April 19, 1932. J. H. WIGGINS 1,854,535

FLOATING ROOF FOR LIQUID STORAGE TANKS

Filed April 11, 1930 2 Sheets-Sheet 1

Fig. 1.

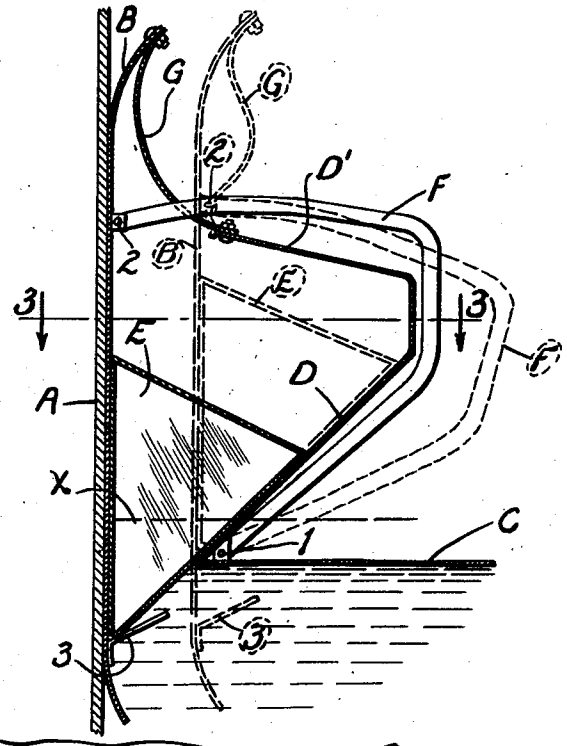

Fig. 2.

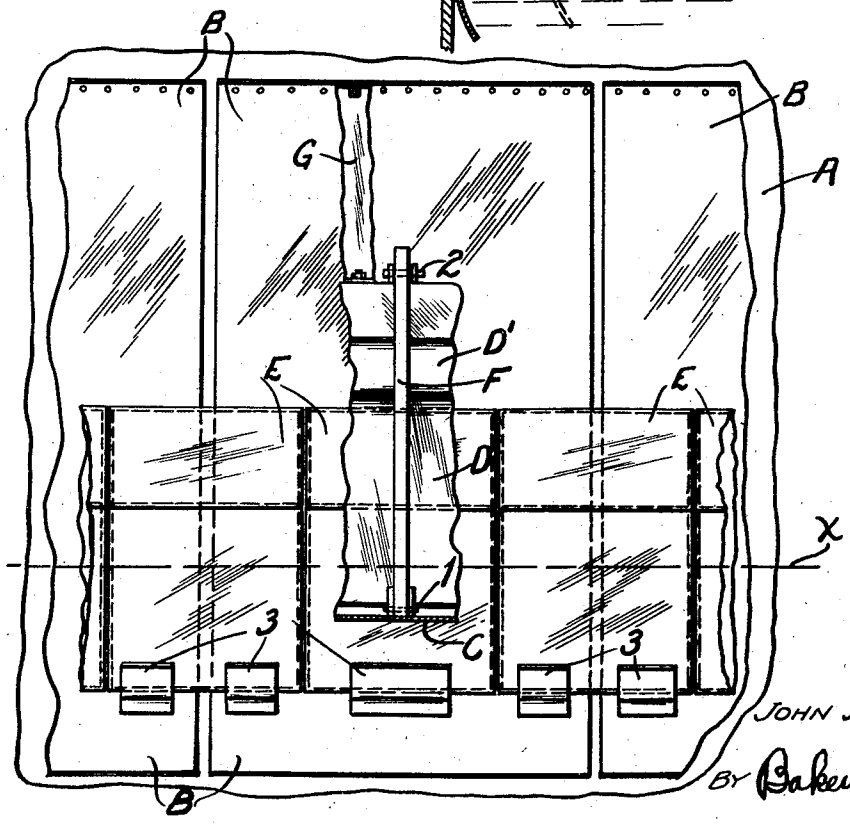

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Fig. 3.

