

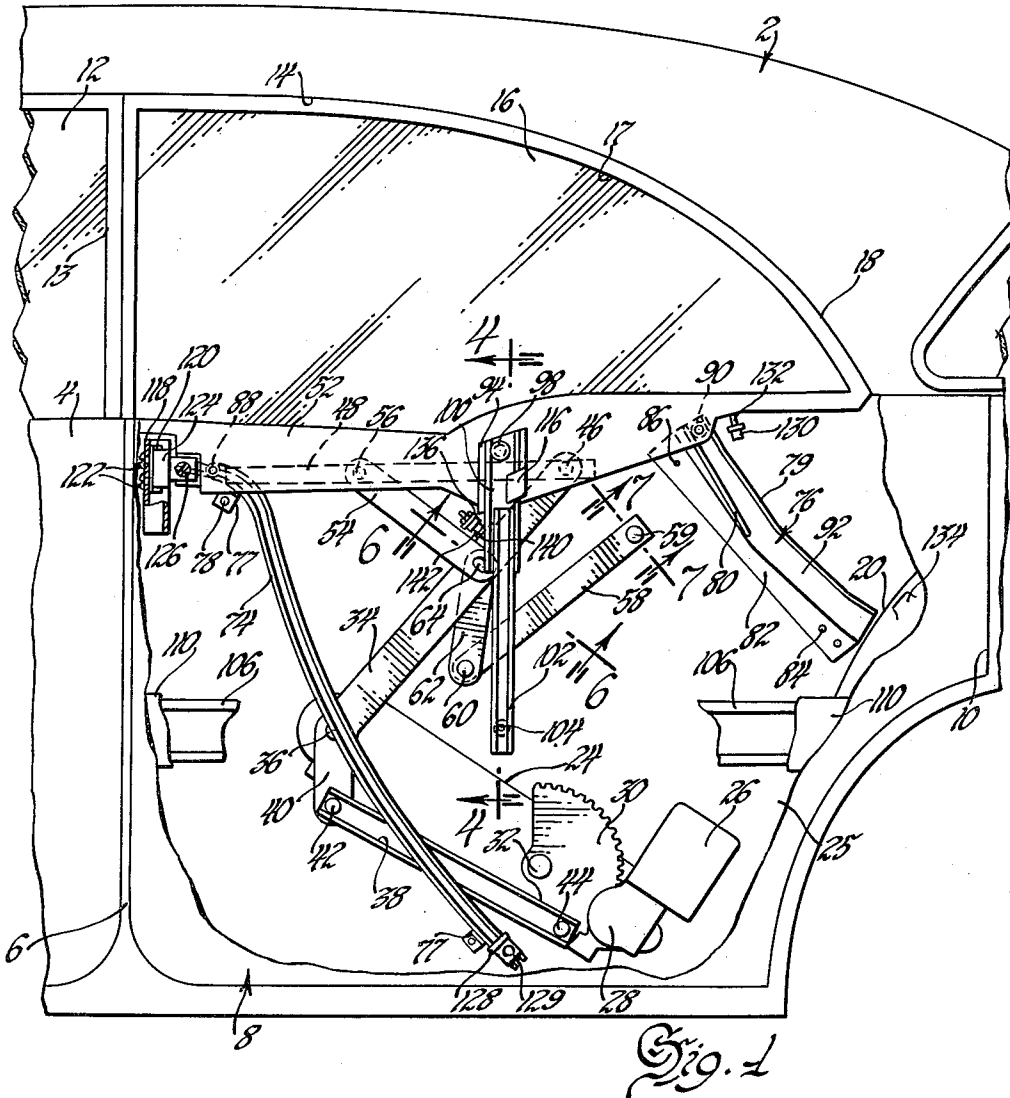
Aug. 29, 1961

D. C. PROBST
WINDOW REGULATOR

2,998,246

Filed Jan. 7, 1955

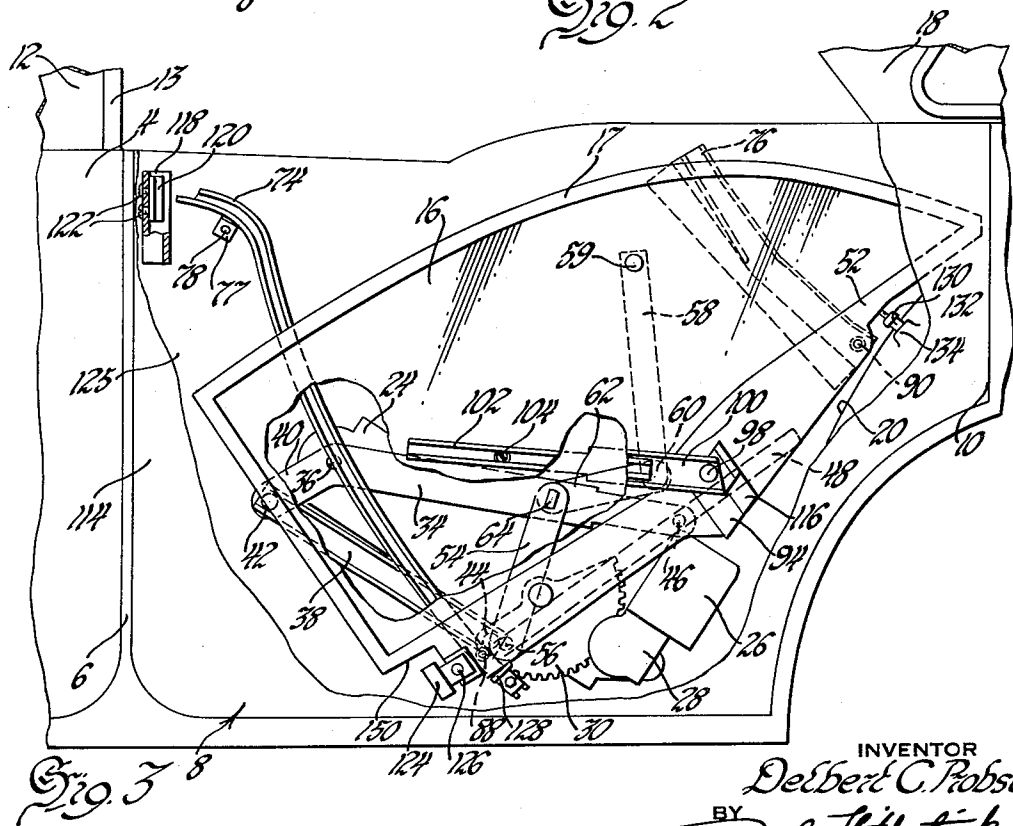
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