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J. E. MARTENS
WINDOW ACTUATOR

3,062,528

Filed May 16, 1958

3 Sheets-Sheet 1

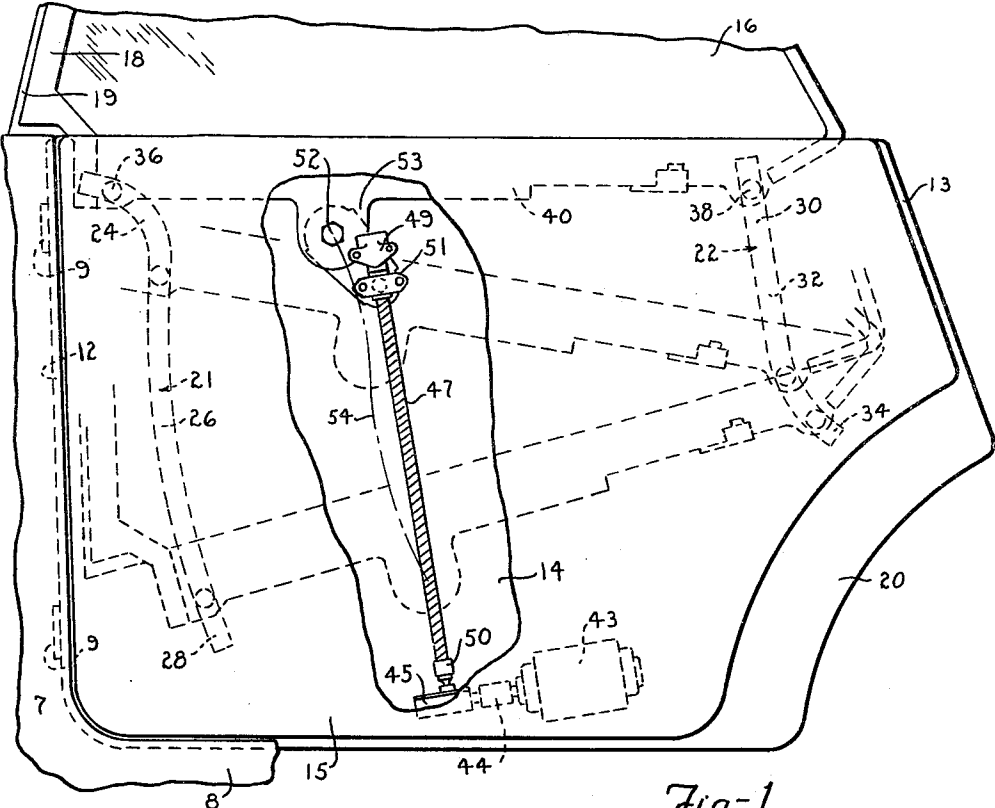


Fig. 1

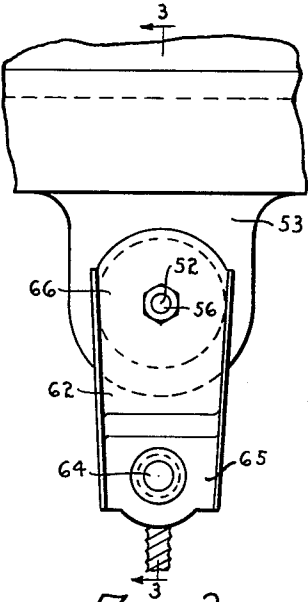


Fig. 2

