Oct. 25, 1960 M. LEVENSON 2,957,210

CAVE WINDOW

Filed March 11, 1959 2 Sheets-Sheet 1

Fig - 1

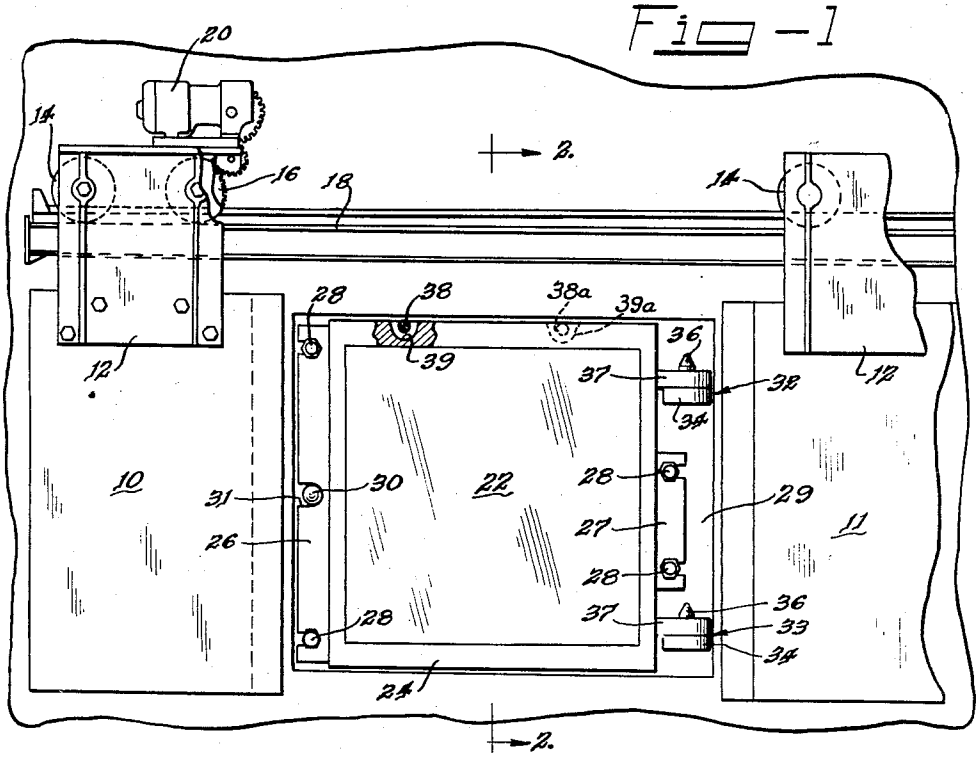


Fig - 5

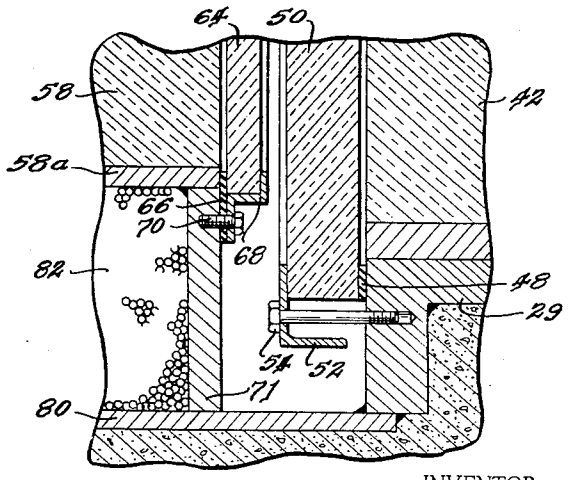
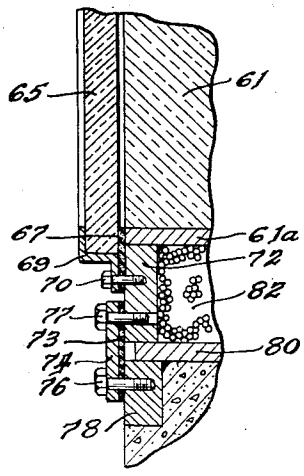