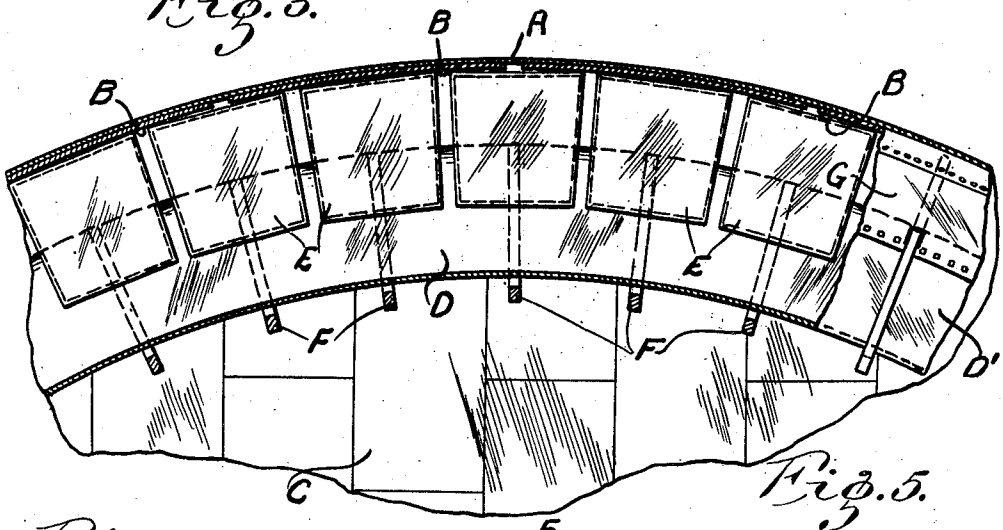

Fig. 4.

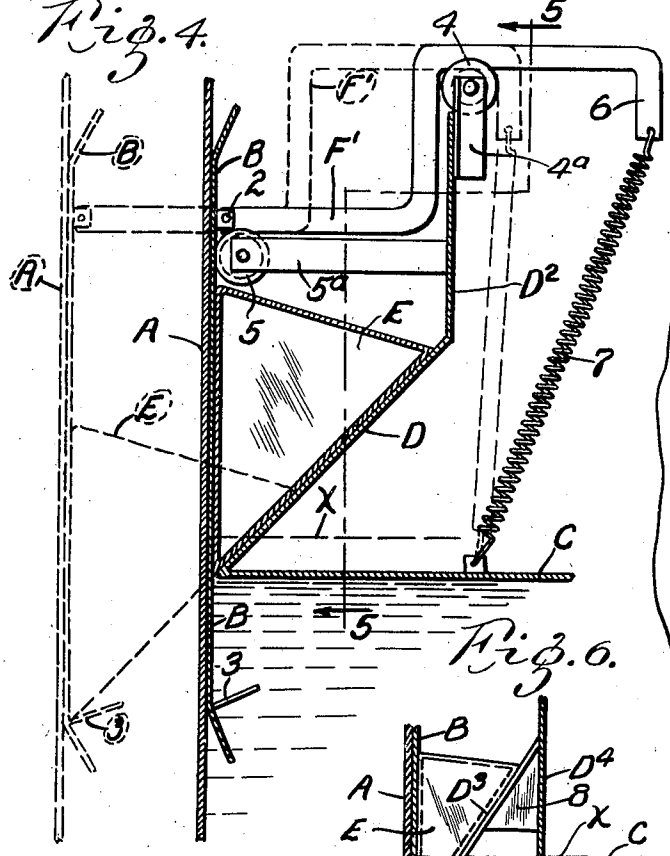

Fig. 5.

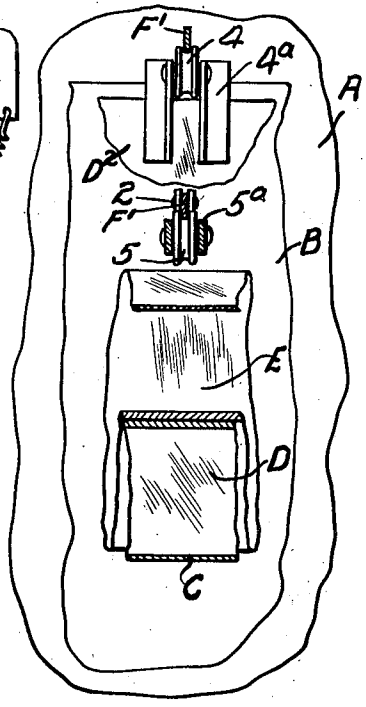

Fig. 6.