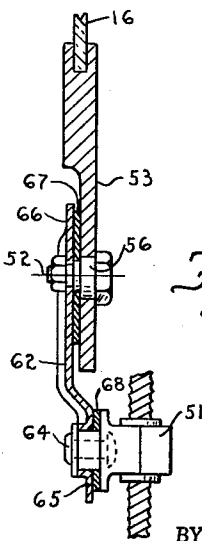


Fig. 3

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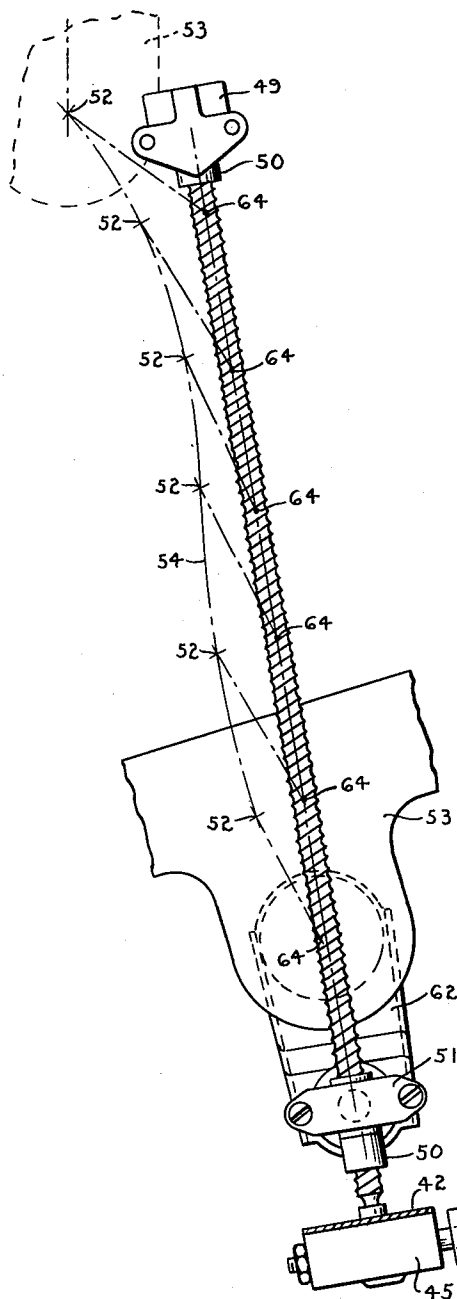


Fig.-5

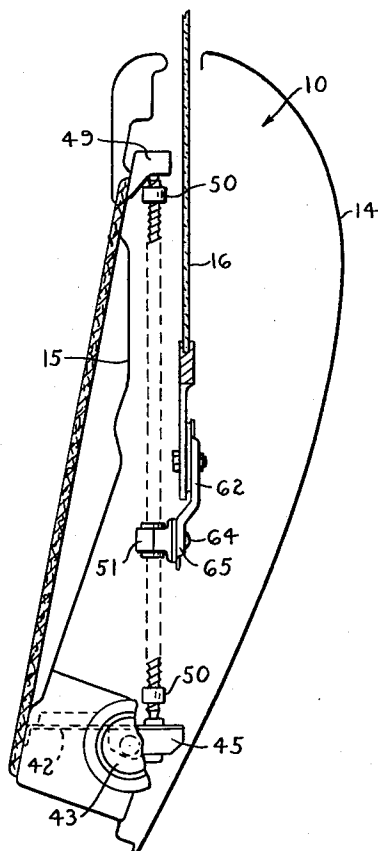
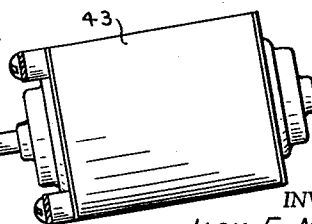