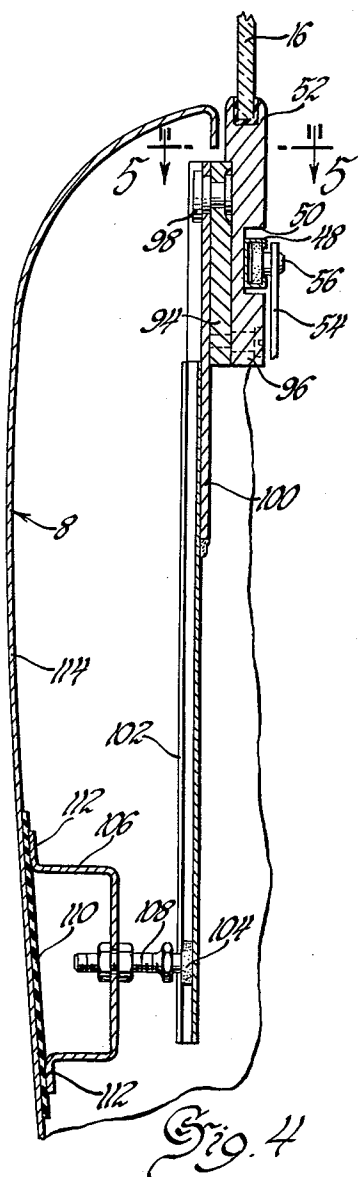
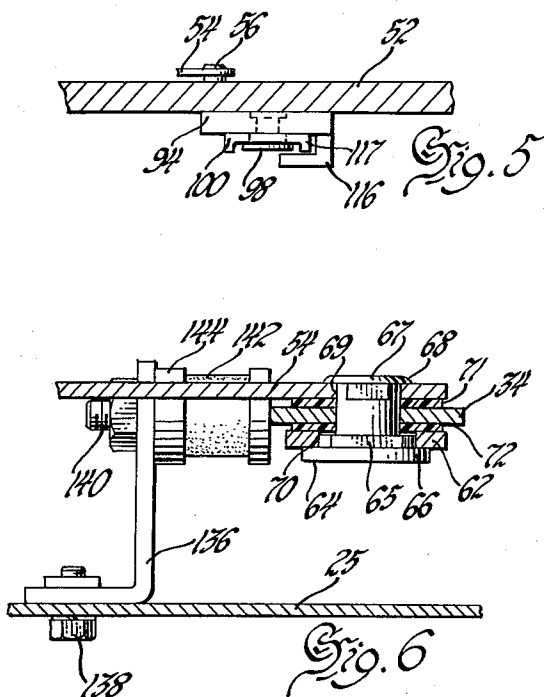
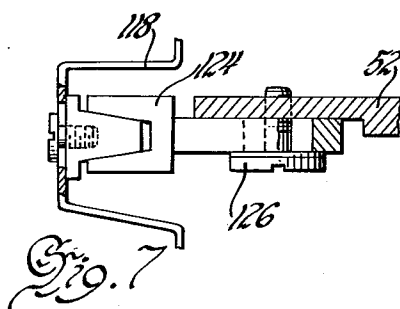
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3 Sheets-Sheet 3



