Aug. 26, 1969 R. J. LYNN ETAL 3,462,881

SLIDE-GLIDE-PLUG DOOR MECHANISM

Filed March 14, 1968 4 Sheets-Sheet 1

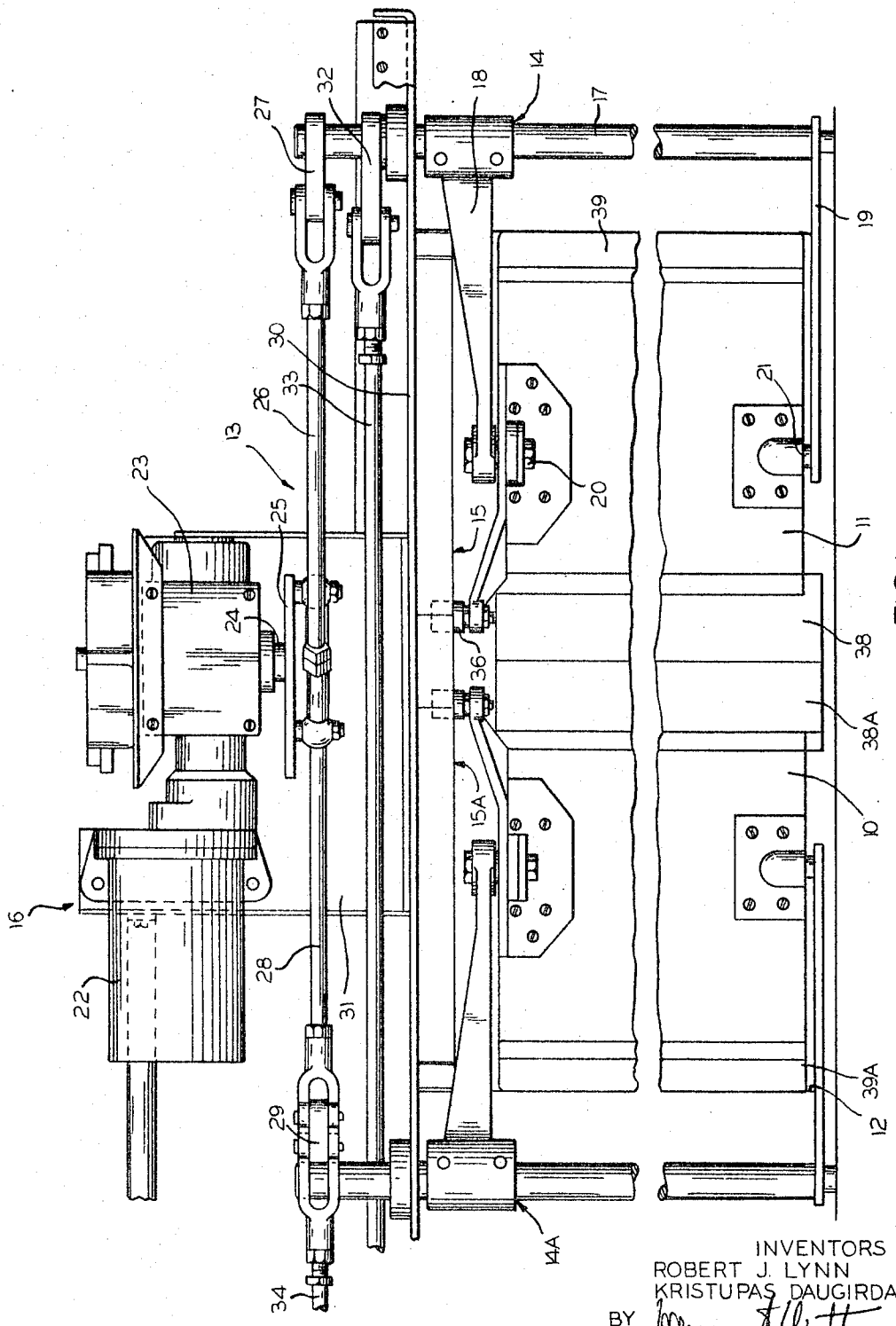