Fig - 4



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CAVE WINDOW

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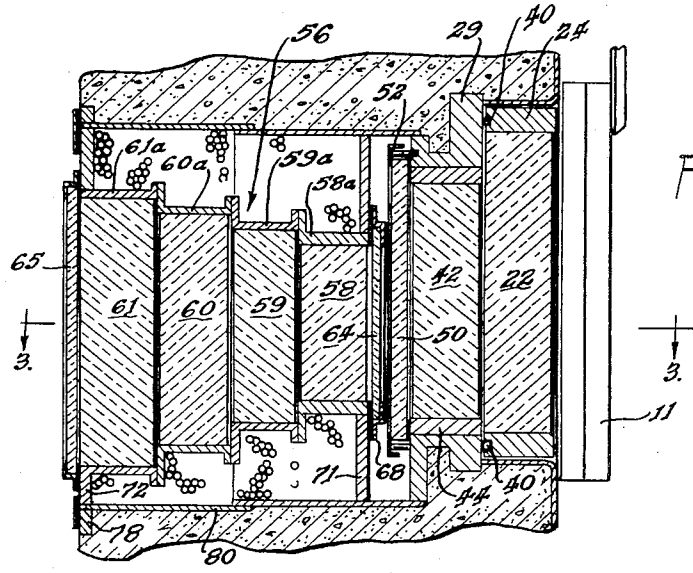

Fig-2

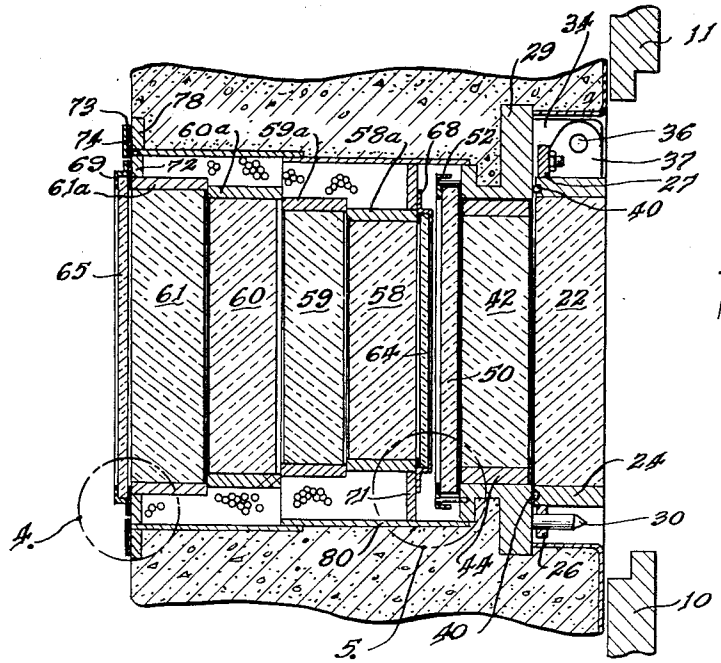

Fig-3

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United States Patent Office 2,957,210 Patented Oct. 25, 1960

2,957,210

CAVE WINDOW

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Filed Mar. 11, 1959, Ser. No. 798,793

2 Claims. (Cl. 20—40)

This invention relates to a window structure for use in highly radioactive areas where thick windows are essential.

It is an object of this invention to assemble cave window components in a configuration that will greatly improve the utilization of the glass involved.

It is also an object of this invention to enlarge the field of view for thick cave windows.

Caves and cave windows have been in general use for several years. However, with the development of melt-refining methods for processing irradiated fuel elements, higher and higher levels of radiation will be encountered. Thicker windows will be needed to protect personnel from the penetrating gamma radiation.

It is well known that gamma radiation causes glass to darken and that the rate of darkening increases as the intensity of the gamma radiation increases. For radiation levels as high as 10^6 r./hr., for example, the accelerated rate of radiation damage would necessitate frequent replacement of the present type of cave windows. The cost of such frequent replacement would be prohibitive, especially where a number of window units are involved.

Conventional cave windows are either rectangular in shape or are formed with successively larger panes toward the exposure side of the window. When windows with these configurations are expanded to a thickness of five feet, for example, either of two choices are possible. The first is to settle for a smaller field of view, or the second is to obtain a large field of view by exposing large and expensive panes of glass to the damaging radiation.