Fig.-4



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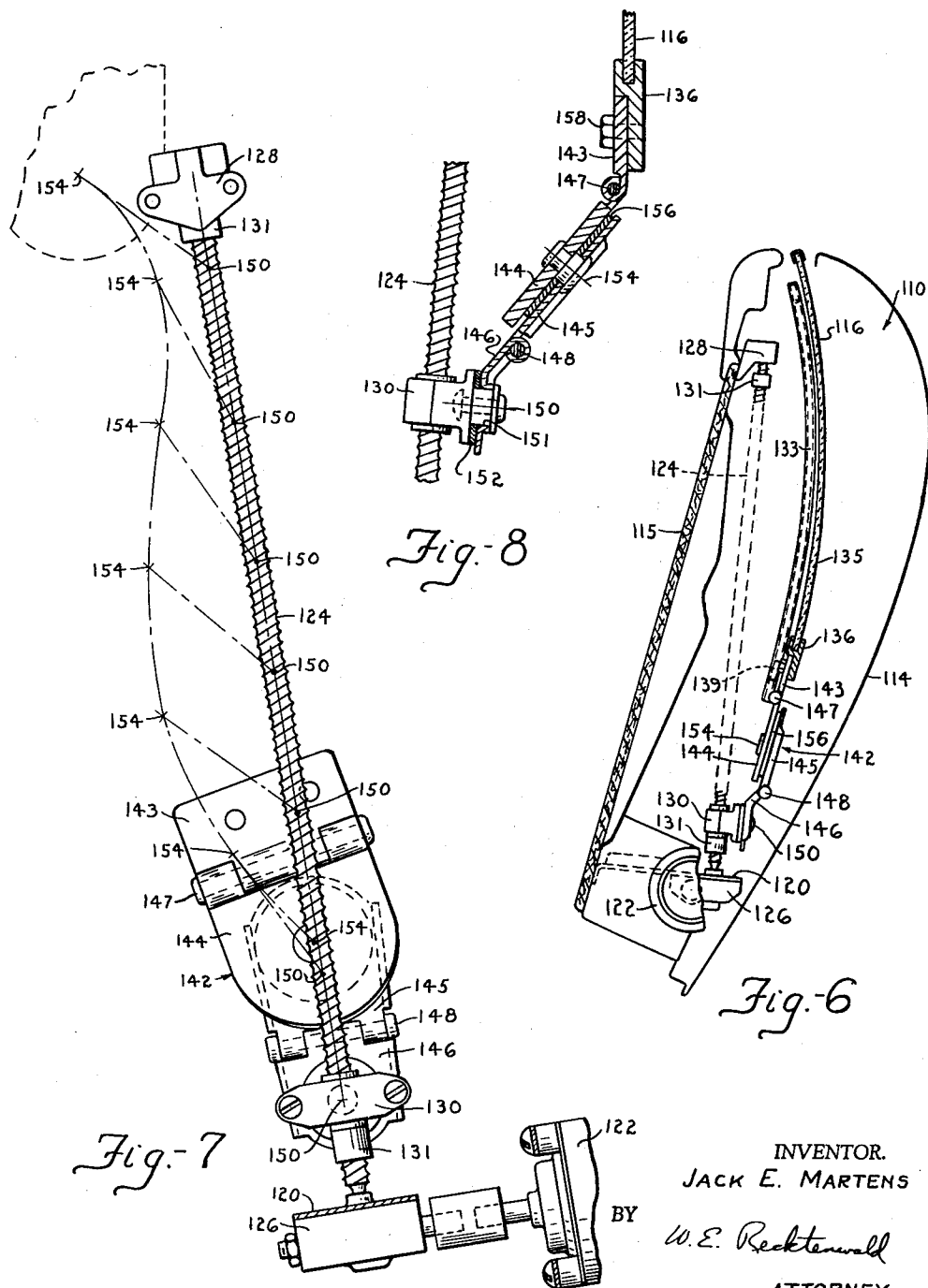
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3,062,528

WINDOW ACTUATOR

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5 Claims. (Cl. 268—124)

This invention relates generally to window regulators for motor vehicles and has particular reference to a window regulator mechanism adapted to move a vehicle window in a predetermined nonlinear path.

Current automotive design is continually moving more and more in the direction of increased complexity of design which requires that larger retractable windows be nested in increasingly smaller areas when in the retracted position. The increased size of the windows and smaller storage space combine with other features to require that the windows move through either a two-dimensional or three-dimensional nonlinear path as they are raised or lowered.

In certain projected designs, it is necessary for the window to not only be moved upwardly and forwardly as it is raised, but also, to be moved in an arcuate path in the plane lying substantially perpendicular to the plane containing the path of the first two movements. To create these different multidirectional movements, it is necessary to have, not only guide means capable of directing the window through the proper predetermined nonlinear path of travel, but also to provide a driving system that is capable of applying multidirectional driving forces to the window structure without jamming or wedging in the guide channels of the body frame structure.

To further complicate the problem, it is necessary to provide the guide structure and driving mechanism with stabilizing means that are adapted to hold the window in any pre-selected raised condition no matter how hard the doors of the vehicle are slammed or how severe the shocks to which the vehicle is subjected due to bumpy road conditions or the like. The window mounting and driving structure must be capable of absorbing severe vibrations and misuse and still be capable of smooth, quiet, and efficient operation at a relatively low installation and maintenance cost.

