

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
28 February 2008 (28.02.2008)

PCT

(10) International Publication Number
WO 2008/024386 A2

(51) International Patent Classification:
B62D 35/00 (2006.01)

(21) International Application Number:
PCT/US2007/018544

(22) International Filing Date: 22 August 2007 (22.08.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11/508,795 23 August 2006 (23.08.2006) US
11/827,721 13 July 2007 (13.07.2007) US

(71) Applicant and

(72) Inventor: **HOLUBAR, Robert** [US/US]; 4359 South
146th Street, Omaha, NE 68137 (US).

(74) Agent: **JACOBS, Adam, H.**; 1904 Farnam Street, Suite
726, Omaha, NE 68102 (US).

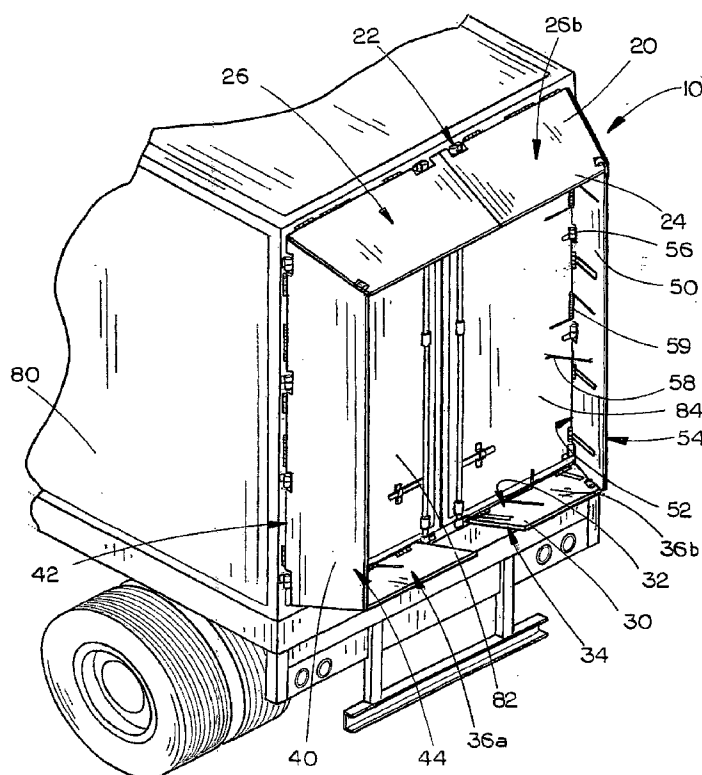
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report

(54) Title: AIR DRAG REDUCTION APPRATUS FOR TRACTOR-TRAILERS



(57) Abstract: A air drag reduction apparatus includes left and right planar panels and top and bottom planar panels for mounting to the rear doors of a tractor trailer along the top, bottom and side edges thereof. Hinges are interposed between the panels and the doors so that the panels can pivot about the hinges between an extended drag-reducing position and a collapsed position generally adjacent the rear doors. Stop devices releasably secure the panels in the extended position, and biasing devices such as tensioning springs are operative to bias the panels outwards and rearwards to the extended position and are further operative to permit the panels to pivot between the extended position towards and to the collapsed position upon impact and contact from an external object occurring and then return to the extended position substantially immediately upon contact ceasing thereby significantly reducing the impact damage.

WO 2008/024386 A2

PETITION

Mail Stop PCT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Your Petitioner, Robert Holubar, citizen of the United States of America and resident of the State of Nebraska, whose residence and mailing address is 4359 South 146th Street, Omaha, Nebraska 68137, prays that Patent Protection be granted to him for an

AIR DRAG REDUCTION APPARATUS FOR TRACTOR-TRAILERS

as set forth in the following specification:

Technical Field

The present invention is directed to air drag reduction devices for vehicles and, more particularly, to an air drag reduction apparatus for tractor-trailers which includes left, right, top and bottom planar panels which are hingedly mounted on the generally rectangular rear doors of the tractor-trailer and which extend at an angle of approximately five to twenty-five degrees inwards from parallel alignment with the top, bottom and side walls of the tractor-trailer when the panels are in their extended drag-reducing position, the device further including a set of biasing devices such as springs mounted within or adjacent the hinges which are operative to permit the left, right, top and bottom planar panels to pivot between the extended position and a collapsed position adjacent and contacting the rear doors such that upon the panels receiving impact from an external object, damage to the panels is significantly reduced due to their being collapsibly mounted on the rear doors.

Background Art

Operation of tractor-trailer units involves significant expenditures for maintenance and upkeep, but the single most costly element of operation is almost certainly the fuel costs required to operate the tractor-trailer. One of the operational features which most significantly increases the fuel consumption cost is the fact that the tractor-trailer as commonly used presents an extremely inefficient aerodynamic shape, as the size and shape of the tractor-trailer is generally dictated by the amount of cargo and size and shape thereof which the tractor-trailer needs to carry. Therefore, a large rectangular box shape is generally used for the trailer unit, as this shape is most conducive to loading and unloading and carrying of cargo therein. However, it is also well-known that the rectangular box shape presents one of the most aerodynamically inefficient shapes known, and it is not only the forward flat front of the trailer which presents aerodynamic inefficiencies, but the rear of the trailer likewise is aerodynamically inefficient, due to the large amounts of turbulence and drag produced by air flow over the top, bottom and sides of the trailer to the squared-off rear. Particularly due to ever-increasing fuel prices, improvement of the aerodynamics of the tractor-trailer is becoming ever more important, and therefore there is a need to improve the aerodynamic performance of the tractor-trailer unit.

Many different inventions have been proposed in the prior art which attempt to address and solve this problem. For example, Roberge et al., U.S. Patent No. 6,485,087, discloses a rear panel configuration for attachment to the rear of a tractor-trailer which is designed to significantly reduce the turbulence and drag produced by the rear of the unadorned trailer. However, while Roberge does provide one form of solution to the aerodynamic problem, it raises other problems, namely, what happens

when, inevitably, the panels encounter an external object such as a loading dock or other vehicle? As taught in the Roberge patent, specifically in Figure 9 of Roberge, a rubber flexible material would be applied to the leading edge of the panel to lessen the damage caused by the impact. Of course, such a rubber flexible edge will be of little use when the panel encounters a loading dock or the like, and it is clear that in such an instance the impact will cause a great deal of damage to the aerodynamic panel.

Many other devices are proposed in the prior art which also incorporate aerodynamic panels on the rear of the tractor-trailer, but not a single one of these addresses the issue of what occurs when the panel impacts a loading dock or the like, as will inevitably occur when the tractor-trailer is being backed into the loading and unloading location. While some of the devices apparently teach manually moving the panels to a storage position prior to opening the rear doors and loading and/or unloading the trailer, this does not fully address the question of what occurs when the driver or loading dock personnel simply forget to move the panels to their storage position. Therefore, there is a significant need for an aerodynamic panel device which will not only function to significantly reduce the cost of operating the tractor-trailer, but also addresses and solves the question of what occurs when the panels accidentally impact an external object such as a loading dock or the like.

Therefore, an object of the present invention is to provide an improved air drag reduction apparatus for tractor-trailers which will significantly reduce and/or eliminate damage to the aerodynamic panels caused by non-ballistic impact with external objects.

Another object of the present invention is to provide an improved air drag reduction apparatus for tractor-trailers which includes left, right, top and bottom planar panels which are hingedly mounted directly on the rear doors of the trailer, the panels

extending rearwards in an extended drag-reducing position at an angle of approximately five to twenty-five degrees inwards relative to the planes defined by the top, bottom and sides of the tractor-trailer.

Another object of the present invention is to provide an improved air drag reduction apparatus for use with tractor-trailers which includes stop devices such as cables or hinge stops which releasably secure the panels in an extended position to generally ensure that the proper angle of orientation is maintained during operation of the tractor-trailer.

Another object of the present invention is to provide an improved air drag reduction apparatus for use with tractor-trailers which includes biasing devices operatively associated with the planar panels which are operative to bias the planar panels outwards and rearwards to the extended position and which are further operative to permit each of the planar panels to pivot between the extended position towards and to the collapsed position upon the panels receiving impact and contact from an external object and then return to the extended position substantially immediately upon contact with the external object ceasing such that damage to the left, right, top and bottom planar panels from the impact is significantly reduced or eliminated.

Finally, an object of the present invention is to provide an improved air drag reduction apparatus for use with tractor-trailers which is relatively simple and durable in design and construction and is safe, efficient and effective in use.

Disclosure of Invention

The present invention provides an air drag reduction apparatus for use with vehicles having generally rectilinear top, side and base walls and a generally rectangular rear door, the apparatus including left, right, top and bottom generally trapezoidal planar panels each having an inner edge and an outer edge and a plurality of hinges mounted on the inner edges of each of the panels, the hinges adapted to be mounted on the rear door of the vehicle such that the left, right, top and bottom planar panels are pivotably mounted thereon. The hinge devices are further operative to permit each of the planar panels to pivot between an extended drag-reducing position which extends generally rearwardly at approximately five to twenty-five degrees of angle relative to the planes formed by the top, side and base walls of the tractor-trailer and a collapsed position generally adjacent the rear door. Stop devices such as cables and/or hinge stops are operatively associated with each of the planar panels for releasably securing the panels in the extended drag-reducing position. Finally, a plurality of biasing devices such as springs and/or gas-driven pistons are operatively associated with the left, right, top and bottom planar panels to bias the panels outwards and rearwards to the extended position and are further operative to permit each of the panels to pivot between the extended position towards and to the collapsed position upon the particular panel receiving impact and contact from an external object. The biasing devices are then further operative to return the panel to the extended position substantially immediately upon contact with the external object ceasing such that damage to the left, right, top and bottom planar panels from the impact is significantly reduced or eliminated.