FIG. 1

INVENTORS
ROBERT J. LYNN
KRISTUPAS DAUGIRDAS
BY
ATTORNEY

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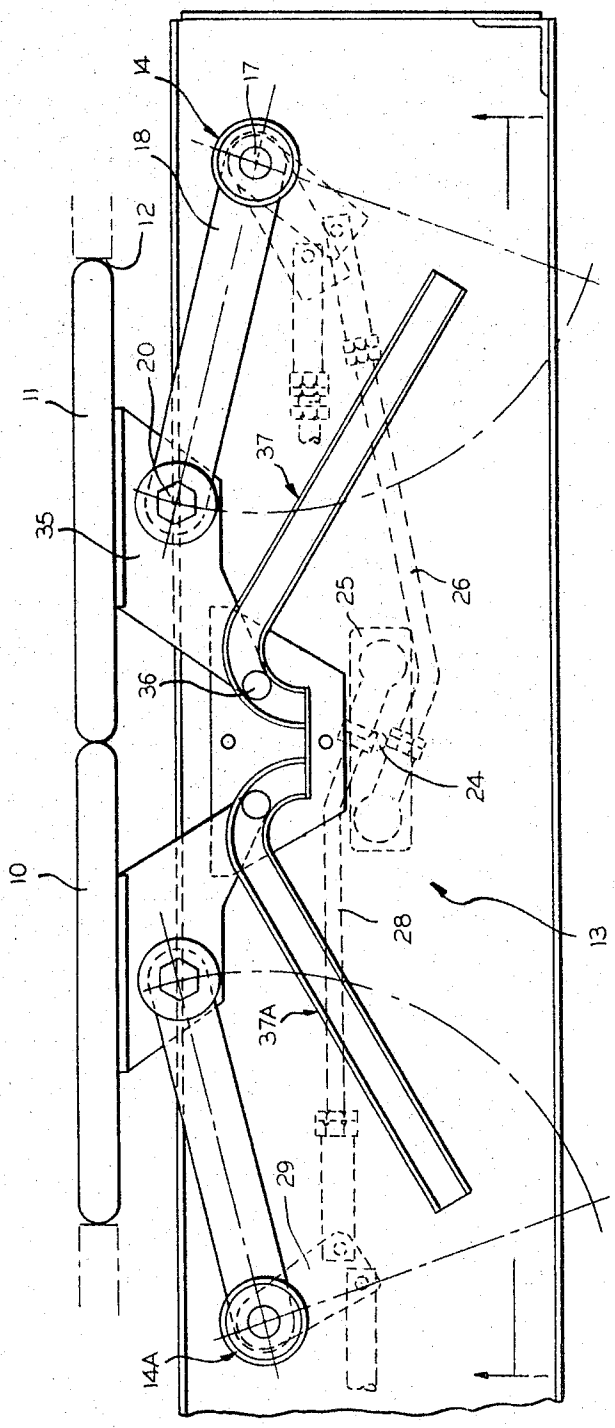