It is, therefore, an object of this invention to provide an improved window lift mechanism that is operative under all conditions of use.

It is another object of this invention to provide an improved window lift that is capable of accomplishing the several different required compound motions to effect the raising and lowering of a vehicle window with a relatively simple direct-acting drive means.

A further object of this invention is to provide an improved window lift that is quiet and efficient in use.

A still further object of this invention is to provide an improved window lift mechanism that is compact enough to fit within relatively thin doors or body panels of automobiles.

And a further object of this invention is to provide a window lift structure that is capable of producing movement of a window in any one, two or three different directions at one time.

It is still a further object of this invention to provide an improved window lift structure having novel interconnected link mechanisms between the motion-transmitting nut and the base of the window that are adapted to create compound movements of the window.

Another object of this invention is to provide an improved window lift that is relatively inexpensive to build and relatively simple to assemble and repair.

And still another object of this invention is to pro-

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vide an improved window lift assembly that is capable of absorbing severe shock loads and vibrations.

It is a further object of this invention to provide an improved window lift assembly having a single, relatively fixed driving means that is adapted to move a window in a plurality of different directions.

A still further object of this invention is to provide a window lift assembly in which provision is made to compensate for any variations or misalignments between the components of the window and window lift assembly.

A significant object of this invention is to provide a unique window assembly comprising a minimum number of components which can be economically manufactured and assembled on a production basis and which can be easily and quickly installed.

These and other objects and advantages of the invention will become apparent as the description of the same proceeds. The invention will be best understood from a consideration of the following detailed description taken in connection with the accompanying drawing forming part of this specification, with the understanding, however, that the invention is not confined to any strict conformity with the showing of the drawing, but may be changed or modified so long as such changes or modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

In the drawings:

FIGURE 1 is a side elevational view, partly broken away, of a portion of the side of a motor vehicle door assembly incorporating the power-driven regulator mechanism of the present invention;

FIGURE 2 is an enlarged side elevational view of the link and pivot arrangement of the present invention;

FIGURE 3 is a cross-sectional view taken on the line 3—3 in FIGURE 2;

FIGURE 4 is an end view of the window regulator mechanism of FIGURE 1 with the window in a partially raised position;

FIGURE 5 is an enlarged side elevational view of the motor, screw and nut, and link assembly of FIGURE 1;

FIGURE 6 is a view similar to FIGURE 4 showing a modified form of the link assembly of my invention;

FIGURE 7 is an enlarged side view of the operative parts of the modified showing of FIGURE 6; and

FIGURE 8 is an enlarged view of FIGURE 6 with the nut advanced on the screw and the link assembly pivoted into a different position.

Referring now to the drawings, and particularly to FIGURES 1 to 5, a pillar 7 integral with the floor 8 of a vehicle is shown wherein hinges 9 support the door 10 having a hinge edge 12, latch edge 13, an outer side panel 14 and an inner side panel 15. The door illustrated is a rear door of a four-door hardtop automobile which is supported by hinges on a center pillar that terminates at the belt line of the vehicle so that there is no fixed supporting pillar of any kind disposed between the front and rear window portions above the belt line thereof. It is to be understood, however, that the window lift mechanism here illustrated can also be mounted in the front door, rear door, rear quarter panel, or the like of any type automobile.

A window panel 16 having a surrounding metal frame 18 is mounted for bodily movement between the raised or closed position shown in solid lines in FIGURE 1 and the lowered or opened position shown by the lowermost set of dotted lines in FIGURE 1. In the lowered position, the window is completely housed within the window well provided in the co-operating body portion of the vehicle.

In the present showing of this invention as incorporated in the rear door assembly, the space available to house

the window 16 in its lowered position is rather limited due to the location of the pillar 7 to which the door 10 is hinged. It will be noted that in the raised position the forward edge 19 of the window projects forwardly beyond the hinge portion 12 of said door. The door must also be formed to have a rear wheel cut-out portion 20 which is adapted to fit over the housing provided in the body for covering the rear wheel on that side of the vehicle. The distance, therefore, through which the rearward portion of the window 16 may be moved along the latch edge of the door is shortened considerably. As a result of the design limitations inherent in these just-enumerated body components, the window 16 cannot be moved between its closed and opened positions either by direct vertical movement or by a simple pivotal movement, but instead must be moved in a predetermined irregular path having several combinations of both longitudinal and vertical movements so as to move the forward edge 19 of the window around the pillar 7 as well as to conform to the limitations imposed by the wheel cut-out portion 20.