The present invention as thus described provides a significant advantage over

other aerodynamic enhancing prior art devices. Specifically, the most significant problem encountered with aerodynamic panels mounted on tractor-trailer units is that the panels are prone to receive accidental non-ballistic impacts which damage the panels, due to the outwardly extending configuration of the panels, thus reducing their effectiveness and eventually requiring replacement of the panels. This significantly increases the cost of operation in using the aerodynamic panels found in the prior art, which immediately and significantly brings into question the value of incorporating such aerodynamic panels, as the savings provided by incorporation of the panels is likely to be substantially offset by the cost of replacement and repair of the panels. None of the devices found in the prior art address or solve this problem, as many of the prior art devices require active retraction or movement of the panels to prevent impact damage. Of course, it is the unintentional damage which presents the significant problem in connection with the known prior art, and it is the significant improvement of the present invention to provide a solution to this problem. It is therefore seen that the present invention provides a substantial improvement over those devices found in the prior art.

Brief Description of the Drawings

Figure 1 is a perspective view of the air drag reduction apparatus of the present invention;

Figure 2 is a perspective view of the invention during impact;

Figure 3 is a top plan view showing how the panels are pivoted on the trailer;

Figure 4 is a rear elevational view of the present invention mounted on a trailer;

Figure 5 is a side elevational view of a side panel of the present invention;

Figure 6 is a top plan view showing the top panel of the invention;

Figure 7 is a perspective view of an alternative embodiment of the air drag reduction apparatus of the present invention;

Figure 8 is a rear elevational view of the embodiment of Figure 7 mounted on a trailer;

Figure 9 is a detailed perspective view of the embodiment of Figure 7 folding down to the collapsed position;

Figure 10 is a detailed perspective view of the embodiment of Figure 7 showing the roller wheels which cooperate to allow the panels to fold down; and

Figure 11 is a top plan view of the embodiment of Figure 7 showing the curvature of the panels and the extended and collapsed positions thereof.

Mode(s) For Carrying Out The Invention

The air drag reduction apparatus **10** of the present invention is shown best in Figures **1-4** as including four aerodynamic panels, specifically a top panel **20**, bottom panel **30**, left side panel **40**, and right side panel **50**. It is preferred that each of the panels have the same general shape, namely, a trapezoidal shape, with the inner edges **22**, **32**, **42**, and **52** of each of the panels having a greater length than the outer edges **24**, **34**, **44**, and **54** of each of the panels. In the preferred embodiment, each of the panels, **20**, **30**, **40**, and **50** would be constructed of a sturdy plastic or metal sheet material, although it has been found that the use of plastic material will significantly decrease the weight of the panels **20**, **30**, **40**, and **50** while simultaneously not sacrificing durability and effectiveness. Of course, however, the precise nature of the construction materials used in connection with the panels **20**, **30**, **40**, and **50** is not critical to the present invention so long as the aerodynamic enhancing features of the present invention are neither degraded nor destroyed.

In the preferred embodiment, the left and right side panels **40** and **50** would be generally identical to one another, and likewise the top and bottom panels **20** and **30** would be generally identical to one another. Therefore, the following description of right side panel **50** and top panel **20** should be understood to relate generally to left side panel **40** and bottom panel **30** respectively. Right side panel **50** is preferably mounted on the outer edge of right rear door **84** of tractor-trailer **80**, as shown best in Figures **1** and **2**. Specifically, right side panel **50** would be mounted on the right rear door **84** itself by a plurality of hinges **56** which connect the inner edge **52** of right side panel **50** to the right rear door **84**. The precise size, shape, and number of hinges **56** used in connection with the mounting of right side panel **50** is not particularly critical to the

present invention so long as the hinges **56** generally permit the right side panel **50** to pivot between an extended position, as shown in Figure **1** wherein the aerodynamic improvement capabilities of the right side panel **50** are utilized and a collapsed position generally adjacent the right rear door **84** as shown in Figure **4**.

In the preferred embodiment, the right side panel **50** would extend at an angle of approximately ten to fifteen degrees (10° to 15°) from parallel with the plane of the left side of the trailer **80**, as it has been found that the range of five to twenty-five degrees (5° to 25°) provides the most significant increase in aerodynamic streamlining available via use of the air drag reduction apparatus **10** of the present invention. To secure the right side panel **50** in this extended position at the precise angle desired, a plurality of securement cables **58** would be connected to the right rear door **84** and extend outward to the right side panel **50** generally adjacent outer edge **54**, as shown best in Figures **1** and **4**. Of course, the securement cables **58** may be substituted by any appropriate securement device, such as hinge stops (not shown) which would be used in connection with the hinges **56** to prevent over rotation of the right side panel **50** beyond the desired position of the extended position.

Of course, the securement cables **58** only serve the purpose of preventing overrotation of the right side panel **50** beyond the desired extended position. It is therefore necessary to include an additional biasing device operatively associated with the right side panel **50** to bias the right side panel **50** outwards and rearwards until the securement cables **58** prevent further extension of the right side panel **50**. There are several biasing mechanisms which may be used in connection with the present invention, such as tensioning springs, torsion bars or gas-filled cylinders, although in the preferred embodiment, the biasing devices will be either a tensioning spring **59**

mounted in or adjacent each of the hinges **56** for biasing the associated hinge **56** outwards thereby pivoting right side panel **50** into its extended position, as shown best in Figures **1** and **2**. Alternatively, a plurality of gas-filled cylinders may extend between and connect the right side panel **50** and right rear door **84** to provide a biasing effect to the right side panel **50** such that the right side panel **50** is biased into its extended position. Of course, the precise and specific nature of the biasing device is not critical to the present invention so long as the biasing devices bias the right side panel **50** outwards into the extended position and further are operative to permit controlled collapsing of the right side panel **50** to its collapsed position in response to certain external stimuli which will be described herein.

Regarding top panel **20**, it is necessary to divide top panel **20** into left and right top subpanels **26a** and **26b** which, in the preferred embodiment, are generally identical mirror images of one another which are mounted to the top of the left and right rear doors **82** and **84**, as shown best in Figures **1** and **2**. As was described in connection with right side panel **50**. Top panel **20** would be mounted on the left and right rear doors **82** and **84** by a plurality of hinges **28** which function in the same manner as the hinges **56** described in connection with right side panel **50**. Furthermore, tensioning springs **29** would be mounted with hinges **28** to bias the top panel **20** rearwards and outwards, and securement cables **27** would function in the same manner as securement cables **58** described in connection with right side panel **50**. Also, although, as shown in Figures **1-4**, it is preferred that top panel **20** extend generally across the entire width of the trailer **80**, the width of top panel **20** is preferably approximately 34 inches, whereas the width of the right side panel **50** is approximately thirty-six inches, although the precise size and shape of the panels may be modified or changed to

adjust the performance characteristics of the air drag reduction apparatus **10** of the present invention. The primary purpose, however, for the smaller width of the top and bottom panels **20** and **30** relative to the left and right side panels **40** and **50** is so that the left and right side panels **40** and **50** overlap the top and bottom panels **20** and **30** such that when the left and right side panels **40** and **50** are moved forwards and inwards to their collapsible position, sliding wheels **60** mounted on the top and bottom panels **20** and **30** are engaged by the left and right side panels **40** and **50** and the top and bottom panels **20** and **30** are collapsed along with the left and right side panels **40** and **50**. This collapsing configuration is important for several reasons, but the most important of these will be described immediately hereafter.

Until now, the air drag reduction apparatus **10** of the present invention as described incorporates many features found in the prior art. However, the significant and critical difference between the present invention and those inventions described in the prior art will now be described. Specifically, the biasing devices, namely the tensioning springs **29** and **59** and the hinges **28** and **56** are designed to releasably secure the top panel **20** and right side panel **50** in their extended positions under normal operating circumstances. However, one of the problems frequently encountered in operation of a tractor-trailer is that the tractor-trailer must be backed into a loading dock or the like in order to load and unload the trailer **80**. With the vast majority of air drag reduction devices found in the prior art, the devices must be manually retracted or shifted into their retracted position. With the present invention, however, when any of the top, bottom, left side or right side panels **20**, **30**, **40** and **50** encounter an external object **90** such as the loading dock or the like, the tensioning springs **29** and **59** permit the impacted panel, specifically the right side panel **50** as shown in Figure 2, to pivot

about the hinges **56** towards and to the collapsed position generally adjacent the right rear door **84** without significant damage being done to the right side panel **50**. When the trailer **80** is moved forwards out of contact with the loading dock **90**, the tensioning springs **59** and hinges **56** act to re-extend the right side panel **50** to its extended position generally immediately after the contact with the external object, namely the loading dock **90**, ceases. This feature virtually ensures that regardless of whether the operator of the tractor-trailer remembers to retract or extend the air drag reduction apparatus, with the present invention, such remembering is rendered unnecessary, thus freeing the operator of at least one additional burden which will likely facilitate his or her improved operation of the tractor-trailer unit.