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UNITED STATES PATENT OFFICE

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FLOATING ROOF FOR LIQUID STORAGE TANKS

Application filed April 11, 1930. Serial No. 443,326.

This invention relates to floating roofs or decks for liquid storage tanks, and particularly, floating roofs of the type in which the seal or closure for the space between the roof and the side wall of the tank is formed by or composed of a plurality of relatively movable members or elements submerged or partly submerged in the liquid between the peripheral edge of the roof and the side wall of the tank.

One object of my invention is to provide a floating roof of the general type mentioned in which the members relied upon to eliminate a liquid surface at the peripheral edge of the roof are installed from the top side of the roof and consist of floats that are arranged between the tank side wall and an inclined surface on the roof that slopes upwardly and inwardly towards the center of the tank.

Another object of my invention is to provide a floating roof of the general type mentioned, which is of such design that the relatively movable members or elements relied upon to practically eliminate a liquid surface at the peripheral edge of the roof, are not liable to bind or stick and thus function improperly, when the seal expands and contracts, or when the roof moves vertically, due to a change in the level of the liquid in the tank.

Another object is to provide a floating roof seal or closure of the general type mentioned, that is inexpensive to construct, easy to install or repair and composed principally of metal parts of such shape and arrangement that the joints or spaces in the structure through which vapors might possibly escape are in the form of relatively tall, narrow slots.

And still another object is to provide a floating roof seal or closure of the general type mentioned, which is of such design that friction between the relatively movable co-acting parts of the structure is reduced to such an extent that the radially movable elements relied upon to fill up the liquid surface at the peripheral edge of the roof are practically certain to remain in operative engagement with the parts of the structure on which they slide or with which they co-act. Other objects and desirable features of my invention will be hereinafter pointed out.

Figure 1 of the drawings is a vertical transverse sectional view through the seal of a floating roof, constructed in accordance with my present invention.

Figure 2 is an elevational view of said seal, looking outwardly from the center of the roof.

Figure 3 is a horizontal sectional view, taken on the line 3—3 of Figure 1, looking in the direction indicated by the arrows.

Figure 4 is a vertical sectional view of a seal of slightly different construction from that shown in Figure 1.

Figure 5 is a sectional view, taken on the line 5—5 of Figure 4, looking in the direction indicated by the arrows; and

Figure 6 is a detail sectional view, illustrating another method of forming the inclined surface on the top side of the roof.

Briefly described, my improved roof seal or closure is composed of an inclined surface on the top side of the roof, arranged adjacent the peripheral edge of the roof and sloping upwardly and inwardly towards the center of the roof, and a plurality of relatively movable elements or members arranged between said inclined surface and the side wall of the tank and constructed so that the lower end portions of said elements will project downwardly into the liquid in the tank and thus eliminate or practically eliminate a liquid surface at the peripheral edge of the roof from which vapors will evaporate. The said relatively movable members are herein illustrated as consisting of floats that rest and slide upon the inclined surface on the top side of the roof, but it is not absolutely essential that said members be liquid tight, and said members may be sustained or supported in various other ways without departing from the spirit of my invention, so long as they will be maintained in such a position in the space between the peripheral edge of the roof and the tank side wall that they will be submerged or partially submerged in the liquid and will be capable of moving relatively to each other and relatively to the roof sufficiently to provide for the expansion and con-