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WINDOW REGULATOR

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This invention relates to a window regulator and more particularly to a window regulator for moving a vehicle window into and out of a window well along a curvilinear path to open and close a window opening.

The recently introduced four-door hard top sedan has no center pillar above the body belt line and no door window frames above the body belt line except for the ventipane window frame at the forward portion of the front door. This results in a continuous window opening from the ventipane window to the rear quarter area when the front and rear door windows are in down position. The front and rear door windows seal against each other and the roof rail to close the window opening, the front door window also sealing against the ventipane window frame.

There are many problems presented by the rear window installation in this type of automobile. The rear window overlaps the center pillar in up position in order to seal against the front window, which requires that the window have forward and rearward movement as well as vertical movement in order to be moved into and out of the door well. The front window may have conventional vertical movement between open and closed positions. The rear window must also be irregularly shaped because of the styling of the body belt line portion of the door and the styling of the roof rail. The rear wheel housing projects into the lower rear portion of the rear door to reduce window stowage space to a minimum and to prevent vertical straight line movement of the window into and out of the door well.

This invention solves the many problems presented by this type of rear window installation by providing a window regulator moving the rear window along a curvilinear path between open and closed positions. The window regulator also securely holds the window in any position without rattling or lateral rotation, for the absence of door window frames above the belt line tends to increase both rattling and lateral rotation.

The window regulator of this invention has many outstanding and noteworthy features in its preferred embodiment. One of the principal features lies in the window regulator linkage which controls the entire movement of the window along its curvilinear path. A lift arm slidably connected to the window lower frame and pivotally mounted on the inner door panel provides the power for the movement of the window. A pair of links in fixed angular relationship are pivotally supported on the lift arm at their junction and function as a bell crank lever. The free end of one link is slidably connected to the window lower frame and the free end of the other link is pivotally connected to the free end of a third link pivoted on the inner door panel. This third link may be called the pivoting restricting link, or controlling link, for the position of this link is critical with respect to any given geometry of the window movement and by changing the pivoting point of the link on the inner panel, the curvilinear path of the window movement can be varied without the use of any other mechanism.

Another principal feature of this invention lies in the front and rear guides fixedly mounted on the inner door panel and slidably connected to the window frame. As hereinbefore stated, both the lift arm and the one link of the pair in fixed angular relationship are slidably connected to the window frame. The front and rear guide

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channels control the fore and aft shifting movement of the window and maintain the correct relationship of the window with the inner door hardware and the inner and outer door panels to prevent interference. They have no function whatsoever of controlling the pivotal movement of the window as it moves along its curvilinear path.

Another feature of this invention lies in the fact that both the front and rear guide channels and the window regulator linkage are mounted on the inner door panel to one side of the window. As hereinbefore stated, the window stowage space is decreased to a minimum by the rear wheel housing and by the styling of the body belt line and, therefore, only a minimum amount of stowage space and space for the window regulator and guides is available. By mounting the guide channels and the window regulator linkage on the inner door panel, space is provided for the window, the window regulator, and the guides within the door well.