FIG. 2

INVENTORS
ROBERT J. LYNN
KRISTUPAS DAUGIRDAS
BY
ATTORNEY

Aug. 26, 1969 R. J. LYNN ETAL 3,462,881

SLIDE-GLIDE-PLUG DOOR MECHANISM

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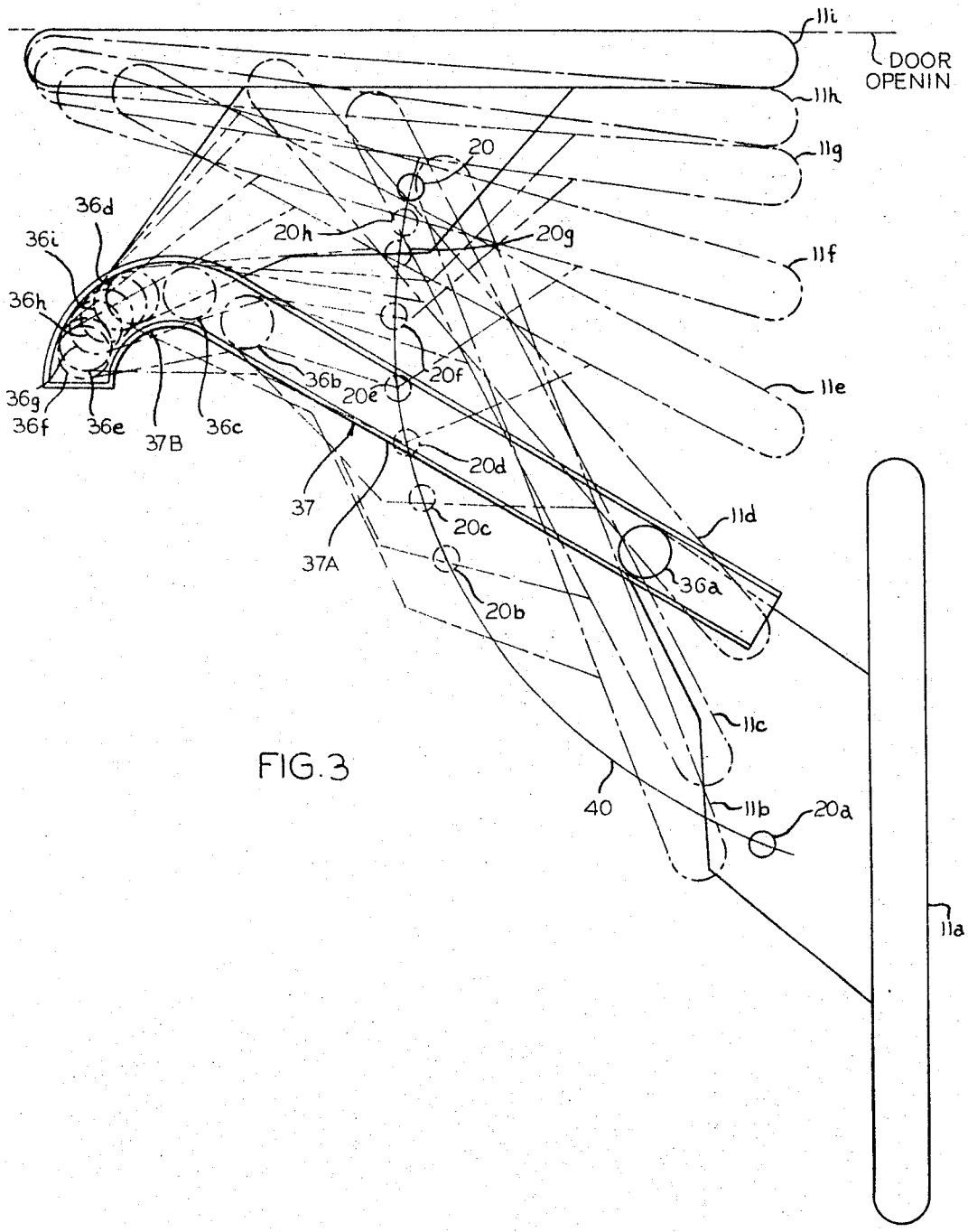

FIG. 3

INVENTORS
ROBERT J. LYNN
KRISTUPAS DAUGIRDAS
BY Duncan Scott
ATTORNEY

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SLIDE-GLIDE-PLUG DOOR MECHANISM