traction of the side wall of the tank. In the present embodiment of my invention, a vertically-disposed circular shoe carried by the floating roof, is interposed between the side wall of the tank and the floats or other relatively movable elements previously referred to, but such a shoe is not absolutely essential to the successful operation of my improved seal. When such a shoe is employed it is preferable to form it from substantially segmental shaped shoe members proportioned so that when they are in sliding engagement with the side wall of the tank, the joints or spaces between the outer surfaces of said shoe members and the inner surface of the side wall of the tank will be in the form of relatively narrow and tall slots, and means is provided for mounting said shoe members on the roof or sustaining said shoe members from the roof in such a way that said shoe members are capable of radial movement. The inclined surface on the roof previously referred to may be formed either by a portion on a rim at the peripheral edge of the roof whose top edge terminates at a point enough above the level of the liquid in the tank to prevent the liquid from overflowing onto the top side of the roof, or said inclined surface may be formed by a separate part attached to the rim or to some other suitable part located adjacent the peripheral edge of the roof, it being immaterial how said inclined surface is constructed, so long as it is arranged on the top side of the roof. The members or elements that are interposed between the shoe members and the inclined surface on the roof are preferably of substantially wedge shape or triangular shape in cross section, so that gravity will tend to hold said members in engagement with the shoe members and with the inclined surface on the roof with the lower end portions of said members projecting downwardly into the liquid between the rim of the roof and the side wall of the tank. When the shoe members move radially either inwardly or outwardly, due to contraction or expansion of the side wall of the tank, the wedge-shaped members or elements that are relied upon to practically fill or eliminate the liquid surface between the rim of the roof and the side wall of the tank also move radially, due, of course, to the fact that they are slidingly mounted on an inclined surface on the top side of the roof which slopes upwardly and inwardly from the peripheral edge of the roof, the inward movement of the shoe members causing said wedge-shaped members to move upwardly over the inclined surface on the roof and move upwardly over the shoe members, and the outward movement of the shoe members causing said wedge-shaped members to move downwardly over said inclined surface and also downwardly over the shoe members.

In the accompanying drawings I have illustrated two different forms of my invention. In the form shown in Figures 1, 2 and 3, A designates the side wall of the tank, and B designates the segmental shoe members which act collectively (see Figure 3) to form a vertically-disposed circular shoe that slides vertically over the inner surface of the side wall of the tank when the floating roof C moves vertically, due to changes in the level of the liquid in the tank, the lower edge of said shoe being submerged in the liquid. At the peripheral edge of the roof is a rim whose top surface constitutes an inclined surface D that slopes upwardly and inwardly towards the center of the tank, and the liquid space between said inclined surface D and the shoe members B is filled by a plurality of substantially wedge-shaped or triangular-shaped members E whose lower end portions project downwardly into the liquid on which the roof C floats, as shown in Figure 1, so as to practically eliminate a liquid surface between the rim D of the roof and the side wall A of the tank. The shoe members B are mounted on or carried by swinging hangers F on the roof which are illustrated in Figure 1 as consisting of substantially elbow-shaped members pivotally connected at 1 to the roof and shaped so that the horizontal arms of same will project outwardly over the rim D of the roof, and thus form supports that are pivotally connected at 2 to the shoe members B adjacent the upper ends of said shoe members.

The shoe members A are preferably curved substantially to the radius of the side wall of the tank, and while the length of said shoe members may vary, I prefer to make said shoe members about 3 ft. long in instances where they are used in connection with a tank of about 117 ft. in diameter. Gaps are formed between the ends of the shoe members B, as shown in Figure 3, and while the width of said gaps may vary, it is preferable to proportion the shoe members so that the ends of the shoe members are in abutting relationship when the seal is in its fully contracted condition. The radially movable members or elements E may be constructed in various ways, but I prefer to construct said members from metal plates combined in such a way as to produce hollow floats that are liquid tight and which have two oppositely inclined flat surfaces, one of which is adapted to slide freely upon the upwardly-inclined surface D on the roof, and the other being adapted to slide freely upon the inner surface of the circular shoe that surrounds the group of elements E. The floats or elements E are preferably made shorter than the shoe members B and are arranged so as to break joints with the shoe members, as shown more clearly in Figure 3. It is not essential that the portions or surfaces of the elements E which contact with the shoe members be

curved, because the versine in the elements E is so small as to be negligible in a seal for a 117 ft. diameter tank. Usually, the box-like elements E will be made of such length that when the seal is in its fully contracted condition, the opposed or abutting end walls of said elements will be in contact or substantially so. When the seal is in its expanded condition, as shown in Figure 3, there will be spaces between the opposed end walls of the elements E.