The window is mounted on suitable means to accomplish the necessary compound longitudinal and vertical movements and for this purpose, there are mounted within the door 10 on the frame of the inner side 15, a pair of guideways 21 and 22 each one of which is disposed, respectively, in close proximity to the generally vertically disposed door edges 12, 13. The forward guideway 21 is shaped so that the top portion 24 is turned at a slight angle with respect to the horizontal whereupon the guideway is bent gradually until it is directed substantially vertically downward throughout an intermediate portion 26 with a lower portion 28 shaped in a gradual curve away from the hinge edge 12 of the door. The rearward guideway 22 is shaped such that the top portion 30 and central portion 32 are substantially in line with each other and are sloped rearwardly a few degrees. The lower portion 34 of guideway 22 is curved rearwardly from portion 32 in a gradual arc.

The guideways 21, 22 are supported on the frame of the inner panel of the door in such a position that a pair of rollers 36 and 38 carried on the frame 18 of the window at the front and rear lower corners, respectively, are engaged in said guideways for supporting and guiding the window during the opening and closing movements. The rollers 36 and 38 are rotatably carried by and extend laterally from a support member 40 of the window frame 18, the support 40 being of conventional design and being engaged with the lower edge portion of the window 16 in such a way that any upward or downward forces exerted on said member 40 will be transmitted directly to the window to effect its raising or lowering. The guideways 21, 22 and their mounting with respect to the window are of a well-known design and are related to the present invention only insofar as they define the path of movement of the window and produce the desired compound motions required to complete the opening and closing thereof. Since the distance between the centers of the rollers 36 and 38 is fixed and the guideways are immovably fastened to the door panel, it is apparent that the window will follow a predetermined pattern of movement while being driven between the raised and lowered positions.

In following the present teaching, the window is raised and lowered by means of a power-operated motion-transmitting means and for this purpose, a motor support bracket 42 is secured to the frame of the inside panel 15 of the door. A motor 43 is mounted on said bracket and has a flexible coupling 44 interposed between the motor and the input side of a gear reduction drive 45, also carried by said bracket 42. The output side of the gear reduction drive is keyed to a motion-transmitting screw or shaft 47 which is rotatably mounted at its upper end portion in a stationary swivel-type bearing 49 carried by the frame of the door panel 15. The screw member 47 has a pair of free-wheeling stops 50 fastened to said

shaft near the opposite end portions for limiting movement of a nut member 51 along the axis of the shaft.

In the example here shown, due to the geometry of the system, there is a point 52 located on a projection 53 carried by the lower edge portion 40 of the window frame that describes in space, a predetermined path of travel as the window 16 is guided between the raised and lowered position by the guides 21, 22. The path followed by this point 52 is best illustrated by the dotted line 54 in FIGURES 1 and 5 of the drawing and lies generally in the plane of the glass. A pivot pin 56 is fastened to said projection 53 and extends laterally therefrom in such a way that the point 52 is located on the axis of said pin 56.

The position of the pin 56 may be varied within reason, but as here shown, is located in the position which follows the simplest path of travel between the raised and lowered positions of the window. The path of travel 54 is located completely to one side of the centerline of the shaft in the illustrated showing of FIGURE 1; however, it is to be understood that the path could cross the axis of the shaft once or several times without departing from the invention.