Another further feature of this invention lies in the use of a lateral stabilizer to prevent tilting movement of the window as it moves along its curvilinear path or in any fixed position of the window. This lateral stabilizer includes a channel pivotally mounted on the window lower frame at its upper portion with the lower portion of the channel pivotally and slidably mounted on the outer door panel by means of a supporting bracket and a stud. As the window moves along its curvilinear path, the lower portion of the channel slides on the stud and follows a curvilinear path different from that of the window.

These and other features of this invention will be readily apparent from the following specification and drawings, in which:

FIGURE 1 is a side elevational view of the window regulator of this invention mounted within the rear door of a four-door hard top sedan with the window in up position;

FIGURE 2 is a view similar to FIGURE 1 showing the window in partially open position;

FIGURE 3 is a view similar to FIGURE 1 showing the window in down position;

FIGURE 4 is a sectional view on the plane indicated by line 4—4 of FIGURE 1;

FIGURE 5 is a sectional view on the plane indicated by line 5—5 of FIGURE 4;

FIGURE 6 is a sectional view on the plane indicated by line 6—6 of FIGURE 1; and

FIGURE 7 is a sectional view on the plane indicated by line 7—7 of FIGURE 1.

Referring now to FIGURE 1 of the drawings, a vehicle body 2 includes a front door 4 hinged at its forward edge to the body and latched at its rearward edge to the center pillar 6, and a rear door 8 hinged at its forward edge to the center pillar 6 and latched at its rearward edge 10 to the vehicle body. The center pillar 6 extends only from the floor of the vehicle to the body belt line, which is the top edge of the front and rear doors. A front window 12 mounted within a window frame 13 is supported within door 4 by a suitable window regulator for vertical movement between open and closed positions. The window seals against the roof rail 14 in closed position and also against the ventipane window frame (not shown) extending upwardly at the forward portion of door 4 to the roof rail and pivotally supporting a ventipane window. A rear window 16 mounted within a window frame 17 is supported within door 8 by the window regulator of this invention and seals against the roof rail 14 and the front window 12 in closed position. Thus, it can be seen that when both the front and rear windows are in open position, a continuous window opening extends from the ventipane window frame to the rear quarter area 18 of the body and accounts for the name of this type of automobile, a four-door hard top sedan.

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Inasmuch as there is no support for either the front or rear windows above the body belt line, each window must be supported entirely within the door wells of the front and rear doors. The front window 12 moves vertically between open and closed positions and a suitable window regulator of known type may be used. However, the rear window cannot move vertically between open and closed positions since it must overlap the center pillar 6 in closed position in order to seal against the front window. The rear door 8 extends rearwardly beyond the rear quarter area 18 of the body and the rear wheel housing (not shown) projects into the lower rear portion of the door. This requires that a portion 20 of the rear wall of door 8 be offset forwardly of the body to further prevent vertical movement of window 16. Thus, in order to stow window 16 within the rear door in open position, the window must move along a curvilinear path between open and closed positions. This curvilinear path is an irregular curvilinear path, for the window pivots about a number of instantaneous centers as it moves between open and closed positions.

The window regulator of this invention will now be described. A back plate 24 mounted on the inner door panel 25 supports an electric motor 26 driving a worm and pinion gear arrangement 28. A sector gear 30 pivoted on the back plate 24 at 32 is driven by the pinion gear and moves the window between open and closed positions by means of the window regulator linkage. This linkage includes a lift arm 34 pivoted on the back plate at 36 and connected to the sector gear by a shifting link 38 pivoted to an angular extension 40 of the lift arm at 42 and to the sector gear at 44. The free end of the lift arm supports a stud 46 slidably mounted in a retainer channel 48, FIGURE 4. The retainer channel is secured to the base of a channel 50 formed within the lower frame portion 52 of window frame 17 and facing inwardly of the vehicle body. A link 54 pivotally supported at one end by lift arm 34 supports a stud 56, FIGURE 4, at its other end which is slidably mounted in the retainer channel 48. Another link 58 pivoted on the inner door panel 25 at 59 has its free end pivotally connected at 60 to one end of an intermediate link 62 pivotally supported by lift arm 34 opposite to link 54.