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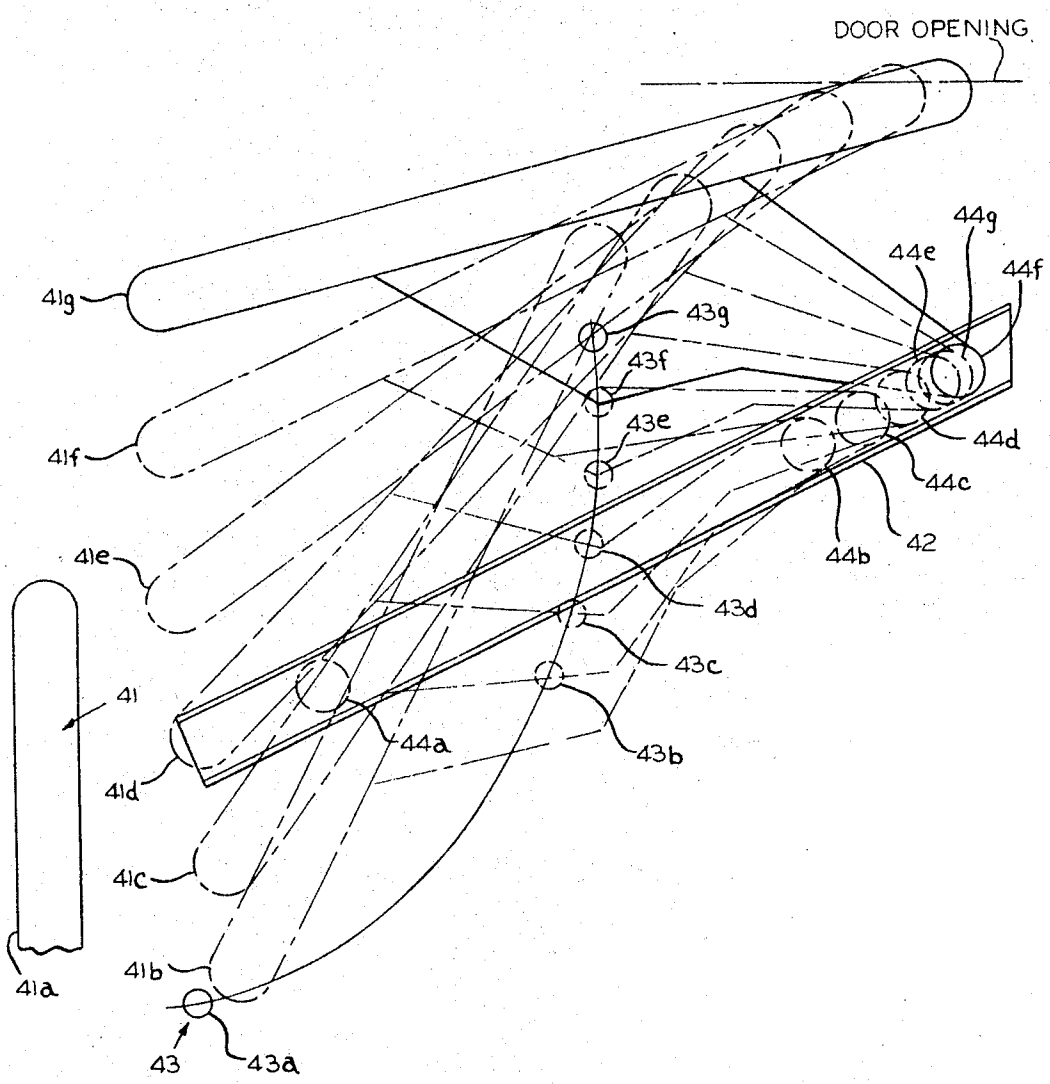
FIG. 4

PRIOR ART



INVENTORS
ROBERT J. LYNN
KRISTUPAS DAUGIRDAS
BY
ATTORNEY

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SLIDE-GLIDE-PLUG DOOR MECHANISM

Robert J. Lynn, Morton Grove, and Kristupas Daugirdas, Wilmette, Ill., assignors to Vapor Corporation, Chicago, Ill., a corporation of Delaware

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Int. Cl. E05f 17/00, 7/06
U.S. Cl. 49—111 7 Claims

ABSTRACT OF THE DISCLOSURE

Mechanism for driving a door through compound movement between open and closed positions including imparting to the door a slide-glide-plug action by actuation of a shaft and lever assembly and guidance from a track unit.