This damage reduction feature of the present invention becomes even more important when accidental non-ballistic impact with any external object is occurring, such as when the trailer is accidentally backed into a building or another vehicle such as a fork lift or the like accidentally contacts the top, bottom, left side or right side panels **20**, **30**, **40** and **50**. In virtually any event, the afflicted panel will retract from the extended position to its collapsed position until the contact with the external object ceases, at which time the afflicted panel immediately returns to its extended position in preparation for continued functioning as an air drag reduction apparatus. No other device found in the prior art currently accomplishes this significant improvement, and therefore the damage reduction capabilities of the air drag reduction apparatus **10** of the present invention are deemed to be not only novel but vital to the functionality of the present invention.

An alternative embodiment of the air drag reduction apparatus **10'** of the present invention is shown in Figures **7-11** as including top, left and right side panels **20'**, **40'**

and 50' which include a significant improvement over the embodiment shown in Figures 1-4. Specifically, as seen best in Figures 7, 9 and 11, the top, left and right side panels 20', 40' and 50' each include an arcuate convexly curved outer wall 222, 242 and 252 which changes the airflow over the top, left and right side panels 20', 40' and 50' from the straight line flow of the first embodiment to an airflow more similar to that encountered with aircraft wings and airfoils. The important result of this significant modification is that the air passing over and flowing off of the top, left and right side panels 20', 40' and 50' forms a less turbulent wake at the outer edges 24', 44' and 54' of the top, left and right side panels 20', 40' and 50' than that encountered during use of the embodiments of Figures 1-4, and in fact this results in significant improvement in the fuel consumption savings afforded by the use of the present invention.

In the preferred embodiment, the top, left and right side panels 20', 40' and 50' each would include the arcuate outer walls 222, 242 and 252 as described above and as shown in Figures 7-11, and the curvature of the arcuate portions 224, 244 and 254 of the arcuate outer walls 222, 242 and 252 may be modified for use with particular models of trailers 80. It is preferred, however, that the convex curvature of the arcuate portions 224, 244 and 254 of arcuate outer walls 222, 242 and 252 be approximately ten to forty degrees (10° to 40°) of arc, with a radius of approximately two to ten feet, depending on the size and shape of the top, left and right side panels 20', 40' and 50'. Of course, it should be noted that particular convex curvature dimensions of the top, left and right side panels 20', 40' and 50' are not necessarily critical to the proper operation of the present invention, so long as the outer edges 24', 44' and 54' of each of the panels are positioned downwards and/or inwards from the inner edges 22', 42' and 52' of each of the panels, as shown in Figures 7, 9 and 11, to enable to turbulence-

reducing feature of the top, left and right side panels **20'**, **40'** and **50'**.

Figure **10** illustrates an additional feature of the present invention, namely the improved sliding wheels **60'** mounted on the left and right side panels **40'** and **50'** which are engaged by the top panel **20'** so that the left and right side panels **40'** and **50'** are collapsed along with the top panel **20'** when the top panel **20'** is moved to the collapsed position as shown in Figure **11**. Finally, it should also be noted that manner by which the top, left and right side panels **20'**, **40'** and **50'** are mounted on the trailer **80** and the hinges, tensioning springs and cables used in connection with the mounting and collapsing functionality of the top, left and right side panels **20'**, **40'** and **50'** are generally identical to those described in connection with the embodiment of Figures **1-4**, and therefore further discussion of those features in connection with the embodiment of Figures **7-11** is deemed unnecessary. However, due to the curvature of the top, left and right side panels **20'**, **40'** and **50'**, some modifications to the mounting of those panels on the trailer **80** may be found to be necessary, and such modifications would be understood by one skilled in the art of mounting after-market accessories on vehicles.

It is to be understood that numerous additions, modifications and substitutions may be made to the air drag reduction apparatus **10** of the present invention which fall within the intended broad scope of the appended claims. For example, the precise size, shape and construction materials used in connection with the top, bottom, left side and right side panels **20**, **30**, **40** and **50** and the top, left and right side panels **20'**, **40'** and **50'** of Figures **7-11** may be modified or changed so long as the intended functionality of the panels is maintained. Also, although the biasing devices have been described as being either tensioning springs or gas cylinders, other types of biasing

devices may be used in connection with the present invention so long as the function to releasably secure the panels in their extended positions absent contact with an external object which will force the afflicted panel towards and to the collapsed position generally adjacent the associated left or right rear door **82** and **84** is maintained. Furthermore, it should be noted that the top and bottom panels **20** and **30**, specifically top subpanels **26a** and **26b** and bottom subpanels **36a** and **36b**, function generally independently of each other, as the division between the sub panels **26a**, **26b**, **36a** and **36b** must be maintained to permit the left and right rear doors **82** and **84** to properly open and close to provide access to the interior of the trailer **80**. Also, regarding bottom subpanels **36a** and **36b**, it is preferred that they be spaced apart from one another in order to provide easy access to the locking handles of the left and right rear doors **82** and **84**, as shown in Figures **1**, **2** and **4**, and this gap may be of any appropriate distance to perform this function. Finally, it should be noted that it is a critical feature of the present invention that the panels be mounted directly on the left and right rear doors **82** and **84** so that the panels will travel with the left and right rear doors **82** and **84** when the doors are being opened and closed. This will ensure proper functioning of the top, bottom, left side and right side panels **20**, **30**, **40** and **50** regardless of the precise size and configuration of the left and right rear doors **82** and **84**.

There has therefore been shown and described an air drag reduction apparatus **10** which accomplishes at least all of its intended objectives.

Claims

I claim:

1. An air drag reduction apparatus for use with vehicles having generally rectilinear top, side and base walls and a generally rectangular rear door, said apparatus comprising:

left and right panels each having an inner edge and an outer edge, said left and right panels each including a convexly curved outer wall extending between said inner edge and said outer edge operative to smooth airflow over and off of said left and right panels;

a top panel having an inner edge and an outer edge, said top panel including a convexly curved outer wall extending between said inner edge and said outer edge operative to smooth airflow over and off of said top panel;

hinge means mounted on said inner edges of each of said left, right and top panels, said hinge means adapted to be mounted on the rear door of the vehicle such that said left, right and top panels are mounted on the rear door of the vehicle, said hinge means operative to permit each of said left, right and top panels to pivot between an extended drag-reducing position which extends generally rearwardly from the rear door and a collapsed position adjacent the rear door;

stop means operatively associated with each of said left, right, and top panels for releasably securing each of said left, right and top panels in said extended drag-

reducing position; and

biasing means operatively associated with said left, right and top panels operative to bias said left, right and top panels outwards and rearwards to said extended position and further operative to permit said each of said left, right and top panels to pivot between said extended position towards and to said collapsed position upon said left, right and top panels receiving impact and contact from an external object and then return said left, right and top panels to said extended position substantially immediately upon contact with an external object ceasing whereby damage to said left, right and top panels from said impact is significantly reduced.

2. The air drag reduction apparatus of claim 1 wherein said left and right panels are generally trapezoidal in shape and have an airfoil cross-sectional shape.

3. The air drag reduction apparatus of claim 1 wherein said top panel is generally trapezoidal in shape and has an airfoil cross-sectional shape.

4. The air drag reduction apparatus of claim 1 further comprising a bottom panel having outer and inner edges, said bottom panel adapted to be mounted on the rear door of the vehicle adjacent the base thereof, hinge means mounted on said inner edge of said bottom panel, stop means operatively associated with said bottom panel for releasably securing it in said extended drag-reducing position and biasing means operatively associated with said bottom panel operative to bias said bottom panel

outward and rearward to said extended position and further operative to permit said bottom panel to pivot between said extended position towards and to said collapsed position upon said bottom panel receiving impact and contact from an external object.

5. The air drag reduction apparatus of claim 4 wherein said stop means comprise a plurality of securement cables extending between and connecting selected ones of said left, right, top and bottom planar panels with a surface of the vehicle thereby preventing overrotation of said planar panels beyond said extended drag-reducing position.

6. The air drag reduction apparatus of claim 4 wherein said biasing means are selected from the group comprising tensioning springs, torsion bars and gas-filled cylinders.

7. The air drag reduction apparatus of claim 4 wherein said biasing means releasably secures said left, right, top and bottom planar panels in said extended position unless at least one of said left, right, top and bottom planar panels receives an impact from an external object, said biasing means then being operative to permit said each of said left, right, top and bottom planar panels to pivot between said extended position towards and to said collapsed position thereby lessening the impact force and substantially decreasing damage to said left, right, top and bottom planar panels.

8. The air drag reduction apparatus of claim 4 wherein said top and bottom planar panels are divided at approximately the midpoints thereof and thereby each

include left and right subpanels, thereby permitting the rear door of the vehicle to be opened and closed.

9. The air drag reduction apparatus of claim 4 wherein said left and right planar panels overlap said top and bottom planar panels, said top and bottom planar panels each further comprising sliding wheels mounted on the outer ends of said top and bottom panels which are engaged by said left and right side panels such that said top and bottom panels are collapsed along with said left and right side panels being collapsed into said collapsed position.