Referring now to FIGURE 6 of the drawings, the pivotal support of links 54 and 62 on lift arm 34 will be described. A stud 64 having opposite flat portions 65 on its shouldered portion 66 and opposite flat portions 67 on its cylindrical shank portion 68 of reduced diameter is rotatably supported by lift arm 34. Links 54 and 62 having openings 69 and 70 similar to the cross section of stud 64 at flat portions 67 and 65, respectively, are positioned by the stud on either side of the lift arm. Thus, the stud maintains links 54 and 62 in fixed angular relationship so that they function as a bell crank lever and allows rotation of the links relative to the lift arm independently of any swinging movement of the lift arm about pivot 36. Washers 71 and 72 provided between lift arm 34 and links 54 and 62, respectively, prevent binding between the links and the lift arm. Link 58 may be called the pivoting restricting link or controlling link, for the position of this link is critical with respect to any given geometry of the window movement. By changing the pivoting point 59 of the link on the inner door panel, the curvilinear path of the window movement can be varied without the use of any other mechanism.

Since both the lift arm and link 54 are slidably mounted within the retainer channel 48, front and rear guides 74 and 76, respectively, are necessary to control fore and aft shifting movement of the window and to maintain the correct relationship of the window with the inner and outer door panels and the inner door hardware to prevent interference as the window moves between open and closed positions. A pair of L-shaped brackets 77 welded to one side of front guide 74 adjacent the ends of the guide are bolted to the inner door panel at 78 to support

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the front guide within the door well. The rear guide 76 has an outwardly flanged edge 79 extending the length of the guide, an outwardly extending rib 80 spaced from flange 79 and extending partially the length of the guide, and an offset flange portion 82 bolted to the inner door panel 25 at 84 and 86 to support the rear guide within the door well. An inwardly extending stud 88 fixed to the inner side of the lower frame portion 52 of the window frame slides in the front guide 74 and a similar stud 90 similarly fixed to frame 52 slides on surface 92 of the rear guide.

The fore and aft shifting movement of stud 90 relative to surface 92 is limited by flanged edge 79 and rib 80 during part of the sliding movement of the stud, and flanged edge 79 limits the rearward shifting movement of the stud during the remainder of its sliding movement. The front guide 74 is in the form of a continuous channel to control the fore and aft sliding movement of stud 88 during its entire path of travel. It will be noted that both the front and rear guides are mounted on the inner door panel inboard of window 16 in order to increase the stowage space within the door well as hereinbefore described.

The front and rear guide channels control the shifting movement of the window in fore and aft directions and in order to prevent tilting movement or lateral instability of the window as it moves between open and closed positions or in any fixed position of the window, a lateral stabilizer is used. Referring now to FIGURES 1, 4, and 5, a plate 94 bolted at 96 to the outer surface of the lower frame portion 52 of the window frame supports a stud 98 at the upper portion of the plate. The stabilizer arm includes an outwardly facing channel 100 welded to a similar channel 102 of smaller cross section and rotatably supported on plate 94 by stud 98. Channel 102 engages a stud 104 adjustably supported on channel 106 by a nut and bolt arrangement 108. Channel 106 spans the lower portion of door 8 and is secured to the front and rear surfaces of the door. A rubber lining 110 provided between the flanged edges 112 of the channel and the outer door panel 114 prevents rattling between the channel and the door. An L-shaped lug 116, FIGURE 5, welded to one side of plate 94 partially surrounds channel 100 in the closed position of the window as can be seen in FIGURES 1 and 5.

Thus, in the closed position of the window, tilting movement of the window inboard of the body is minimized by the leverage action of the stabilizer arm on studs 98 and 104 and the large bearing area between plate 94 and channel 100, and tilting movement of the window outboard of the body is minimized by the same leverage action and the engagement of lug 116 within one side 117 of channel 100. As the window moves between open and closed positions, as can be seen in FIGURES 2 and 3, the stabilizer arm moves outwardly from underneath lug 116 and follows a curvilinear path different from that of the window. After the stabilizer arm has moved from underneath lug 116 the effectiveness of the arm is decreased in relation to outboard tilting movement of the window but the leverage action of the arm on studs 98 and 104 still holds this tilting movement to a minimum. However, since lateral instability or tilting movement of the window is most objectionable in the closed or substantially closed position of the window, the interlock between the lug and stabilizer arm is most effective where needed.

Additional lateral stability of the window in closed position is provided by a tongue and groove interlock between the forward portion of the lower window frame portion 52 and the inner and outer door panels. Referring now to FIGURES 1 and 7, a bracket 118 secured to the inner and outer door panels mounts a triangularly-shaped tongue 120 which is adjustably secured to the bracket by bolts 122 extending through slots 123 in the bracket to allow adjustment of the tongue relative to the bracket. A grooved member 124 adjustably bolted to the

lower window frame portion 52 at 126 interlocks with the tongue member in the closed position of the window as shown in FIGURE 1 to add additional lateral stability to the window in closed position.