This invention relates in general to a door opening and closing mechanism especially useful for vehicles that transport passengers, and more particularly to a door operating mechanism capable of imparting a slide-glide-plug movement to a door of a vehicle.

Heretofore, mechanisms for controlling door operation in vehicles that transport passengers have taken many forms. These vehicles, which include buses and railway cars, are provided with openings to permit ingress and egress of passengers, which openings are normally provided with a plurality of door leaves. Generally a pair of door leaves are provided for each door opening. Doors having a swinging movement about hinges are objectionable in that when they are open they obstruct the passageway. Sliding doors are either outside hung and therefore project beyond the perimeter of the vehicle presenting a poor aesthetic appearance, or are inside hung thereby allowing a portion of the door opening to be exposed when the doors are closed. Further, sliding doors require pockets for receiving the doors when they are in open position. Also conventional sliding doors are difficult to seal. Doors mounted for a sliding and guiding movement have employed a straight track arrangement where the leading edge of the door in certain positions has a motion that is beyond the seal at the door closed position, thereby causing as the door moves to and into closed position the rubber edge of the door to bend and rub against the more solid seal of the opening in the vehicle, and such rubbing action is injurious to the rubber parts thereby shortening their life.

The door operating mechanism of the present invention overcomes the objections of heretofore known mechanisms in that a slide-glide-plug action is imparted to the door which obtains a better sealing action relative to the door opening, and encounters rubbing action relative to the rubber sealing parts during plugging action to thereby extend the life of the rubber parts. Moreover, the door operating mechanism of the present invention enables the doors to be flush with the outer surface of the car when in closed position, thereby enabling the doors to be contoured or straight to match the outer car or vehicle walls. During operation of the door mechanism of the present invention, the door is moved through a compound movement laterally and longitudinally relative the car or vehicle wall swinging through 90° rotation and taking a position at right angles to the car wall in fully opened position. Engagement of the sealing members on the door is encountered only at the very end of the closing cycle during the plugging action of the door thereby eliminating the sliding and scraping action of the door seals when almost closed, and eliminating undue wear.

The mechanism of the present invention includes a shaft and lever assembly having a vertical shaft pivoted at opposite ends to the frame of the car and attached to the door by means of levers that are fixed for rotation with the shaft but pivotally connected to the door. A roller is also mounted on the door and guided in a track unit that conditions the position of the door as it is swung by the shaft and lever assembly to obtain the slide-glide-plug action. This track includes a straight portion that is inclined relative to the door in closed position and a curved portion that provides the proper plugging action.

Accordingly, it is an object of the present invention to provide an improved door operating mechanism for vehicles that transport passengers to impart a slide-glide-plug movement to the door.

Another object of this invention is in the provision of a door mechanism for operating a door between open and closed positions that employs rubber sealing members, wherein the door action is such as to virtually eliminate the sliding and scraping action of the seals in the closing cycle, thereby substantially eliminating undue wear of the wheels.

Still another object of this invention resides in the provision of a door operating mechanism for controlling the movement of doors in vehicles transporting passengers, whereby the mechanism causes the door to move through a lateral and longitudinal compound movement, and enables the door to be flush with the outer surface of the vehicle in closed position so that the outer surface of the door may be contoured or straight to match the outer vehicle walls.

A further object of this invention is in the provision of a door operating mechanism for vehicles that transport passengers that incorporates the features of a sliding door, a swinging door, and a plugging door, while eliminating many of the disadvantages of these doors.