10. In combination:

a tractor-trailer unit having generally rectilinear top, side and base walls and generally rectangular, outwardly swinging left and right rear doors;

an air drag reduction apparatus comprising;

left and right panels each having an inner edge and an outer edge, said left and right panels each including a convexly curved outer wall extending between said inner edge and said outer edge operative to smooth airflow over and off of said left and right panels;

a top panel having an inner edge and an outer edge, said top panel including a convexly curved outer wall extending between said inner edge and said outer edge operative to smooth airflow over and off of said top panel;

hinge means mounted on said inner edges of each of said left, right and top panels, said hinge means on said left and right panels mounted adjacent the outside edges of said left and right rear doors on said left and right rear doors, respectively, of said tractor-trailer, said hinge means of said top panel mounted adjacent said top edge of said left and right rear doors with said left and right subpanels of each of said top and bottom planar panels mounted on said left and right rear doors, respectively, said hinge means operative to permit each of said left, right and top panels to pivot

between an extended drag-reducing position which extends generally rearwardly from the rear door and a collapsed position adjacent the rear door;

stop means operatively associated with each of said left, right and top panels for releasably securing each of said left, right and top panels in said extended drag-reducing position;

biasing means operatively associated with said left, right and top panels operative to bias said left, right and top panels outwards and rearwards to said extended position and further operative to permit said each of said left, right and top panels to pivot between said extended position towards and to said collapsed position upon at least one of said left, right and top panels receiving impact and contact from an external object and then return said left, right and top panels to said extended position substantially immediately upon contact with an external object ceasing whereby damage to said left, right and top panels from said impact is significantly reduced; and

said left, right and top panels operative to significantly reduce drag on said tractor-trailer when in said extended drag-reducing position thereby decreasing fuel consumption needed to transport said tractor-trailer.

11. The combination of claim 10 wherein said left and right panels are

generally trapezoidal in shape and extend at an at an angle of between five to twenty-five degrees (5° to 25°) from parallel with the plane of the adjacent one of said side walls of said tractor-trailer and have an airfoil cross-sectional shape.

12. The combination of claim **10** wherein said top panel is generally trapezoidal in shape and extend at an at an angle of between five to twenty-five degrees (5° to 25°) from parallel with the plane of said top wall of said tractor-trailer and has an airfoil cross-sectional shape.

13. The air drag reduction apparatus of claim **10** further comprising a bottom panel having outer and inner edges, said bottom panel adapted to be mounted on said rear door of said tractor-trailer adjacent the base thereof, hinge means mounted on said inner edge of said bottom panel, stop means operatively associated with said bottom panel for releasably securing it in said extended drag-reducing position and biasing means operatively associated with said bottom panel operative to bias said bottom panel outward and rearward to said extended position and further operative to permit said bottom panel to pivot between said extended position towards and to said collapsed position upon said bottom panel receiving impact and contact from an external object.

14. The combination of claim **13** wherein said stop means comprise a plurality of securement cables extending between and connecting selected ones of said left, right, top and bottom panels with an adjacent one of said left and right rear doors of said tractor-trailer thereby preventing overrotation of said left, right, top and bottom

panels beyond said extended drag-reducing position.

15. The combination of claim **10** wherein said biasing means are selected from the group comprising tensioning springs, torsion bars and gas-filled cylinders.

16. The combination of claim **13** wherein said biasing means releasably secures said left, right, top and bottom panels in said extended position unless at least one of said left, right, top and bottom panels receives an impact from an external object, said biasing means then being operative to permit said each of said left, right, top and bottom panels to pivot between said extended position towards and to said collapsed position generally adjacent one of said left and right rear doors thereby lessening the impact force and substantially decreasing damage to said left, right, top and bottom panels.

17. The combination of claim **13** wherein said top and bottom planar panels are divided at approximately the midpoints thereof and thereby each include left and right subpanels, thereby permitting said left and right rear doors of said tractor-trailer of the vehicle to be opened and closed.

18. The combination of claim **10** wherein said left and right panels overlap said top and bottom panels, said top and bottom panels each further comprising sliding wheels mounted on the outer ends of said top and bottom panels which are engaged by said left and right side panels such that said top and bottom panels and said left and right side panels all are collapsed into said collapsed position.