The shaft 47 has the nut means 51 drivingly connected therewith for movement up and down the shaft as the shaft 47 is rotated. A link means 62, as shown in FIGURES 2 and 3, is pivotally connected to the nut means 51 by means of a shouldered rivet 64 passing through an aperture formed in the offset end portion 65 of said link 62. The other end portion 66 of the link 62 is pivotally secured to the projection 53 carried by the frame 40 of the window assembly by means of the pivot member 56 passing through an aperture in the projection and through an aperture in said upper portion 66 of the link 62. An antifriction washer 67 is positioned between the upper portion 66 of the link means 62 and the projection 53 and washer 68 is positioned between the lower portion 65 and the nut 60 to reduce the friction between and add stability to the respective opposite end portions of the link, and the nut and the projection. Since the opposite end portions of the link 62 are free to pivot about the axes of both the shouldered rivet 64 and the pivot member 56, it is possible for the linear movement of the nut member 51 to be transmitted to multidirectional non-linear movement of the window assembly 16.

As the nut member 51 is moved up the shaft, a linear force is exerted on the rivet 64 in a direction substantially parallel to the axis of the shaft 47. This force is transmitted through the link 62 to the pivot 56 joining the link to the projection 53 on the window frame. Since the linear unidirectional force on the rivet 64 is transmitted to the pivot 56 at a point off the axis of the force, the force at pivot 56 is broken down into substantially two components. One component of force is tending to move the window up the channels 21, 22, the other component of force is tending to move the window toward the hinge end of the door. Thus as the nut member 51 is moved up the screw, the window is moved in an upward and generally forward direction. Conversely, as the nut member 51 is moved down the shaft 47, the window is moved in a downward and generally rearward direction by the forces acting through the link 62.

The horizontal axis of the rivet 64 moves in a substantially straight line in a plane containing the axis of the shaft 47. The axis 52 of the pin 56 traverses a path, shown as the dashed line 54, which describes a relatively flat sine-type curve lying to the one side of the plane containing the axis of the shaft 47 and the axis of the rivet 64. The angle lying between the axis of the shaft and the line joining the axis of the rivet 64 and axis 52 of pivot 56 must of necessity vary between zero degrees and an acute angle of preferably less than 45 degrees in order for the forces to be transmitted from the nut 51 to the window frame assembly. Due to the fact that the just-

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enumerated angle is generally acute, and due to the position of the link 62 in the fully raised position of the window, the forward component of force on the window is greater than usual tending to drive the window forward with an extra push for seating the window in the closed position. The extra closing push results from the toggle arrangement created by the angle between the axis of the shaft 47 and the line joining the pivot 56 and rivet 64 approaching the 45° value such that practically all the force from the nut is thrown over into a short, generally forward direction for driving the window into closed position.

In the invention shown in FIGURES 1 through 5, the window structure is moved through a predetermined non-linear path lying in substantially a single plane, which plane coincides with the plane of the glass of the window.

In the modified form of my invention shown in FIGURES 6 through 8, a more complex nonlinear path of movement is shown. FIGURE 6 is an end view of a curved window 116 in association with a body portion of a vehicle so as to illustrate, in the solid-line position, a window structure nested in the door of a motor vehicle. The door 110 has an outer panel 114 and an inner panel 115 and has a motor mounting bracket 120 fastened to the frame of the inner panel 115 near the lower portion thereof. A reversible motor 122 carried by the bracket 120 is flexibly connected to a rotatable threaded shaft 124 through a gear-reduction drive 126 such that selective operation of the motor will drive the shaft 124 in either a clockwise or counterclockwise direction. The upper portion of the shaft 124 is mounted in a swivel-type bearing 128 which is carried by the frame of the inner panel 115 of the door. A motion-transmitting nut 130, similar in operation and construction to the nut 51 described with respect to FIGURES 1 through 5 inclusive, is operatively associated with the shaft 124 for movement along the axis of said shaft 124. A pair of stops 131 are mounted on the shaft 124 to limit axial movement of the nut 130 along the shaft.

A pair of channel members 133 are mounted in the door cavity and are in part shaped substantially the same as the channels 21, 22 of FIGURE 1 except an additional curvature is added to the channels in the curved plane of the window 116. The channels 133 are shaped to produce three different directions of movement of a window as it is being moved from a lowered to a raised position. The first two directions of movement are the more conventional types shown in FIGURE 1 wherein the window is moved, up and down, and front and rear. The third direction of movement is in an arcuate path substantially the same as the arcuate curve of the window and is in a plane transverse to the plane of the first two directions of movement.