For a better understanding of this invention, reference is made to the accompanying drawings in which:

Fig. 1 is a front elevation of the window structure of the present invention from the side exposed to radiation;

Fig. 2 is a vertical sectional view of the window structure taken along a line 2—2 of Fig. 1;

Fig. 3 is a horizontal sectional view of the window structure taken along line 3—3 of Fig. 2;

Fig. 4 is an enlarged fragmentary view of the portion within the area 4 on Fig. 3; and

Fig. 5 is an enlarged fragmentary view of the portion within the area 5 on Fig. 3.

As shown in Fig. 1, a metal shutter 10 is joined by a supporting member 12 to wheels 14 and 16 which roll on a track rail 18. The wheel 16 is gear-driven by a remotely operated motor 20. A second metal shutter 11 is similarly supported and operated.

An outer expendable window pane 22 is supported

by a frame 24 with extensions 26 and 27 which are secured by bolts 28 to a housing 29. The extensions 26 and 27 not only serve to anchor the frame 24 but also provide means for optically aligning the window pane 22. This is accomplished by tightening each of the bolts 28 to make the surfaces of the pane 22 parallel to the surfaces of the other window panes. A guide pin 30 is attached to the housing 29 to center the frame 24 by engaging a slot 31 in the extension 26.

Two hinges 32 and 33 support the frame 24. Each hinge has a lower member 34 anchored to the window structure housing 29, a pin 36 fixed to lower member 34, and an upper hinge member 37 attached to the frame 24 and having a hole for receiving the pin 36.

Two bars 38 and 38*a* are fixed to the top of the frame 24 across recesses 39 and 39*a* therein to receive the hooks of a crane, not shown, by which the window pane 22 and frame 24 are installed or removed.

As shown in Fig. 2, the window frame 24 compresses a dust seal 40 against the window structure housing 29. A second expendable window pane 42 and its frame 44 slide into a recess in the window structure housing 29 in a direction transverse to its thickness or smallest dimension.

As shown in Fig. 5, a gastight seal 48 is compressed between a two-inch thick window pane 50 and the housing 29 by an angle frame 52 which is anchored with bolts 54 to the housing 29.

As shown in Figs. 2 and 3, a permanent, oil-filled subassembly 56, which forms the balance of the window structure, comprises glass panes 58, 59, 60 and 61, with their frames 58*a*, 59*a*, 60*a*, and 61*a* joined as by welding and with a thin glass pane 64 on the inner side and a thin glass pane 65 on the observer side. The panes 58, 59, 60, and 61 are oblong and increase progressively in length (Fig. 3) and width (Fig. 2) from one pane to the next. Oil fills the spaces between the panes 58, 59, 60, 61, 64, and 65. Figs. 5 and 4, respectively, show the panes 64 and 65 held against oil seals 66 and 67, at frames 58*a* and 61*a* by brackets 68 and 69 which are secured by bolts 70 to flanges 71 and 72 on the frames 58*a* and 61*a*. In Fig. 4 a gas seal 73 is held in position by plate 74 which, with the help of bolts 76 and 77, secures the flange 72 on the viewer's end of the subassembly 56 to a flange 78 on the end of an extension 80 of the housing 29. The flanges 71 and 72 at the ends of the subassembly 56 hold it spaced on all sides from the housing extension 80. The space thus formed is filled with material 82 such as lead shot having a density sufficient to block radiation from the cave.

When the cave window is in use, the metal shutters are moved apart to allow an unobstrructed field of view. In this position there is ample clearance for replacing the expendable windows.

The expendable window 22 is removed by swinging the window and frame out 90° from the wall, then lifting. In this position there is sufficient clearance at the hinge line to permit lifting the window 22 a few inches with the hooks of a remotely operated crane under bars 38 and 39 to disengage the hinges 32 and33.

The expendable window 42 is removed by sliding it into the cave area onto a portable platform or rack constructed for that purpose. It is contemplated that the second window will not be replaced more than once or twice in the lifetime of the cave.

The windows **22** and **42** are made of glass with a density of 3.3 containing 1.75% cerium. The outer window **22** is 10 inches thick, which is sufficient to absorb the major portion of radiation capable of darkening glass. The inner window **42** is 9 inches thick and should absorb the remaining radiation that is capable of darkening glass. These expendable windows are suitable for use where exposure levels will reach approximately 10^6 r./hr.

As shown in Figs. 2, 3, and 5, the gastight seal **48** in conjunction with the two-inch thick window **50** retains the inert atmosphere of the cave and is capable of excluding oxygen from the cave when the cave area is under partial atmospheric pressure. The arrangement of seal **48** and window **50** permits flexibility in that replacement of expendable windows is made possible from the cave side without disturbing the cave atmosphere and without disturbing the seal.