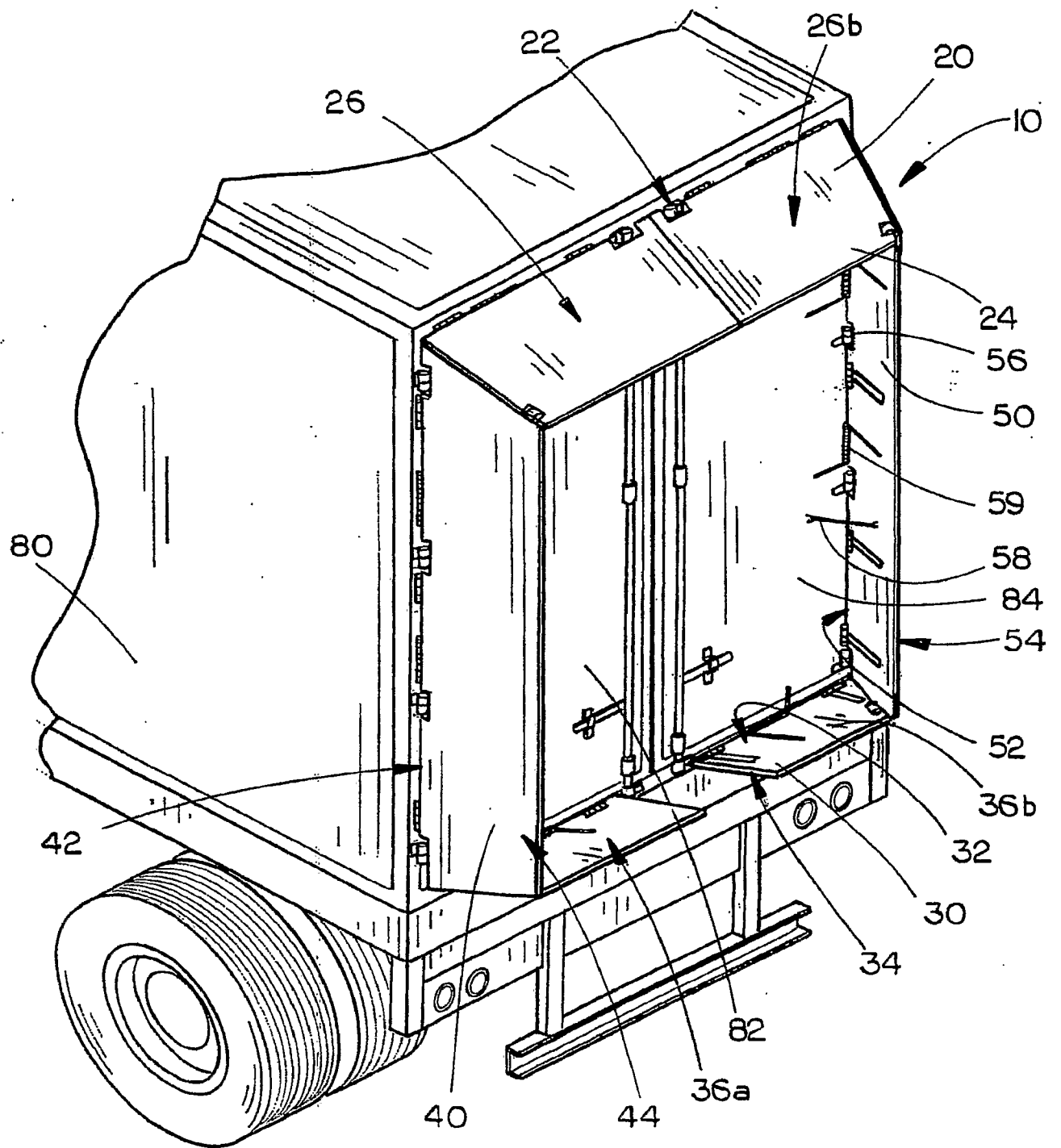


FIG. 1

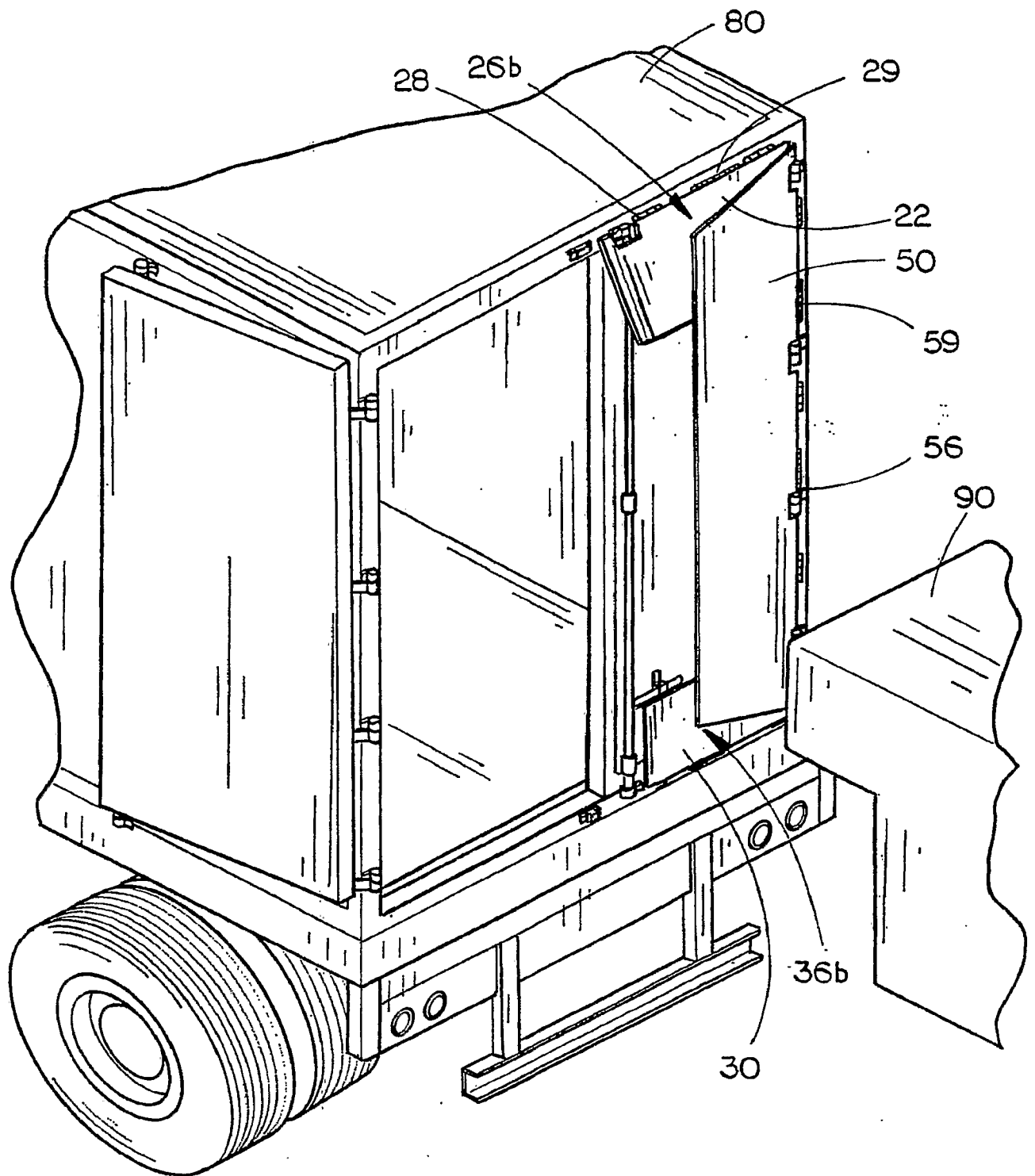
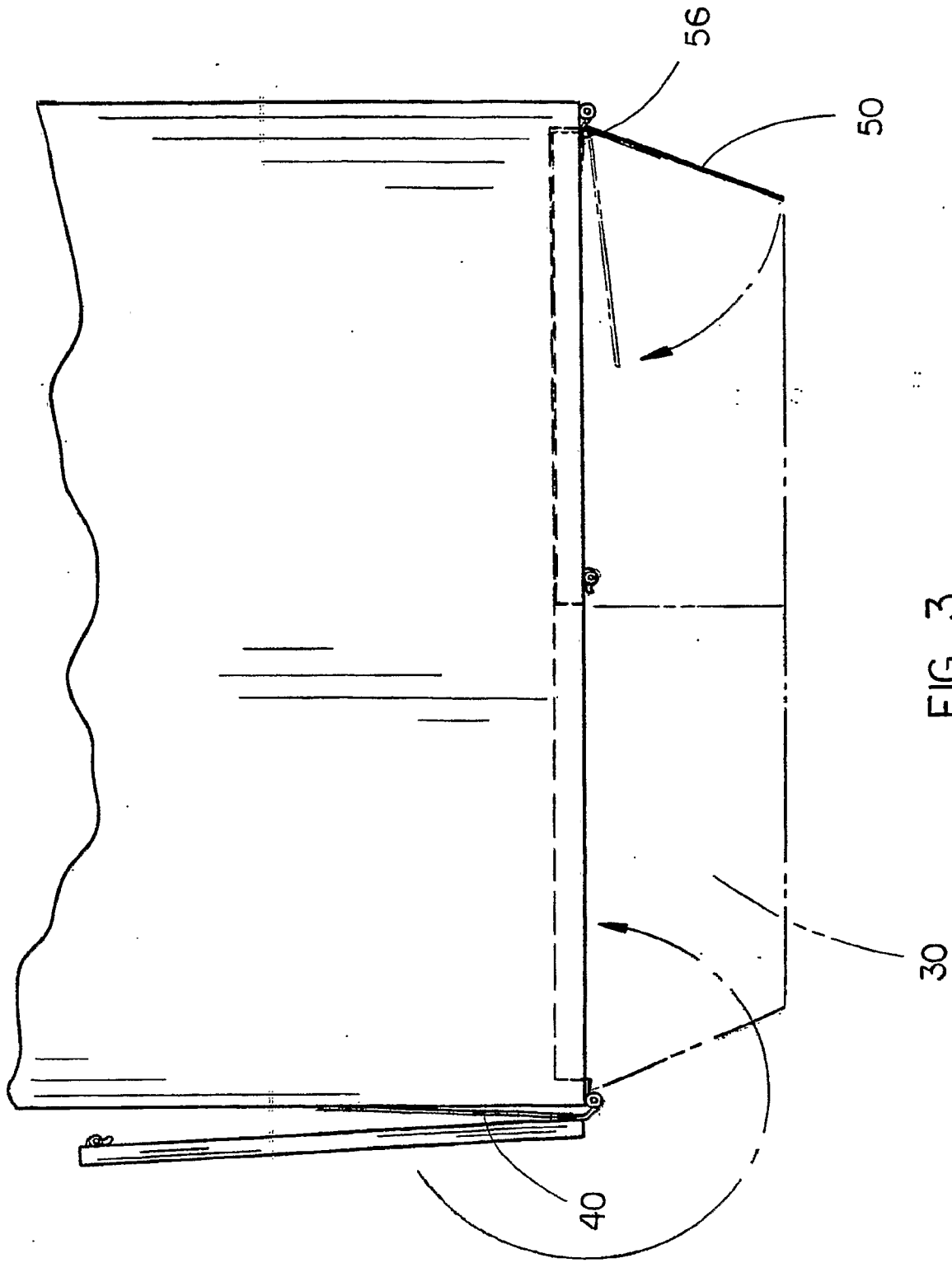