In the form of my invention herein illustrated the rim at the peripheral edge of the roof which constitutes the inclined surface D on which the radially movable elements E are normally supported is curved, as shown in Figure 3, so as to conform substantially to the curvature of the side wall of the tank, but it is not essential that the inclined surface D be curved. It is preferable, however, that the inclined surface D of the roof on which the elements E rest be of considerable height or depth, so that the joints between said parts will be in the form of a relatively tall slot, the same as the joints between the shoe members B and the side wall of the tank, as spaces or joints of this character greatly reduce the tendency of vapors escaping upwardly through the seal or structure relied upon to eliminate a liquid surface between the floating roof and the side wall of the tank. I also prefer to construct the inclined portion D of the roof so that it maintains its constant slope, at least, as far as the liquid level x, as by so doing I eliminate a liquid surface at the edge of the roof from which vapors might evaporate. The surfaces or portions of the elements E that bear against the inner surfaces of the shoe members B are also preferably proportioned so as to provide relatively tall slots or joints between said contacting parts. As shown in Figure 1, the shoe members E are provided at their lower ends with inwardly-projecting brackets or devices 3 that serve as supports for the radially movable elements E when the seal is in its fully expanded condition.

If desired, the rim at the peripheral edge of the roof C may be provided at its top edge with an outwardly-projecting portion D′ that acts as a baffle for any entrained liquids that are carried by gases which escape upwardly through the joints between the radially movable elements E and the inclined supporting surface D on which said elements rest. Such a baffle is not essential to the successful operation of my improved seal, but it is a safe-guard that may be used, if desired, to eliminate the possibility of liquid being carried out of the tank with escaping gases and being splashed onto the top surface of the roof. When the seal is equipped with a baffle D′ arranged as shown in Figure 1, any gases that escape upwardly through the joint between the inclined surface D and elements E will be sure to strike the baffle D′, and if any liquid is entrained in such escaping gases, the liquid will be separated or removed from the gases by contact of the gases with the baffle D′. Another feature that may or may not be used is a rain shield G consisting of a piece of rain-tight fabric that is attached to the upper ends of the shoe members B and to the outer edge of the baffle D′. The purpose of this shield G is to prevent rain from falling into the space in which the elements E are arranged, but it also aids in reducing evaporation losses by preventing wind from flowing freely into and out of the space between the rim on the roof and the side wall of the tank.

In my improved seal the circular shoe formed by the segmental shoe members B performs two functions;

(1) It eliminates friction between the side wall of the tank and the radially-movable elements E; and

(2) It acts as a support for the elements E when the seal is in its fully expanded condition. The hangers F or other means that are used to support the shoe members B carry the weight of the shoe members and overcome the combined friction, due to the horizontal outward thrust set up by the weight of the shoe members B, plus the horizontal thrust set up by the weight of the radially movable elements E. The rim of the roof, in addition to preventing the liquid in the tank from overflowing onto the top side of the roof, acts as a supporting surface for the elements E, which is of such form that there is little danger of evaporation through the joints between said supporting surface and the elements E. If the rim is provided with a baffle D′, there is little liability of entrained liquids being carried out of the tank and splashed onto the top surface of the roof.

As previously stated, it is not essential, so far as my broad idea is concerned, that the seal be equipped with an annular shoe interposed between the side wall of the tank and the elements E. However, when the seal is equipped with an annular or circular shoe constructed so as to serve as a support for the elements E when the seal is in its fully expanded condition, there is no tendency for the elements E to bind or function improperly when the seal expands and contracts, or when the roof rises and falls, due to the fact that the outward movement of the elements E is restricted by shoe members B which are capable of moving outwardly only a certain approximate distance, and the downward movement of the elements E is restricted by the brackets or other supporting devices 3 on the shoe members. The weight of the elements E tends to throw the lower ends of the shoe members outwardly and hold the lower end portions of the shoe members

pressed against the side wall of the tank, and another very desirable feature of a seal of the particular construction herein illustrated is that the elements E move downwardly farther into the liquid in the tank, as the seal expands, with the result that the liquid takes up part of the weight or load of the elements E, and thus reduces the outward thrust which the weight of the elements E exerts on the shoe members B. This is a very desirable feature of my seal, as it tends to hold the floating roof C centered properly with relation to the side wall of the tank.