Other objects, features and advantages of the invention will be apparent from the following detailed disclosure taken in conjunction with the accompanying sheets of drawings, wherein like reference numerals refer to like parts, in which:

FIG. 1 is a vertical elevational view of a pair of door leaves having the door operating mechanism of the present invention, wherein this view is somewhat fragmentary and broken away for purposes of clarity, and taken generally along the line 1—1 of FIG. 2;

FIG. 2 is a somewhat diagrammatic plan view of the door operating mechanism of the present invention, with some parts fragmentary and other parts in dotted for purposes of clarity;

FIG. 3 is a door movement diagram for the door operating mechanism according to the present invention; and

FIG. 4 is a door movement diagram for a door operating mechanism of the prior art for illustrating the advantages of the present invention.

Referring now to the drawings, and particularly to FIG. 1, a pair of door leaves **10** and **11** are illustrated for selectively opening and closing the opening **12** in a passenger vehicle or car. While the door opening **12** is illustrated being selectively opened or closed by a pair of door leaves it should be appreciated that a single door leaf might be employed. Normally it is preferred that a pair of door leaves are used in view of the size of the door opening. The door operating mechanism is generally designated by the numeral **13**, and includes lever and shaft assemblies **14** and **14A**, track guiding means **15** and **15A**, and a door operator **16**.

The lever and shaft assemblies **14** and **14A** serve to support the door leaves **10** and **11** and to drive the door leaves between open and closed position as guided by the track guiding means **15** and **15A**. Each lever and shaft assembly includes a vertically extending shaft **17** pivotally supported at its upper and lower ends by suitable means,

upper and lower levers **18** and **19** secured to and rotatable with the shaft **17**, and supporting at their free ends in pivotal manner a door leaf. Thus, suitable pivot connection means **20** and **21** are provided to pivotally support the door leaf **11** by the levers **18** and **19**. Further, the pivot points of pivot connection means **20** and **21** are coaxial and along a line that is parallel to the shaft **17**.

The lever and shaft assemblies are driven by the door operator **16** which includes generally a reversible electric motor **22** and a reduction gear assembly **23**. An output shaft **24** extends from the reduction gear assembly and has secured thereto a double acting crank arm **25**. Pivotally connected to one end of the crank arm **25** is a link **26** that is in turn pivotally connected to a single acting crank arm **27** which is secured and rotatable with the shaft **17**. Similarly, a link **28** is pivotally connected at one end to the end of the double acting crank arm **25** opposite the connection of the link **26**, and at the other end to a single acting crank arm **29** that is secured to and rotatable with the shaft of the lever and shaft assembly **14A**. Thus, rotation of the double acting crank arm **25** by operation of the door operator **16** causes movement of the links **26** and **28** to in turn transmit force to the single acting crank arms **27** and **29** that drive the lever and shaft assemblies **14** and **14A** for opening and closing of the door leaves **10** and **11**. The structure of the assembly **14A** is essentially the same but of the opposite hand to cause movement of the door leaf **10** in the opposite direction. Structurally, a base plate **30** may be provided for attachment to the car body and for supporting bearings that rotatably support the lever and shaft assemblies, and that also support an upstanding bracket **31** to which the door operator **16** may be mounted. While the door operator **16** is primarily illustrated in only driving the door leaves **10** and **11**, it should be appreciated that it could through suitable connections be employed to drive other door leaves between open and closed positions. In connection with this, a single acting crank arm **32** is shown mounted on the shaft **17** and pivotally connected to a link **33** that would be in turn connected to a crank arm mounted on a shaft of a lever and shaft assembly operating in an adjacently mounted door. Similarly, a driving link **34** may be pivotally mounted on the single acting crank arm **29** of the lever and shaft assembly **14A** for further connection to a lever and shaft assembly of another door leaf.

The pivot point connection **20** for the door leaf **11** is provided by a bracket **35** that extends laterally and inwardly from the upper end of the door leaf **11**, and on which is also mounted a freely rotatable roller **36** that is received in a guide track **37** which guides or cams the pivotal movement of the door leaf relative to the levers **18** and **19** during opening and closing of the door leaves. Similarly, but in reverse position, a guide track **37A** controls movement of the door leaf **11** during operation of the lever and shaft assembly **14A** which is synchronized with the operation of the lever and shaft assembly **14**. The guide tracks **37** and **37A** are herein illustrated as being mounted on the underside of the base plate **30**, but it should be understood that they could be mounted on the upper side of the base plate and suitable slots could then be provided in the base plate to enable the rollers to extend upwardly into the guide track. Further, the rollers could take the form of pins or other types of followers for coaction with any suitable guide means that would provide the desired door movement.

