights.

The outer dome-shaped members **10** and **11** are formed so as to have a plurality of outwardly facing, convex sections, so as to have the maximum rigidity and resistance to crushing when the hollow body is partially vacumized.

Thus, each of the sheets **10** and **11**, for ordinarily encountered skylights, is subdivided along an arched, transverse, narrow depression indicated at **13** into two substantially equal, outwardly convex portions **14**. The depressions **13** are preferably flattened along their bottoms and lie parallel to the flat marginal areas which are sealed together at **15** to form the hollow body. A pair of strips of thermoplastic sheeting are formed into an accordion pleated truss member indicated at **16**, and the opposite bends thereof are cemented to the inner surfaces of the depressions **13** and to the opposed surfaces of the intermediate sheet **12** to form a double truss extending across the interior of the hollow body, the arches of the truss being the bottoms of the depressions **13**, and the central chord comprising the sheet **12**. The truss is of sufficient strength so as to be indesructible and unyielding under pressures of the highest order which might be encountered. Therefore, the unsupported spans of the sheets **10** and **11** subjected to loading under differences between internal and external pressures are reduced from the entire width of the skylight to half the width of the skylight. The unit loading on a skylight of this character may be far more than double the unit loading which a single span skylight will endure. The intermediate sheet **12** is preferably provided with openings **17** therethrough so that pressures throughout the interior will be equalized.

It will readily be appreciated that the overall thickness of a skylight formed in accordance with my present invention in its preferred form is less than would be the case if the central depressions were not provided, and the strength thereof is materially increased over the strength of an untrussed skylight made of considerably thicker material. However, the insulating value is still greatest and sufficient toward the center of the skylight where the greater need for insulation exists.

The skylight is illustrated as being applied to a skylight curb **20** surrounding a light well in the roof of a building. The curb **20** has its rim lying in a single plane and is quickly and easily constructed as a rectangle of wooden beams surrounding a square opening in the roof decking **21**. Any suitable weatherproofing material may be employed on the roof, such as the roof felt **22** to which asphalt and gravel is applied, as indicated at **23**. The roofing felt should extend up to the top of the curb, preferably passing over a coping strip **24**; and the upper, outer edge of the curb is preferably chamfered, as indicated at **26**. A gasket **27** of moistureproof material such as neoprene-bound cork, is laid on the rim of the curb and, preferably, adhered thereto, and the skylight is then placed on the gasket. A plurality of retaining rails **28**,

each comprising an angle bar of lightweight, stainless steel or other noncorrosive alloy, and having a long, vertical flange **29** and a relatively short, horizontal flange **30**, are fixed to the curb in a manner to retain the skylight. The upper flange **30** overlies the margin of the skylight, and the vertical flange **29** extends alongside of and in outwardly spaced relation to the outer edge of the skylight and the outer surface of the curb. The retaining rail is preferably maintained in position by suitable means such as twist nails **31** which pass through neoprene washers **32** to space the rail from the curb and provide a drain passage therebetween. The retaining rail is provided in linear sections, the ends of which may be mitered to form neat joints, or merely overlapped as desired. The meeting edges of the sections of retaining rail may be suitably fastened together to provide a stronger structure, but it is not required that the space between the retaining rail and the skylight be sealed against moisture. Any water which runs beneath the flange **30** will drip from the edge of the skylight and fall through the space between the retaining rail and the curb. Preferably, the lower sheet **11** is provided with a downwardly turned, angular drip flange **33** to further insure against water running back between the skylight and the curb. The drain passage is quite narrow, so that there is not much tendency for wind to blow water back between the drip flange and the roofing felt, and if any is blown back it will be blocked by the gasket **27**. It is emphasized that the retaining rail is merely a retainer, as distinguished from expensively installed flashing or other weatherproofing means. The interior of the light well may be smooth, since there are no expensive interior gutters or drain tubes leading to the outside of the curb. Therefore, the interior surfacing such as plaster, indicated at **34**, may be easily applied.

A modification of the skylight is illustrated in Fig. 4, in which it is seen that three sheets **10, 11** and **12** exactly as previously described, are formed with convexities **14** and intervening depressions as at **13**, and interior truss members are provided, in this case in the form of a pair of flat sheets of thermoplastic material indicated at **35**, the edges of which are respectively cemented to the sheets **10, 11** and **12**. Preferably, such sheets are provided with openings **36** so as to lighten the construction as much as possible and permit free flow of air throughout the entire construction.

A further modification is illustrated in Fig. 7, in which the outer sheets **40** and **41**, the latter being provided with a drip flange **43** as previously described, are cemented at their edges to an intermediate plain sheet **44**. In this instance each of the outer sheets **40** and **41** are subdivided into four substantially equal, convex portions **45** separated from each other by depressed, transverse areas indicated at **46**, in the form of a cross. A plurality of internal truss members **48** are cemented in position between the intermediate sheet and the depressed areas as previously described, so as to subdivide the hollow body into four spans instead of one large span. The number of subdivisions may be as desired, and the skylight may comprise several spans along the length of a long, rectangular skylight. The form of trussing may vary, as previously described. As previously described, the intermediate sheet **44** is provided with a plurality of openings **49** to equalize pressures and permit air to flow throughout the construction.