FIG. 2



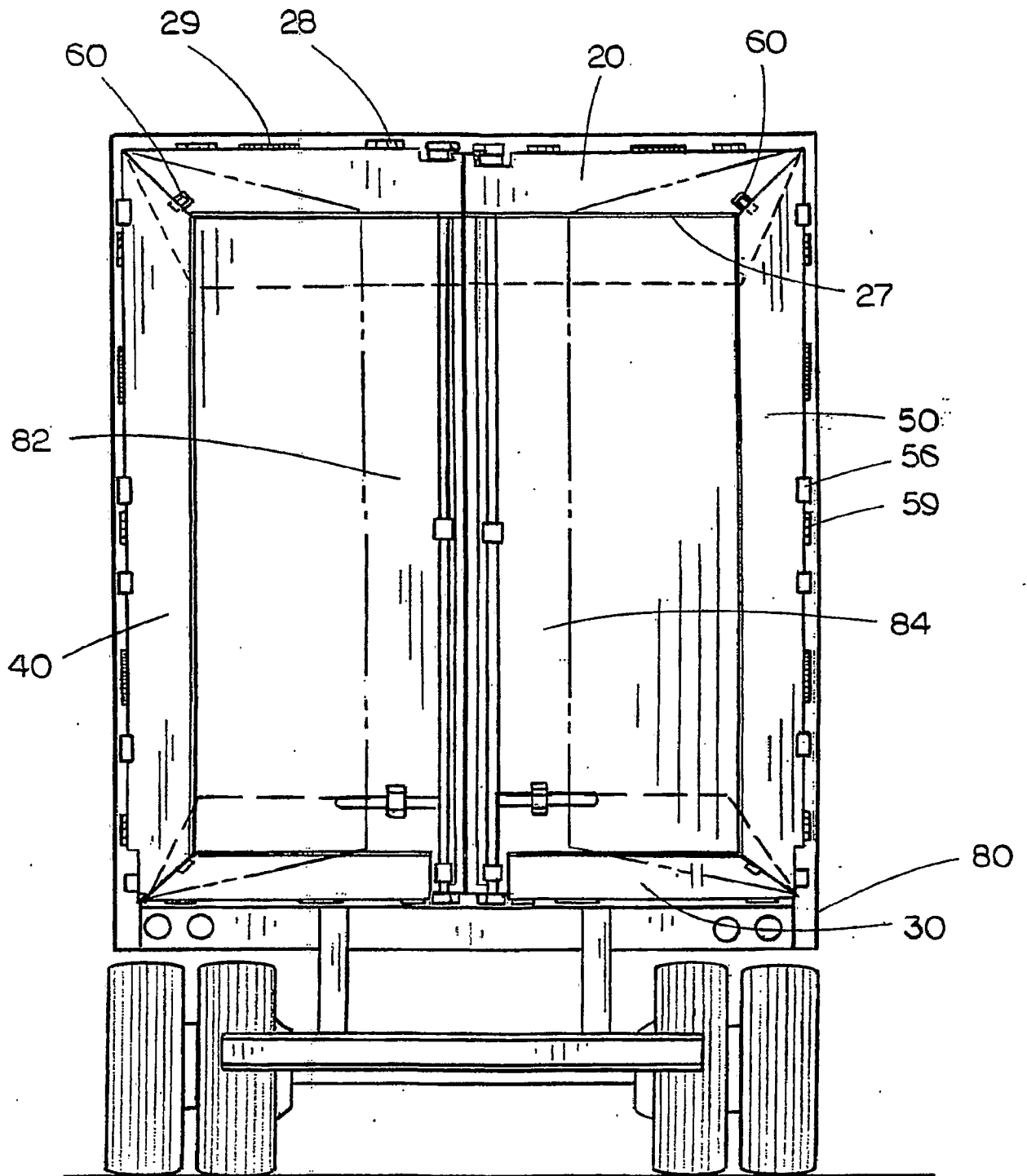


FIG. 4

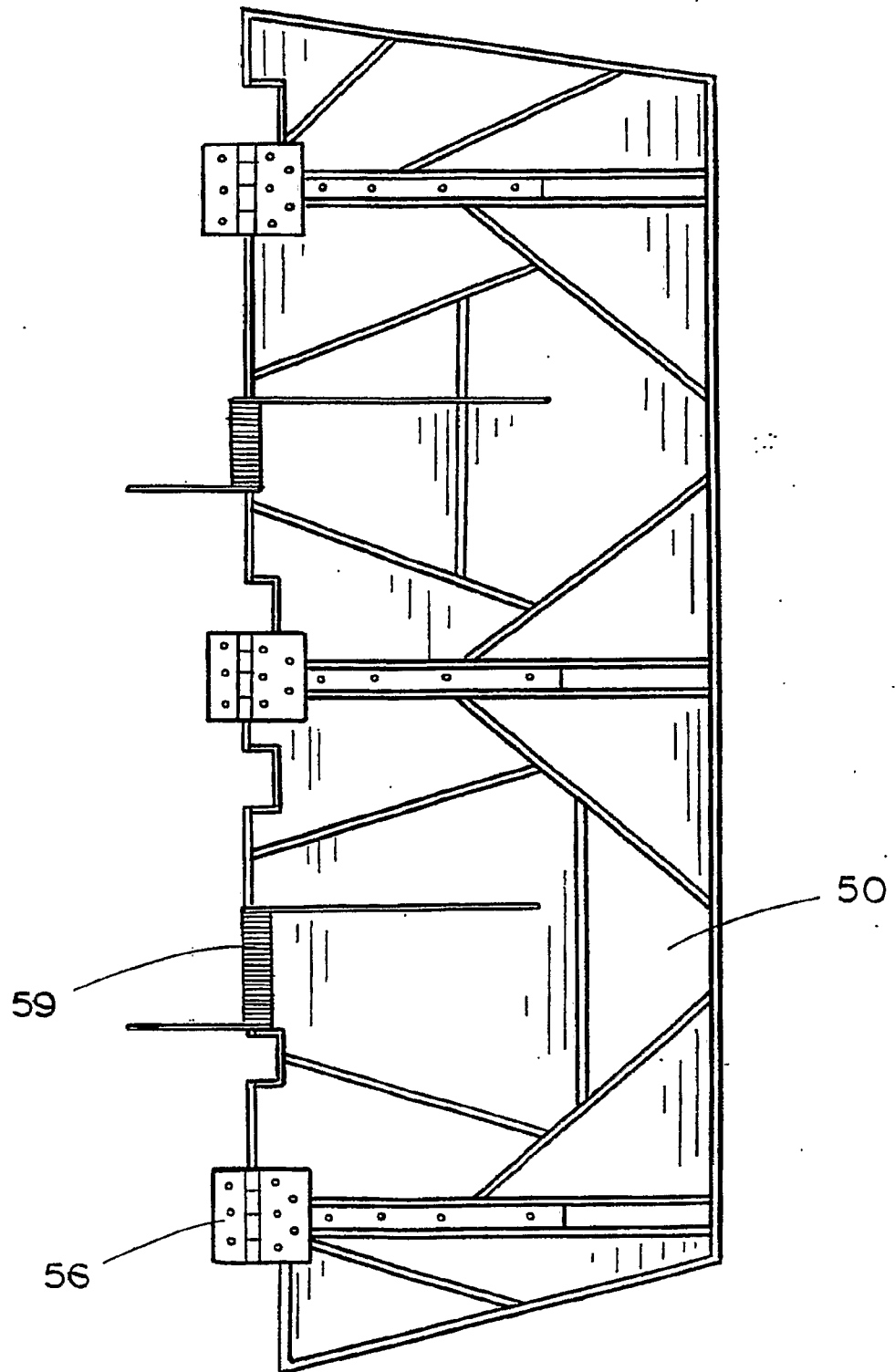


FIG. 5

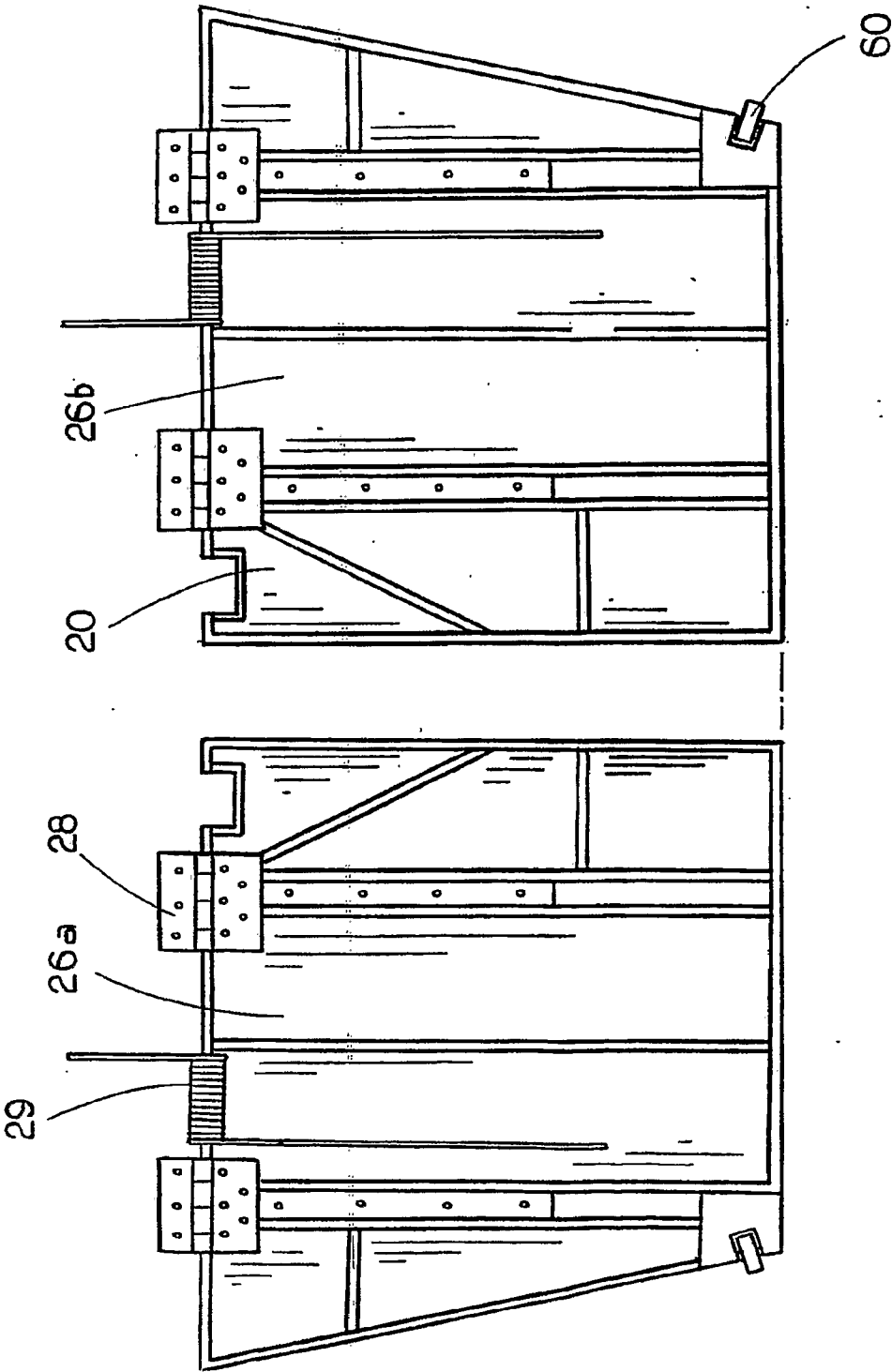