It is important that the door leaves **10** and **11** in closed position substantially seal the opening **12**, and accordingly flexible rubber strips **38** and **39** are provided on opposite vertical edges of the door leaf **11**. Similarly, rubber strips **38A** and **39A** are provided on the opposite edges of door leaf **10**. These flexible rubber strips serve to seal door opening **12** when the door leaves are in closed position. A similar type of strip may also be provided on top edge of the door if so desired, and a depending or flexible strip may be suspended from the bottom of

the door leaves. The present invention avoids undue wear on the rubber strips by virtue of the closing action imparted to the door leaves which is guided by the guide tracks **37** and **37A**.

Referring now to FIG. 3 for a clear understanding of the door leaf movement as controlled by the lever and shaft assembly **14** and the track **37** that receives the roller **36**, various progressive positions of the door leaf and the pivot connection **20** and the roller **36** are illustrated between open and closed position. The door takes the position **11***a* when open and the position *IIi* when closed, and intermediately thereof the positions **11***b*, **11***c*, **11***d*, **11***e*, **11***f*, **11***g* and **11***h*. The pivot connection **20** takes positions along an arcuate path **40**, and in open position of the door takes position **20***a* while the closed position of the door takes the position **20***i*. Intermediate the open and closed positions of the door, the pivot connection **20** takes the positions **20***b*, **20***c*, **20***d*, **20***e*, **20***f*, **20***g* and **20***h*. The arcuate path **40** of the pivot connection **20** is of course controlled by the swinging lever arm on the shaft **17**.

The roller **36** takes the position **36***a* when the door is in open position and the position **36***i* when the door is in closed position, all of which are dictated by the contour of the track **37**. The track **37** includes a straight run portion **37A** and an arcuate or curvate run portion **37B**. The straight run portion **37A** extends angularly relative to the door in its closed position **11***i*, whereby the end of the straight run portion connecting to the arcuate run portion is spaced closer to the door leaf in closed position and also adjacent the upright edge of the door leaf that would engage the upright edge of the adjacent door leaf **10**. It is this end of the straight run portion that connects with the arcuate run portion **37B** which has its convex side facing the door leaf in closed position. It should be noted that the intermediate positions **36***b*, **36***c*, **36***d*, **36***e*, **36***f*, **36***g* and **36***h* of the roller **36** are not progressively arranged along the straight and curvate run portions of the track **37**, and it is because of the curvate run portion and this phenomenon that a lateral movement of the door before closing and sealing, which may be termed a plugging action, is defined. Thus the arcuate run portion **37B** may be considered the plugging portion of the track **37**. The conditions of movement of the door leaf which would exist with a straight track are not present here because of the curvature run portion.

As the door leaf **11** closes beyond the position **11***c*, the leading edge of the door leaf begins to travel in a parallel direction relative the opening in the car wall and at a substantially uniform distance from the seal of the opening. This parallel movement action commences at position **11***d* and follows through position **11***f*. At position **11***g*, it can be seen that the door leaf is almost closed in the longitudinal direction and motion has now started in the lateral, or plugging direction. The velacity of the door leaf as it plugs is slowed down considerably, in combination with conventional movement, which results in a smoother type of action. As the door seals the opening between psitions **11***h* and **11***i*, it encounters little rubbing action, if any, against the seal of the car opening. Thus, the lateral movement of the door leaf before closing and sealing has eliminated sliding or rubbing action of the rubber seals, thereby preventing excessive wear and replacement requirements. The sealing action hereis not detrimental to the rubber sealing members at the time of closing.