In Figures 4 and 5 I have illustrated another form of my invention, wherein a slightly different means is used to support or sustain the shoe members B. Instead of sustaining the shoe members by swinging or pivotally mounted hangers, as shown in Figures 1 to 3, the shoe members are pivotally connected at 2 to the horizontally-movable carriers F′, which are arranged at the peripheral edge of the roof in such a way that they are capable of moving radially, inwardly and outwardly, relatively to the side wall of the tank. As shown in Figure 4, each of the carriers F′ consists of a bar-like member that is slidingly mounted on two rollers 4 and 5 carried by the rim of the roof and disposed so that said member F′ is capable of moving outwardly or radially from the position shown in Figure 4 into the position shown in broken lines. The roller 4 is mounted in a bracket 4^a that is attached to a vertically-disposed portion D^2 of the rim which projects upwardly from the inclined portion D of the rim on which the elements E slide, and the roller 5 is mounted in a horizontally-disposed bracket 5^a that projects outwardly from the rim at a point below the extreme top edge of the rim. At the inner ends of the carriers F′ are depending arms 6 to which springs 7 are attached, said springs being of such tension and combined with the carriers in such a way that they exert pressure on the carriers F′ in a direction tending to move the carriers outwardly towards the side wall of the tank and hold said carriers in a substantially level or horizontal position when the shoe sustained by the carriers is in its fully expanded condition. The depending arms 6 at the inner ends of the carriers serve as stops that co-act with the rollers 4 to restrict or limit the bodily outward movement of the shoe members B relatively to the roof C.

In Figure 6 I have illustrated how the inclined surface on the roof that serves as a support for the floats or other elements E may be formed by an inclined member D^3 attached to the outer side of a rim D^4 at the peripheral edge of the floating roof C, said member D^3 being reinforced and strengthened by gussets 8 so as to make it strong and rigid enough to successfully perform its function.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a liquid storage tank, the combination of a side wall, a roof that floats on the liquid in the tank, an expansible and contractible shoe sustained by the roof and arranged in sliding engagement with said side wall with its lower edge submerged in the liquid in the tank, an inclined surface on the roof that slopes upwardly and inwardly from the peripheral edge of the roof, and radially-movable elements for practically filling up the liquid surface between the tank side wall and roof, arranged in sliding engagement with said inclined surface and with the inner surface of said shoe but having no direct connection with the same.

2. A floating roof for liquid storage tanks, provided with an expansible and contractible shoe that is adapted to slide upon the inner surface of the side wall of the tank, an inclined surface adjacent the peripheral edge of the roof that slopes upwardly and inwardly towards the center of the tank, and elements for practically filling up the liquid space between the peripheral edge of the roof and the tank side wall, arranged in sliding engagement with the shoe and with the inclined surface on the roof with the lower ends of said elements projecting into the liquid, the joints between said elements and the shoe and inclined surface on the roof being in the form of relatively tall slots.

3. A floating roof for liquid storage tanks, provided at its peripheral edge with a rim having a surface that slopes upwardly and inwardly towards the center of the tank, an expansible and contractible shoe carried by said roof and adapted to slide on the side wall of the tank, substantially wedge-shaped elements arranged in contact with the inner side of the shoe and with the inclined surface on the rim and having their lower end portions projecting downwardly into the liquid between the peripheral edge of the roof and the side wall of the tank, and means for causing the weight or load of said elements to be partially sustained by said shoe when the shoe is in its fully expanded condition.

4. A floating roof for liquid storage tanks, provided adjacent its peripheral edge with a rim having an inclined surface that slopes upwardly and inwardly towards the center of the tank, an expansible and contractible shoe surrounding the roof and adapted to slidingly engage the side wall of the tank, means for mounting said shoe on the roof, a plurality of substantially wedge-shaped hollow elements interposed between the inner surface of the shoe and the inclined surface on the roof and normally sustained by said inclined surface, with the lower end portions of said elements projecting into the liquid in the tank, and devices on the shoe for assisting

in sustaining the load or weight of said elements when the shoe is in its expanded condition.

5. A floating roof for liquid storage tanks, provided at its peripheral edge with a rim, a shoe surrounding said roof and composed of a number of vertically-disposed shoe members that are adapted to slide on the side wall of the tank, a supporting means on the roof from which said shoe members are pivotally suspended, constructed so as to permit said shoe members to move outwardly a limited distance, elements partially submerged in the liquid at the peripheral edge of the roof, arranged in sliding engagement with said shoe members and with a supporting surface on the roof and constructed so that gravity tends to hold said elements in contact with the surfaces with which they coact, and means on said shoe members for limiting the downward movement of said elements relatively to the roof and shoe members.

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