The versatility of the present invention is illustrated in Fig. 5 wherein it is seen that a plurality of small skylights **50** constructed in accordance with the present invention may be retained in a frame, such as a window frame **51**, which is mounted in an opening in the wall **52** of a building. Such a construction is of particular utility in bathroom windows, where light but not visibility is desired, or in factory buildings, or in other installations where glass brick is now employed. The term "skylight" as used herein is meant to include such constructions.

The skylight thus formed is a pillow-shaped, air impervious construction, subdivided into stress areas of lesser extent than the entire surface area thereof, and providing a soundproof, thermally insulated, and condensation-proof construction. Tests have demonstrated that whereas a single wall skylight may have moisture condensed on its inner surface when the outside temperature is below forty degrees Fahrenheit and the inside relative humidity is within normally encountered ranges, the present construction will prevent condensation if the temperature drops below zero degrees Fahrenheit, unless the inside relative humidity should be far in excess of normal conditions, and even under abnormal conditions condensation is slight. The interior of the pillow-shaped body is preferably maintained under partial vacuum. The thermal insulating qualities of a vacuumized space are well known, it being sufficient to state that thermal conductivity through a single walled skylight is substantially four times that through a skylight formed in accordance with the present invention and vacuumized to six or seven inches of mercury, at sea level. Sound transmission through the present invention is correspondingly reduced. The improved subdivided skylight disclosed in the present application may be vacuumized to a much higher degree, which has been found desirable in certain localities. For example, some cities in the United States are situated above four thousand feet, and as such are subjected to extreme changes in temperature and atmospheric pressure. Under such conditions implosion may occur if the extent of vacuumizing is excessive or explosion may occur if the body has not been vacuumized enough. Furthermore, thermal insulating value may be lost, particularly when the air temperature is excessively low and the sun is shining directly on the skylight. By effectively subdividing the skylight into small stress areas, the skylights may be vacuumized to have six to eight inches of mercury vacuum pressure at average conditions at high elevations.

The outer sheets of the skylight are formed as described in my application identified above, by slightly modified apparatus. The flat sheet of thermoplastic material is heated to a floatable condition, and is then clamped to a table **60** having a felt covering **61** thereon, by means of a rectangular angle bar frame **62** and C-clamps **63**. Air under pressure, supplied from a suitable source such as the pump **64**, is admitted through the center of the table by means of a pipe **65** under control of a valve **66**, so as to blow the sheet into a dome shape. In this instance the frame **62** is provided with a crossbar **67** which holds the center transverse portion of the sheet to the shape desired for the depressed area **13**, and pressure is continued until the convex areas **14** are provided. The air and table may be maintained in heated condition, such as by means of the resistance heater **68** connected to a source of current **69** and controlled by a switch **70**. It is to be appreciated that the frame may be provided with transverse bars **67** to provide the number of depressed areas required, and that they may be crossed in order to form a skylight such as illustrated in Fig. 7.

When forming sklights embodying trusses such as the pleated strips **16**, the strips are formed to shape by heating and bending. A suitable adhesive is applied to the contacting bends of the strip **16** and it is fitted into place in the outer sheet. Adhesive is applied to the marginal areas and bends of a pair of such subassemblies and the two are then clamped to the central sheet. The same procedure is followed when using internal struts such as illustrated in Fig. 4. As illustrated and described in the above-identified copending application, air is blown through the interior and around the exterior of the skylight until all solvent is evaporated, annealing of the sheets is effected, then the vacuum is drawn and plugs applied to the openings through which air was circulated and the vacuum drawn.

Having illustrated and described a preferred embodiment of the present invention, it should be apparent that the same permits of modification in arrangement and detail. I claim as my invention all such modifications as come within the true spirit and scope of the appended claims.

I claim:

1. A skylight comprising a central, flat sheet of light transmitting material, two dome-shaped members of air impervious, light transmitting sheet material placed on opposite sides of said central sheet to form a pillow-shaped skylight subdivided transversely across the interior thereof by said flat sheet, said dome-shaped sheets each having a continuous, flat margin hermetically sealed to the marginal portions of the adjacent surfaces of said central sheet throughout their extent, and light transmitting truss members secured respectively to the opposite surfaces of said central sheet and to the inner surfaces of said dome-shaped members, said truss members being in alignment with each other and subdividing said skylight into stress areas of less extent than the exent of the skylight, the interior of said skylight being under partial vacuum, and said central sheet having an opening therethrough for equalization of pressures on opposite sides thereof.

2. A skylight comprising a pair of substantially identical, dome-shaped, light transmitting sheet members disposed in opposed reverse relation to each other to form a pillow-shaped, hollow skylight, a flat sheet subdividing the interior of said skylight with the edges of said members and said flat sheet being hermetically sealed to each other throughout whereby said skylight may be placed under vacuum, said flat sheet having an opening therethrough for equalization of pressures on opposite sides thereof, and light transmitting truss members secured respectively to the opposite surfaces of said flat sheet and to the overlying inner surfaces of said dome-shaped members to form therewith a double truss extending across the interior of the skylight, said dome-shaped members each being subdivided into smaller, outwardly convex sections by arched depressions extending across the extent of the skylight, and said truss members each being secured to said dome-shaped members along the bottoms of said depressions.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,918,023 December 22, 1959

Bruce H. Bettcher

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 22, for "vacumized" read -- vacuumized --; line 38, for "indesructible" read -- indestructible --; column 4, line 42, for "floatable" read -- flowable --.

Signed and sealed this 31st day of May 1960.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

UNITED STATES PATENT OFFICE

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