Oct. 6, 1964 W. A. BOHNER ETAL 3,151,663

INFLATABLE CLOSURE APPARATUS

Filed Oct. 27, 1961 2 Sheets-Sheet 1

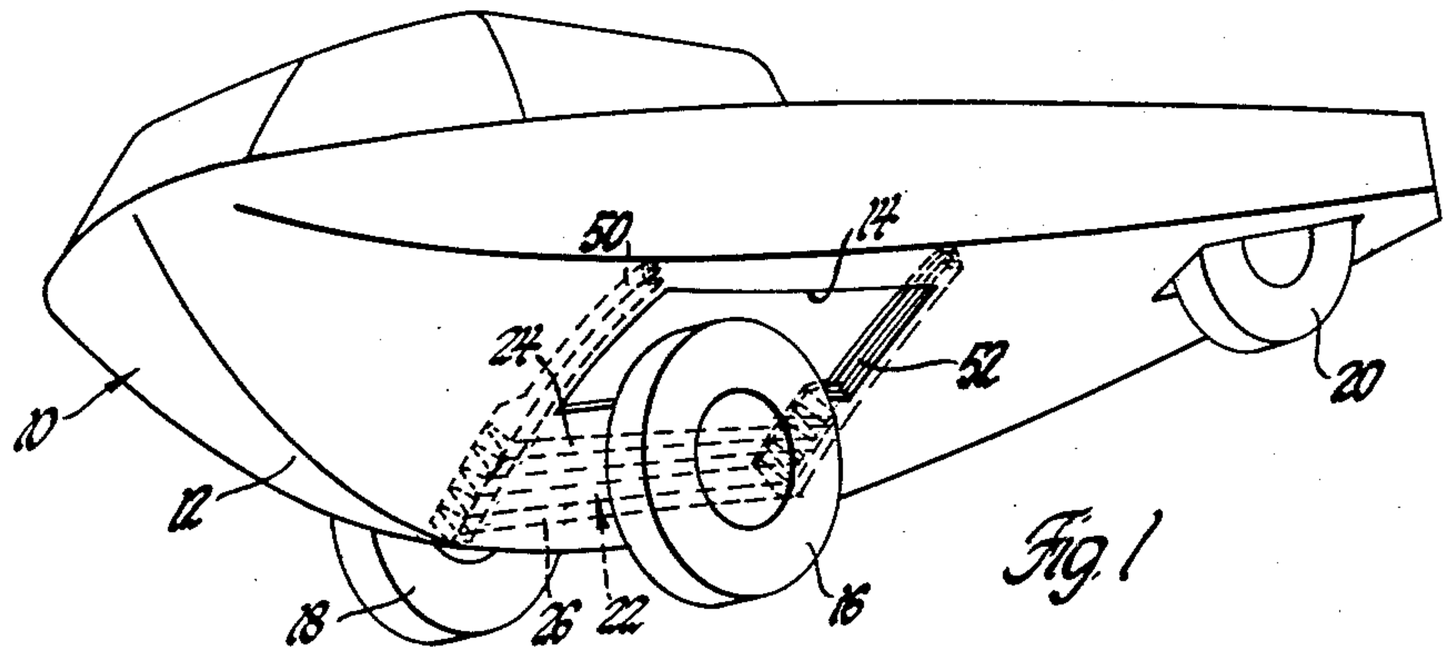


Fig. 1