FIG. 6

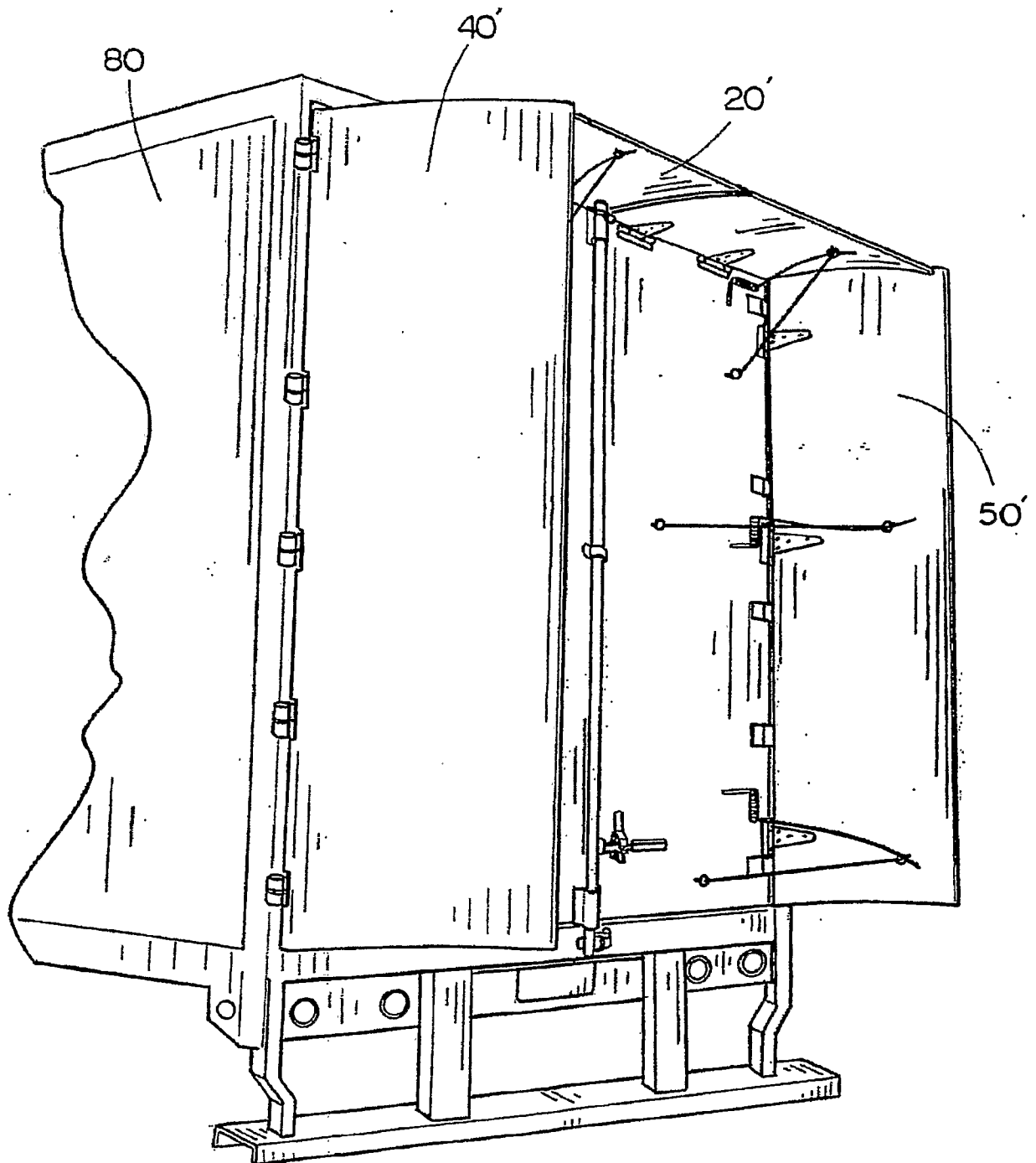


FIG. 7

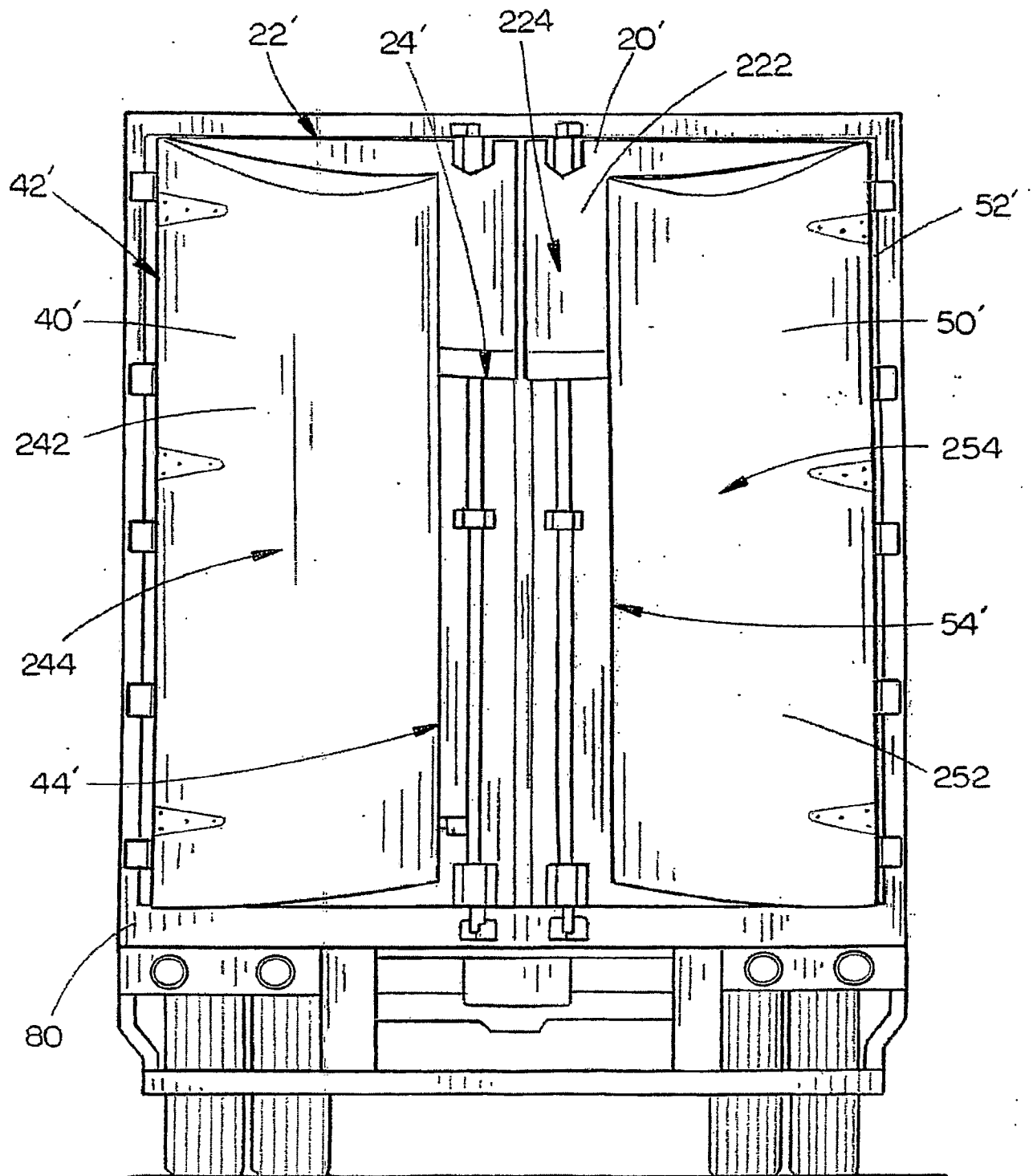


FIG. 8