A comparison of the present invention relative to the heretofore known straight track arrangement may be appreciated from viewing FIG. 4 which shows a door leaf **41**, a straight track **42**, a pivot connection on the door **43** and a track roller **44**. The leading edge of the door leaf **41** at positions **41***e*, **41***f* and **41***g* has a motion which is beyond the seal of the door opening at the door closing position. Actually the rubber edge of the door bends and rubs against the more solid seal of the opening in the car structure at these points. This rubbing action is detrimental

to the rubber parts, and shortens the life of them and especially the rubber cap at the top of the door.

In view of the foregoing, it can be readily appreciated that the slide-glide-plug action defined by the door closing mechanism according to the present invention, while incorporating the features of a sliding door, a swinging door and a plugging door, eliminates many of the disadvantages of the respective actions of these doors, and ultimately provides a door closing action that virtually eliminates the sliding and scraping action of the door seals when almost closed.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention, but it is understood that this application is to be limited only by the scope of the appended claims.

The invention is hereby claimed as follows:

1. In a vehicle having a door opening in the vehicle wall selectively opened and closed by at least one door leaf, a mechanism for opening and closing the door leaf relative the door opening to cause the door leaf to be moved through a compound movement laterally and longitudinally of the vehicle wall swinging through 90° rotation and becoming at right angles to the wall in the fully opened position, said mechanism including a lever and shaft assembly having a rotatively mounted vertical shaft and lever means extending therefrom and rotatable therewith, said lever means being pivotally connected to said door leaf, a roller mounted on said door leaf in spaced relation to said lever means pivot, a track mounted on the vehicle adjacent the door for guidably receiving the roller, said track being shaped to provide a slide-glide-plug action and including a long straight portion and a short curvate portion, the convex side of said curvate portion facing the door leaf in closed position, said straight portion being inclined relative the door leaf in closed position at an angle less than 90° wherein the end closest to the door leaf is the end closest to the edge of the door leaf leading during its closing cycle, a door operator having an output shaft, and linkage interconnecting said output shaft and vertical shaft to drive the door between open and closed positions as guided by said track.

2. The combination as defined in claim 1, wherein said lever means includes a pair of spaced levers secured to said shaft and pivotally to said door leaf at the upper and lower ends thereof.

3. The combination as defined in claim 1, wherein said track is mounted above said door.

4. In a vehicle having a door opening in a side wall and a pair of door leaves operable between closed position to close the opening and open position to open the opening, a mechanism for driving said door leaves between open and closed positions and through a compound movement laterally and longitudinally of the side wall swinging through 90° rotation and the leaves becoming at right angles to the wall one at each of the upright edges of the opening in the fully opened position, said mechanism including a lever and shaft assembly for each door leaf having a pivotally mounted upright shaft and lever means secured thereto for rotation therewith extending toward said door leaf and pivotally connected thereto at its free end, guide means mounted on said vehicle adjacent each door leaf, follower means on each said door guidably coacting with each said guide means, each said guide means controlling each door leaf movement to provide a slide-glide-plug action and including a long straight portion and a short curvate portion, the convex side of said curvate portion facing the door leaf in closed position, said straight portion being inclined relative the door leaf in closed position at an angle less than 90° wherein the end closest to the door leaf is the end closest to the edge of the door leaf leading during its closing cycle, a door operator having an output shaft, and linkage interconnecting said output shaft and the shafts of said lever and shaft assemblies.

5. The combination as defined in claim 4, wherein said guide means is mounted above said door.

6. The combination as defined in claim 4, wherein said lever means for each door leaf includes a pair of levers secured to the respective shafts and pivotally to the respective door leaves at the upper and lower ends thereof.

7. The combination as defined in claim 4, wherein said guide means are arranged in opposed relation for the respective door leaves.

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DAVID J. WILLIAMOWSKY, Primary Examiner

J. KARL BELL, Assistant Examiner

U.S. Cl. X.R.

49—252