Various stop arrangements are provided to adjust the position of the window in both open and closed positions. An L-shaped bracket 128 adjustably bolted at 129 to the lower slotted end of the front guide 74 provides a stop for the forward portion of the lower edge of window frame portion 52 in the open position of the window, as can be seen in FIGURE 3. A cylindrical rubber member 130 supported by a bolt 132 extending into a threaded aperture in the lower edge of the window frame portion 52 provides a stop for the rear portion of the lower edge of window frame portion 52 in the open position of the window by engaging an offset portion 134 of portion 20 of the rear wall of door 8. Thus, the open position of the window within the door well is controlled by both adjustable stops.

Since the rear window 16 must overlap the center pillar 6 in closed position and seal against the front window 12, a yielding stop is provided to ensure that the forward edge of the rear window will be located in a substantially vertical position to prevent interference with vertical movement of the front window and to effectively seal against the rear edge of the front window in the closed position of the front window. Referring now to FIGURE 6 of the drawings, an L-shaped bracket 136 bolted to the inner door panel 25 at 138 supports a bolt 140. An apertured rubber cylinder 142 fits on the shank of the bolt and extends between the bolt head and an apertured cup-shaped member 144 also fitting on the shank of the bolt and bearing against bracket 136. As the window moves upwardly to closed position, the upper edge of lift arm 34 engages the bolt head to stop upward movement of the window and locate the front edge of the window in a substantially vertical position. The rubber cylinder extending between the bolt head and the cup-shaped member provides resiliency to reduce any noise caused by the engagement of the lift arm with the bolt head and reduce the shock transmitted to the pivot 36 of the lift arm on the back plates 24.

Referring now to FIGURES 1, 2, and 3 of the drawings, the operation of the window regulator linkage will be described. As lift arm 34 swings downwardly and clockwise about pivot 36 from its position of FIGURE 1 to its position of FIGURE 2, stud 46 slides slowly rearwardly within retainer channel 48 and moves the rear portion of the window rearwardly and downwardly away from roof rail 14 at a faster rate than the forward portion of the window. This allows the forward portion of the window to move rearwardly and slightly downwardly from the roof rail 14 and withdraw the forward portion 150 of window frame portion 52 from the overlapping position with respect to center pillar 6 of FIGURE 1 to the position shown in FIGURE 2. If the rearward portion of the window did not move downwardly at a faster rate than the forward portion of the window, the forward portion of the window could not be moved away from the roof rail and the portion 150 of the window frame could not be withdrawn from overlapping position with respect to the center pillar.

During this initial movement of the window from the position of FIGURE 1 to the position of FIGURE 2, links 54 and 62 are likewise moved rearwardly and downwardly as stud 64 moves clockwise in an arc about pivot 36 at a slower rate of travel than the rate of travel of stud 46 in its arc about pivot 36. As link 62 moves downwardly with the lift arm 34, it is slightly rotated counterclockwise about the lift arm as link 58 swings counterclockwise in an arc about pivot 59. This slightly rotates link 54 in a counterclockwise direction about the lift arm since both links 54 and 62 are rotatably supported in fixed angular relationship on the lift arm by stud 64. The movement of points 56 and 46 rotate the window slightly

clockwise, lowering the rear portion relative to the front portion.

Considering now that the pivotal connection 60 between links 62 and 58 swings in an arc about pivot 59 and that this arc controls the rotation of link 62 about the lift arm 34 and also the rotation of link 54 about the lift arm, the movement of the window from its position of FIGURE 2 to its position of FIGURE 3 will be described. Referring now to FIGURE 1, an arc can be struck about pivot 36 through pivot 60 in the closed position of the window and this arc will diverge away from the arc of pivot 60 about pivot 59. Initially the two arcs are tangent to each other, and then both arcs begin to diverge in a downward direction, the arc about pivot 36 diverging in a clockwise direction and the arc about pivot 59 diverging in a counterclockwise direction. It should also be noted that the arc about pivot 36 is concentric with the arc of pivot 64 about pivot 36 and the arc of stud 46 about pivot 36. Thus, as the window initially moves rearwardly and downwardly from its position of FIGURE 1 to its position of FIGURE 2, pivot 60 and its arc of movement control the rotation of links 54 and 62 and thus the downward movement of the forward portion of the window. Pivot 60 moves in its arc of movement about pivot 59 only a slight distance, and since at this portion of the arc it is tangent to the arc about pivot 36 and just beginning to diverge, there is no appreciable downward movement imparted to the forward portion of the window. Therefore, the window moves rearwardly and downwardly, with the rear portion of the window moving downwardly at a greater rate of travel than the forward portion of the window.