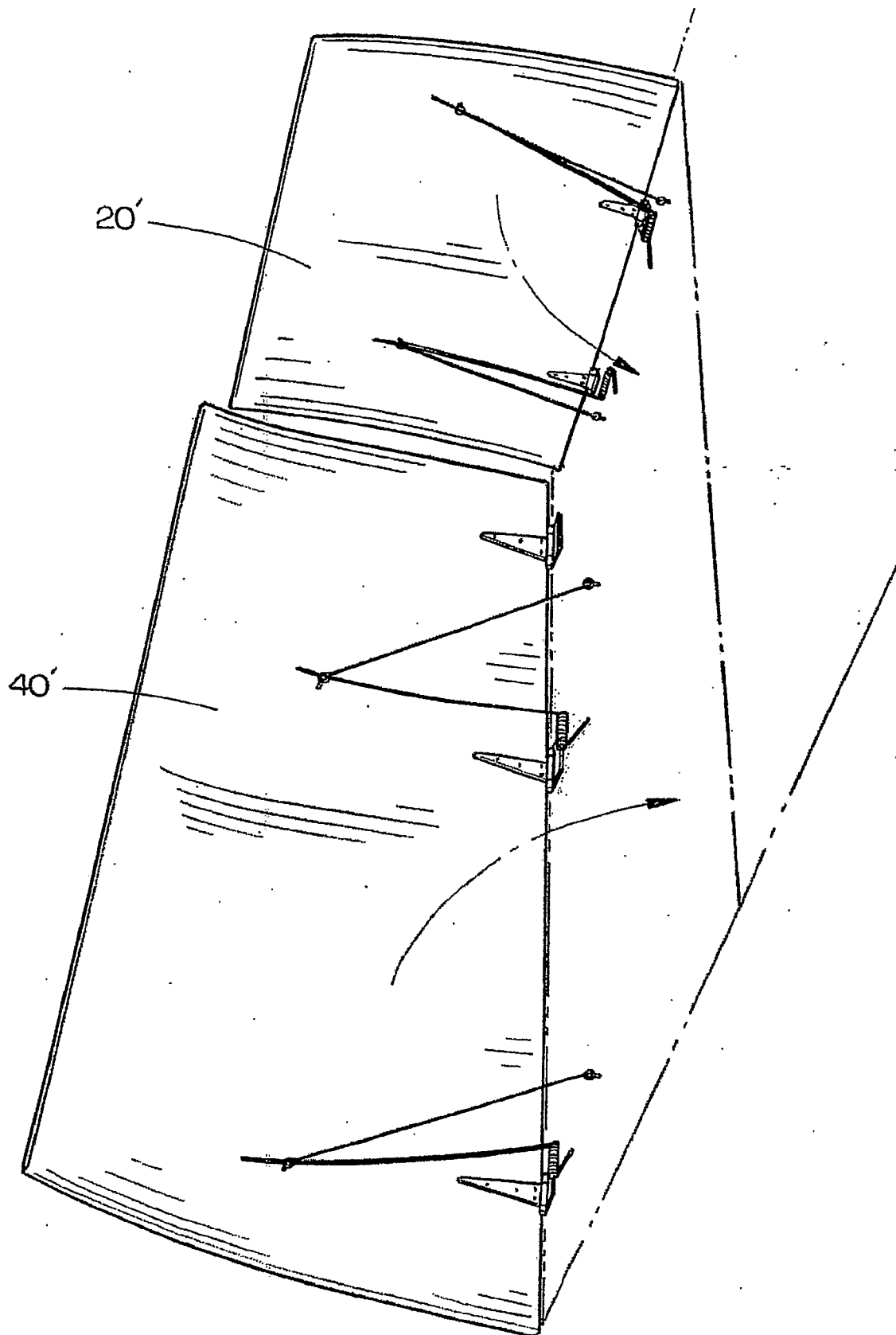


FIG. 9

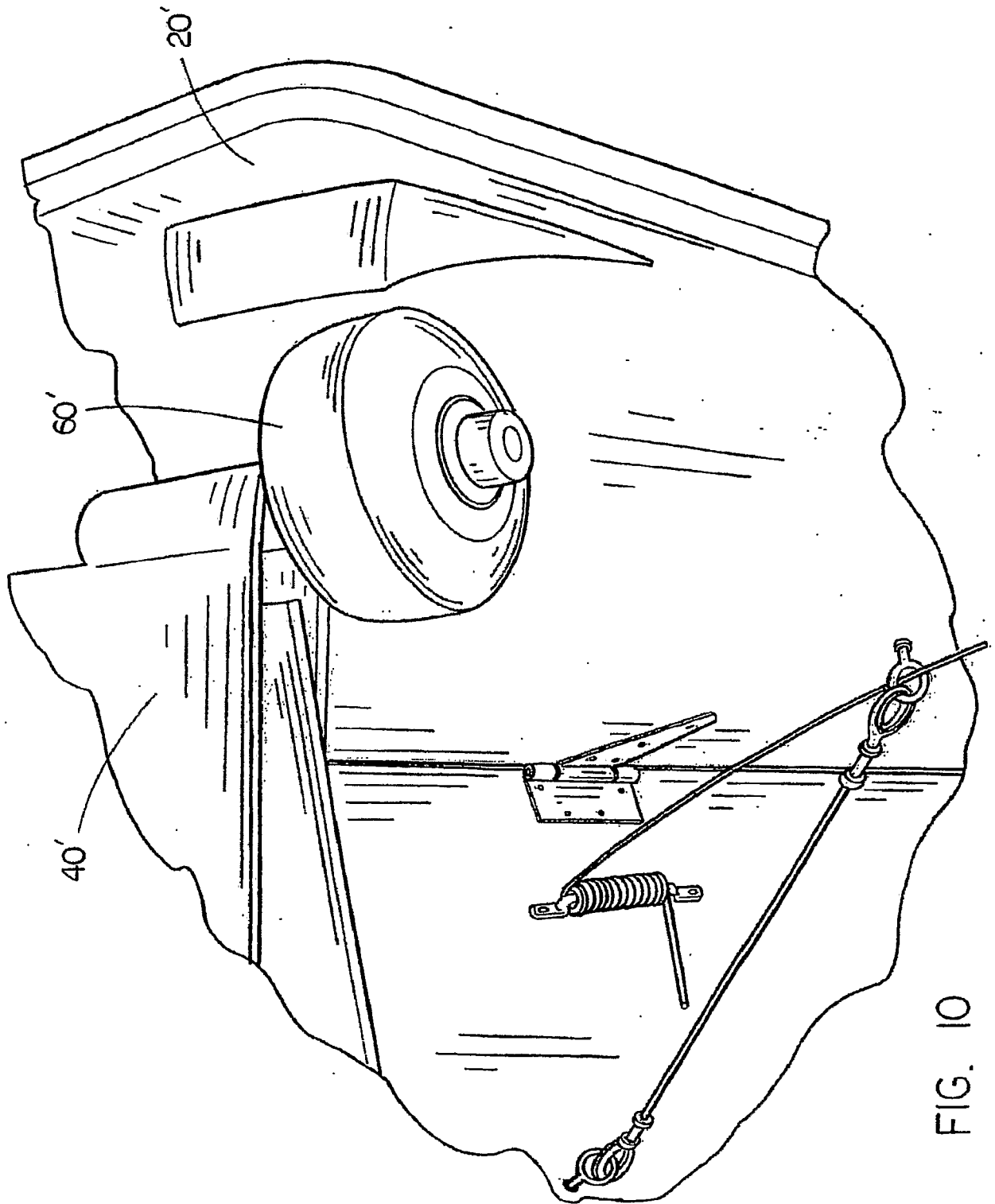


FIG. 10

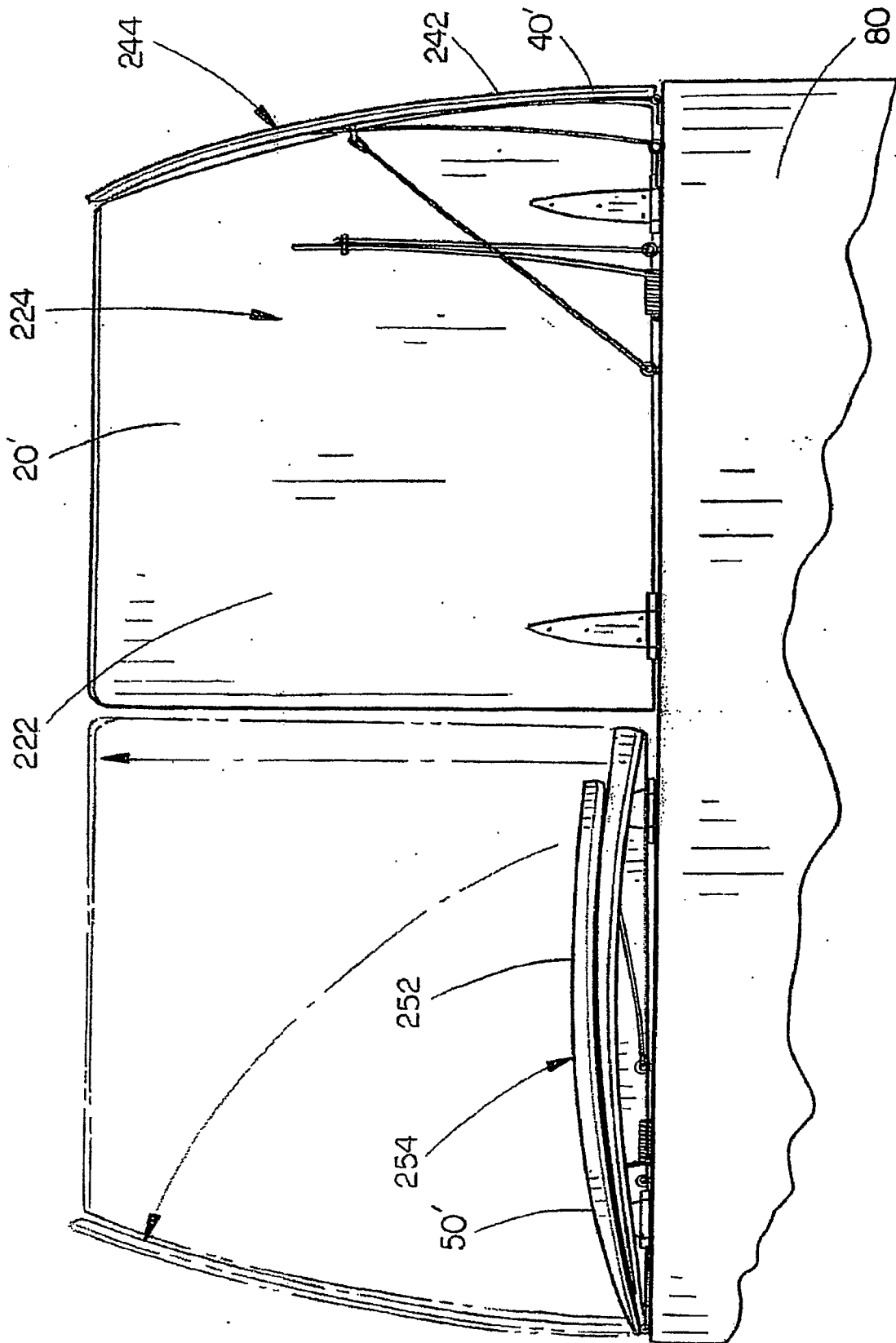


FIG. 11