The window 116 has a frame 136 which has rollers 138, 139 connected to the front and rear corner portions thereof. The rollers 138, 139 are operatively engaged with the shaped channels 133 in such a way that application of an upward force on the window frame 136 causes the rollers to follow the shaped channels to move the window 116 through the three above-described directions of movement between the down and up positions of the window. In the particularly illustrated form, with the window in the fully retracted position and starting to be raised, the first movements are a gradual frontward shift as the front portion of the window is raised faster than the rear portion and the upper portion of the whole window moves in an arcuate path inwardly from the outside of the vehicle. This motion continues until the rear portion starts to move more rapidly upwardly, then the whole window will move forward as the rear portion moves more rapidly upwardly and the inward arcuate movement of the window continues until the fully raised dotted-line position of FIGURE 7 is reached.

To produce the three-dimensional driving force required

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for this modification, a link structure 142 formed in four parts or portions, namely, upper 143, two intermediate 144, 145, and lower 146, is pivotally connected to the nut member 130 and rigidly connected to the frame 136 of the window 116 for transmitting the linear movement of the nut member 130 to the compound predetermined non-linear movement of the window.

Specifically, the link 142 has the upper portion 143 and one intermediate portion 144 hinged together by a hinge or pivot pin 147 and has the other intermediate portion 145 hinged to the lower portion 146 by a hinge or pivot pin 148. The longitudinal axes of pins 147, 148 each lie in the planes of the respective joined portions 143, 144 and 145, 146, so that one portion can move relative to its hingedly joined other portion in a plane lying substantially perpendicular to the axis of the appropriate pin 147 or 148 in the general direction toward or away from the screw member 124.

The lower portion 146 of the link is pivotally secured to the housing of the nut assembly 130 by means of the shouldered rivet 150 which passes through a flanged aperture 151 in said portion 146. An antifriction type washer 152 is sandwiched between the portion 146 and the nut 130 to reduce friction therebetween. The rivet 150 is of such a type that the lower portion 146 is free to pivot about the axis of the rivet 150 in a plane substantially parallel to the axis of the screw member 124 as the nut member 130 is moved along the axis of the shaft 124. The intermediate portions 144 and 145 of the link are coextensive with each other and are pivotally joined together by a pivot 154 passing through the central portions thereof. An antifriction type washer 156 is sandwiched between the coextensive relatively pivoted intermediate portions 144, 145 of the link so as to permit rotation of one of said portions relative to the other about the axis of the pivot 154.

The upper link 143 is fastened to the frame 136 of the window structure by means of a pair of screws 158 or the like, such that the link 143 is to all intents and purposes considered rigid or integral with respect to the window frame structure.

The upper portion 143 of the link is hinged to the intermediate portion 144 of the link by means of the pin 147 such that the intermediate portion 144 and upper portion 143 can move relative to each other in a direction substantially toward and away from the axis of the screw 124 in a plane substantially perpendicular to the axis of the pin 147. The other intermediate portion 145 of the link is hinged to the lower portion 146 of the link by means of the pin 148 such that the portions 145 and 146 are free to move relative to each other in a direction substantially toward and away from the axis of the screw 124 in a plane substantially perpendicular to the axis of the pin 148. The pins 147 and 148 permit the window to be moved through an arcuate path from the lowered to the raised position such as illustrated in FIGURE 6 between the solid-line position and the dotted-line position. That is, as the nut 130 is moved up the shaft 124, the guides 133 on the respective ends of the window will cause the portions 143, 144 and 145, 146 of the link 142 to pivot or swing about the axes of the pins 147, 148 to drive the window through the arcuate path defined by the arcuate shape of the guide channels.

Simultaneously with the arcuate movement of the window is the nonlinear forward and upward movements of the window created by the additional nonlinear shapes of the channels 133. That is, in addition to the arcuate path of movement the window may be additionally moved through the same two movements illustrated with respect to FIGURE 1. To accomplish the additional forward and upward movement, the link 142 is provided with the pivot 154 through the intermediate portions 144 and 145 and the pivot or rivet 150 through the lower portion 146 of the link 142. The axis of the pivot 154 is substantially perpendicular to the planes of the in-

intermediate portions 144 and 145, and the axis of the pivot 150 is substantially perpendicular to the plane of the lower portion 146 such that the lower portion 146 of the link 142 can pivot about the axis of the pivot 150 in a plane substantially perpendicular to the axis of the pivot 150 and the intermediate portions 144 and 145 can pivot about the axis of the pivot 154 in planes substantially perpendicular to the axis of the pivot 154.