However, as the rearward and downward movement of the window continues from its position of FIGURE 2 to its position of FIGURE 3, the arc of pivot 60 about pivot 59 diverges substantially from the arc about pivot 36, and thus links 62 and 54 are rotated an increasing amount relative to lift arm 34 causing stud 56 to impart a downward movement to the forward portion of the window and causing the forward portion of the window to move downwardly at a faster rate than the rear portion of the window until the window frame portion abuts against the stops hereinbefore described and assumes its position of FIGURE 3.

In this position of the window, pivot 60 in its arc about pivot 59 is at the greatest distance of divergence from the arc about pivot 36, and thus if it is now desired to raise the window from its position of FIGURE 3 to its position of FIGURE 2, the forward portion of the window swings upwardly at a greater rate of travel than the rear portion of the window until the window again assumes its position of FIGURE 2. At this position of the window and during movement of the window to the position of FIGURE 1, the window moves forwardly, and the rear portion moves at a greater rate than the forward portion of the window since the arc of pivot 60 about pivot 59 is approaching tangency with the arc about pivot 36. Thus, the window then moves to its position of FIGURE 1 with no appreciable forward and upward movement imparted to the window by studs 56 of link 54, since for all practical purposes this stud is now moving in an arc about pivot 36 concentric with the arcs of studs 64 and 46 and, therefore, stud 46 will impart substantially all the forward and upward movement to the window since it must move at a faster rate through its arc about pivot 36 than either studs 64 or 60 because of its greater radial distance from pivot 36. Thus, the general statement can be made that during the initial downward movement of the window or during the final upward movement of the window, pivot 60 can be said to move in an arc about pivot 36 concentric with the arcs of travel of studs 64 and 56, and since stud 56 is at the greater radial distance from pivot 36 than pivot 60 and thus must move at a faster rate of travel, it will impart all the force to the window in these stages of movement.

As hereinbefore described, the link 58 may be called

the pivoting restricting link or controlling link and the position of pivot 59 is critical with respect to any given geometry of the window movement for by changing the position of this pivot, the curvilinear path of the window movement can be varied without the use of any other mechanism. This is true since pivot 59 controls the arc of travel of pivot 60 and the rotation of links 54 and 62 relative to the lift arm which controls any force imparted to the forward portion of the window.

It must also be remembered that the window regulator linkage of this invention must be employed with guides to control the fore and aft shifting movement of the window as it moves between open and closed positions, since both the lift arm 34 and the link 54 are slidably connected to the window. The guides must be of a certain shape and spaced apart at certain distances to allow rearward and downward and forward and upward movement of both the front and rear portions of the window without any binding of studs 88 and 90 with respect to the guides, and thus, the shape and spacing of the channels will vary with the various curvilinear paths of movement which may be imparted to various windows to stow them within the door well.

The window illustrated moves in a vertical plane of travel, but it is obvious that the window may follow a curved path when moving between open and closed positions by appropriately curving the front and rear guide channels in an outward direction with respect to the inner door panel and allowing a certain play between studs 46 and 54 and the retainer channel 48 so that the studs can move inwardly and outwardly in the retainer channel. The window may also be curved so that it will follow the outer contour of the rear door when in closed position and the window regulator of this invention may be used with equal success with the slight modifications just previously noted. Since both the window regulator linkage and the guide channels are mounted on the inner door panel inboard of the window in all positions of the window, curvature of the guide channels and the window may be had without materially reducing the stowage space within the door well to a point where it will not receive the window in closed position.

While a specific embodiment of this invention has been shown and described, various changes and modifications may be made within the scope and spirit of the invention.