The permanent subassembly **56** makes up approximately two-thirds of the total thickness of glass in the window structure and represents a major portion of the expense invested in glass panes. This assembly of glass panes is approximately 40 inches thick and is sufficient to absorb the remaining radiation which, although not sufficient to darken glass, would be harmful to personnel. The panes **59**, **60**, and **61** are made of 3.3 density glass containing approximately 1% cerium; the remaining pane **58**, also of 3.3 density glass, contains approximately 1.75% cerium.

The vertical sectional view of Figure 2 illustrates an "hourglass shape," or a configuration of two truncated pyramids joined at their planes of truncation. It will be noted that the area and volume of glass in window pane **58** is much less than in either pane **61** or pane **22**. The same configuration, although less pronounced, is shown in the horizontal sectional view of Figure 3.

The direct line of sight for an operator standing close to the window on the operator's side is such that the small pane **58** in the center of the window structure does not restrict his field of view. The larger panes on the observer and exposure sides permit the operator to see a wider field by moving right and left or up and down.

The expense and weight of glass involved in a conventional cave window may be reduced materially without altering the field of vision by use of the "hourglass shape." On the other hand, for about the same weight and expense involved in a conventional cave window, a larger field of view may be obtained by using the "hourglass shape."

Considerable flexibility is inherent in this window structure. The configuration shown in Figure 2 is designed for an operator standing on a floor somewhat lower than the floor level in the cave. In this installation the extended field of view is provided in an upward direction.

An added advantage to this configuration is the increased field of view made possible by the refractive index of the glass when viewed diagonally through the window. Here again the "hourglass shape" takes full advantage of the refractive properties of the glass by permitting more extreme angles of viewing. This is made possible by the larger window panes on the observer and exposure sides. This wider field of view could not be accomplished with conventional cave windows at a reasonable cost.

The dimensions of window panes in this example are summarized as follows:

Table

Pane No.	Width (in.)	Length (in.)	Thickness (in.)
22	36	36	10
42	29	32	9
50	36	38	2
64	22	33	1
58	20	30	9
59	24	33	9
60	30	34	9
61	33	36	9
65	35	39	1

The invention is not to be limited by the details given herein but may be modified within the scope of the appended claims.

What is claimed:

1. A cave window structure comprising a sealed subassembly comprising a plurality of permanent thick glass panes, each successively larger in window pane area proceeding from one end to the other, frames on the glass panes attached to one another, inner and outer thin glass panes sealed to said frames to that oil filling the spaces between the panes is prevented from escaping; a gas seal including a thin glass pane positioned adjacent the pane of smallest windowpane area of said sealed subassembly; an unsealed assembly comprising expendable thick glass panes arranged in order of increasing windowpane area from about the center of said window structure to a radiation exposure side, the outer pane on said exposure side being pivotally mounted, and the pane adjacent the outer pane being slidably removable in a direction transverse to its thickness when said outer pane is pivoted away; said permanent panes and said expendable panes being assembled in the configuration of two truncated pyramids joined at their planes of truncation; a thick metal shutter positioned to cover said exposure side of said window structure; and support means for enabling it to be moved out of the way to allow free access to said expendable panes.

2. A cave window structure comprising a sealed subassembly comprising a plurality of permanent thick glass panes, each successively larger in windowpane area proceeding from one end to the other, frames on the glass panes attached to one another, oil filling the spaces between the panes; and an unsealed assembly comprising expendable thick glass panes arranged in order of increasing windowpane area from about the center of said window structure to a radiation exposure side, the outer pane on said exposure side being pivotally mounted, and the pane adjacent the outer pane being slidably removable in a direction transverse to its thickness when said outer pane is pivoted away; said permanent panes and said expendable panes being assembled in the configuration of two truncated pyramids joined at their planes of truncation.

References Cited in the file of this patent

UNITED STATES PATENTS

2,811,487	Stanton	Oct. 29, 1957
2,858,451	Silversher	Oct. 28, 1958
2,897,725	Klemt et al.	Aug. 4, 1959

OTHER REFERENCES

U.S. Atomic Energy Document T–1D5276, Lead Glass Windows, on page 101 of Chemical and Processing Equipment Booklet TK–9360–C5.