The pivots 150, 154 permit the axial force from the nut 130 to be transmitted through the link 142 to the window assembly for raising or lowering the window. The pivot 150 always moves in an axial path up or down the screw. The force through the lower and intermediate portions 146, 145 to the pivot 154 will be divided into two forces, one upward and one forward (assuming that the window is being raised) so as to move the window forwardly and upwardly. The transmission of forces from the nut to the window frame through the link 142 with respect to the forward and upward directions of movement is centered about the pivots 150 and 154 and results in a movement substantially identical with the two movements described with respect to FIGURES 1-5.

In the modified form of my invention shown in FIGURES 6-8, as the nut member 130 is moved in a linear direction up the shaft 124, a nonlinear movement of the window assembly is created by the combined effects of the link 142 and the shaped guides 133. That is, the window assembly is given an arcuate path of movement by the arcuate shape of the guides and by the hinge pins 147, 148 permitting the window to follow a path generally toward and away from the axis of the shaft 124. At the same time, the shape of the guides 133 in the generally forward and upward directions and the pivots 154 and 150 permit the window assembly to be driven forwardly and upwardly as the nut member 130 advances up the screw 124. The result is a relatively simple drive arrangement that is capable of producing a relatively complex plurality of movements of a window assembly.

The modification of FIGURES 6-8 has a toggle arrangement similar to the arrangement described with respect to FIGURES 1-5 for driving the window into seating position in the fully raised condition. That is, the angle between axis of the shaft and the line joining the pivots 154 and 150 approaches 45° whereupon substantially all the force from the nut 130 to the pivot 154 is exerted in a substantially forward direction for seating the window in closed position.

It is to be understood that the particular shape of the guides 21 and 22 (FIGURES 1-5) and guides 133 (FIGURES 6-8), as illustrated and described, and the particular path of motion created thereby does not form a part of this invention. Any set of guides that directs the window in any odd or unusual pattern to accomplish an equivalent action is to be considered within the scope of the invention.

Having thus described my invention, it is obvious that variations and modifications may be made in the same

without departing from the spirit of my invention; hence, I do not wish to be understood as limiting myself as to the exact forms, constructions, arrangements and combinations of parts herein shown and described for use as mentioned.

I claim:

1. A window regulator for a vehicle having a window panel movable between raised and lowered positions, comprising coacting means on the window and vehicle for guiding said window in a predetermined nonlinear path, means including a threaded shaft and a nut movable thereon providing a straight-line drive, means operatively connecting the nut and window panel, said connecting means comprising first and second links pivotally connected to each other at their inner ends along a first axis lying transverse to the axis of the threaded shaft, the first link being pivotally connected at its outer end to the window panel, the second link being pivotally connected at its outer end to the nut, the last-named connections lying along axes transverse to the first-mentioned axis whereby the means connecting the nut and window is articulatable to transmit the straight-line motion of the nut to the predetermined nonlinear motion of the window panel.

2. The structure as defined in claim 1 wherein the last-named connections lie on opposite sides of the pivotal connection between the links.

3. In combination: a window having an edge provided with a part, a threaded shaft, a nut connected to said shaft and provided with a part extending therefrom, and an assembly operatively connecting said parts for actuating said window when said shaft is rotated, said assembly comprising a pair of flat members secured together in a superimposed relation for relative pivotal movement about a first axis disposed transverse to the axis of said shaft, and a pair of pivot means respectively connecting said members to said parts for movement about axes disposed substantially perpendicular to said first axis so that said members may pivot relative to one another and relative to said respective parts when said window is actuated.

4. The combination defined in claim 3 in which the assembly extends generally lengthwise alongside the shaft and the part provided on said nut is pivotally connected thereto for movement about an axis disposed substantially perpendicular to said shaft.

5. The combination defined in claim 3 in which said parts and members extend continuously in an end-to-end relation in a direction generally lengthwise alongside said shaft.

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