We claim:

1. A window regulator mechanism for imparting translational and rotational movement to a vehicle window comprising, a support, a driving arm pivotally mounted on said support and pivotally connected to said window, a balance arm pivoted on said driving arm and pivotally connected to said window, and a control link having one end thereof pivotally mounted on said support and the other end thereof pivotally connected to said balance arm for swinging said balance arm about said driving arm as said driving arm imparts translational movement to said window to cause said balance arm to rotate said window about said pivotal connection of said driving arm to said window in a direction opposite the direction of swinging of said driving arm.

2. A window regulator mechanism for imparting translational and rotational movement to a vehicle window comprising, a support, a driving arm pivotally mounted on said support and pivotally connected to said window, a balance arm pivoted on said driving arm and pivotally connected to said window, and a control link having one end thereof pivotally mounted on said support for swinging movement of said link in a direction opposite the direction of swinging movement of said driving arm, the other end of said link being pivotally connected to said balance arm for swinging said balance arm about said driving arm as said driving arm imparts translational movement to said window to cause said balance arm to rotate said window about said pivotal connection of said driving arm

to said window in a direction opposite the direction of swinging of said driving arm.

3. A window regulator mechanism for imparting translational and rotational movement to a vehicle window movable between open and closed positions comprising, a support, a driving arm pivotally mounted on said support and pivotally connected to said window, a balance arm pivoted on said driving arm and pivotally connected to said window, and a control link pivotally mounted on said support and pivotally connected to said balance arm for swinging said balance arm about said driving arm as said driving arm imparts translational movement to said window to cause said balance arm to rotate said window about said pivotal connection of said driving arm to said window in a direction opposite the direction of swinging of said driving arm, the pivotal connection between said control link and said balance arm lying at the tangent point of arcs having their centers at the pivotal connection of said driving arm on said support and the pivotal connection of said control link on said support in one of said positions of said window.

4. In a window control mechanism for raising and lowering a window in a motor vehicle body, a regulator gear pivotally mounted upon the body, an actuating arm having its lower end movable with said regulator gear and its upper end pivotally connected to the lower edge of said window rearwardly of the center thereof, a second arm pivotally connected intermediate its ends to an intermediate part of said actuating arm, a horizontal guideway at the lower edge of said window forwardly of the center thereof, means slidably connecting the forward end of said second arm to said guideway, a short link having its lower end pivotally connected to the lower end of said second arm, means pivotally connecting the upper end of said link to said body at a point spaced rearwardly and above the connection of said link to said second arm to effect an initial rearward movement of the upper end of said second arm and a subsequent downward movement thereof to move the forward portion of the window first generally rearwardly and then generally downwardly.

5. The structure defined by claim 4 which is further characterized in that said actuating arm and said second arm diagonally cross each other in the raised position of the window to form generally an X-shape, said short link being so positioned that the pivotal connection between the link and said second arm moves in an arc diagonally downwardly and rearwardly during the initial lowering movement of the window and subsequently moves generally rearwardly during the lowering movement of said window.

6. In a window control mechanism for raising and lowering a window in a motor vehicle body, a pair of regulator arms pivotally interconnected intermediate their ends and crossing each other in X fashion in the raised position of said window, regulator mechanism connected to one of said regulator arms to raise and lower said window, means pivotally connecting one end of one of said regulator arms to the lower portion of said window, means pivotally connecting the opposite end of said one regulator arm to said vehicle body at a fixed point, means connecting one end of the other of said regulator arms to the lower portion of said window for longitudinal sliding movement therealong, and a link movably supporting the opposite end of said other regulator arm upon said vehicle for movement in a predetermined path, said link having its lower end pivotally connected to said last mentioned regulator arm and its upper end pivotally connected to said vehicle body, said link extending diagonally upwardly and longitudinally away from the pivotal connection of said one regulator arm to said vehicle body in the raised position of said window to move said pivotal connection between said link and said last mentioned regulator arm first in an arc generally downwardly and longitudinally and subsequently generally longitudinally in the lowering movement of said window.

7. In a window control mechanism for raising and lowering a window, a support, a pair of regulator arms pivotally interconnected intermediate their ends and each being pivotally connected at one end to said window at spaced points, means pivotally connecting the opposite end of one of said regulator arms to said support, regulator mechanism connected to one of said regulator arms to raise and lower said window, and a link pivotally connected at spaced points to said support and to the opposite end of the other of said arms, said link extending

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diagonally upwardly and longitudinally away from the pivotal connection of said one regulator arm to said support.

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