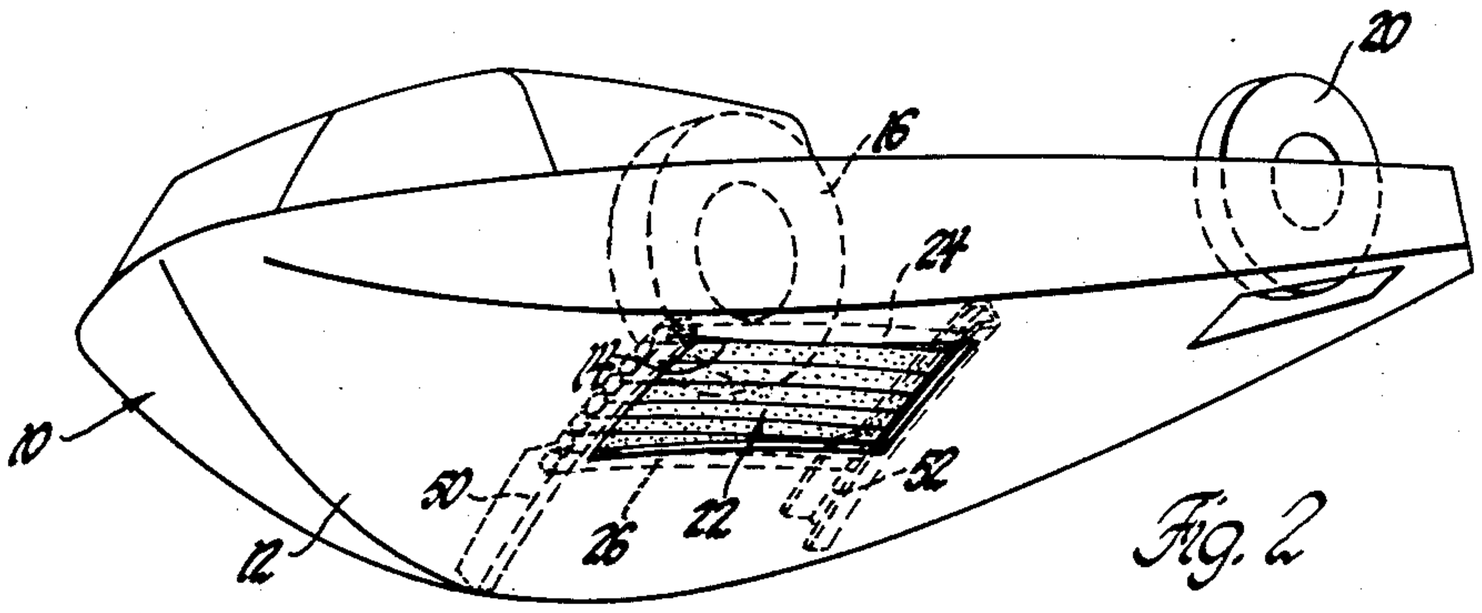


Fig. 2

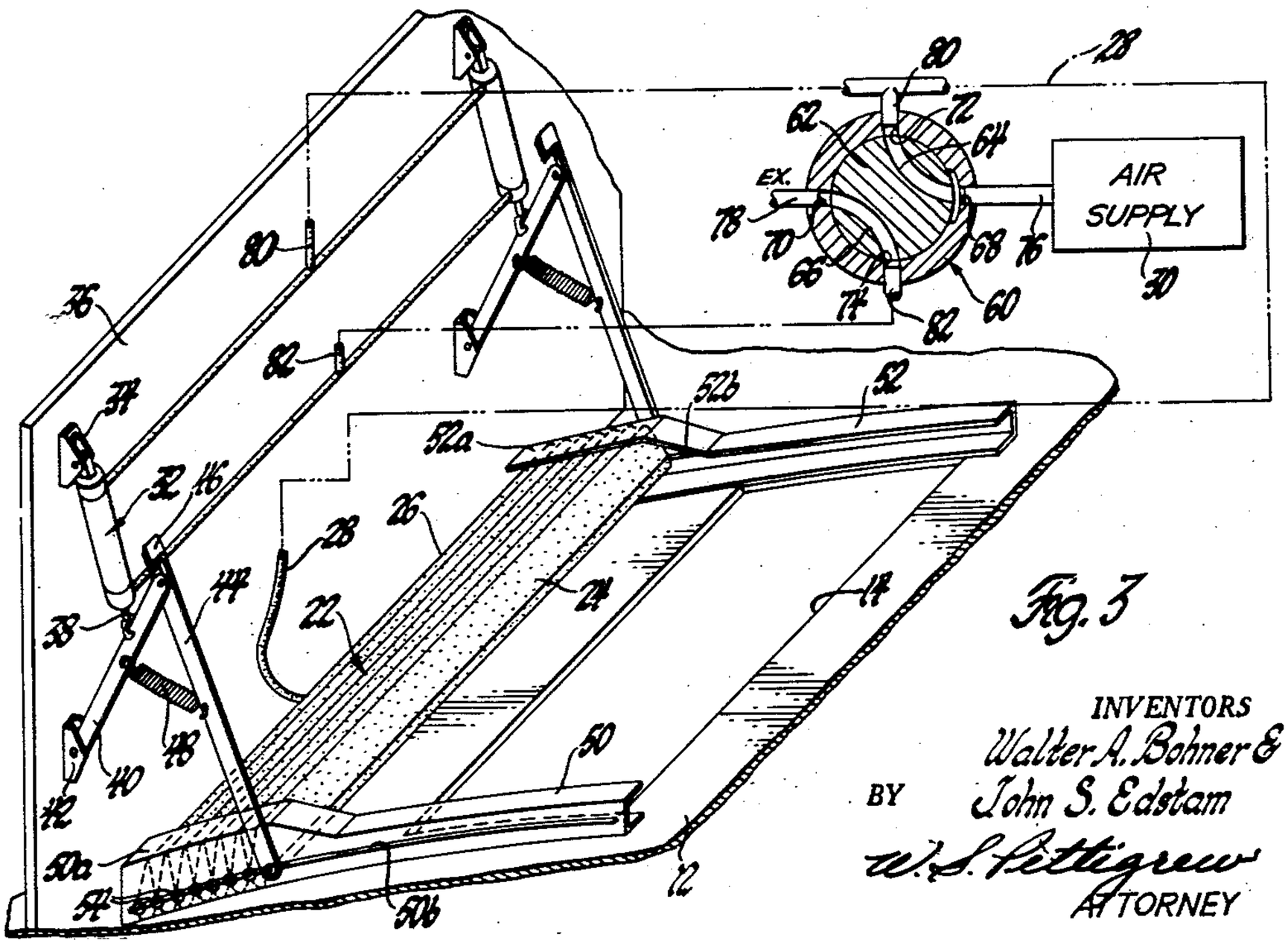


Fig. 3

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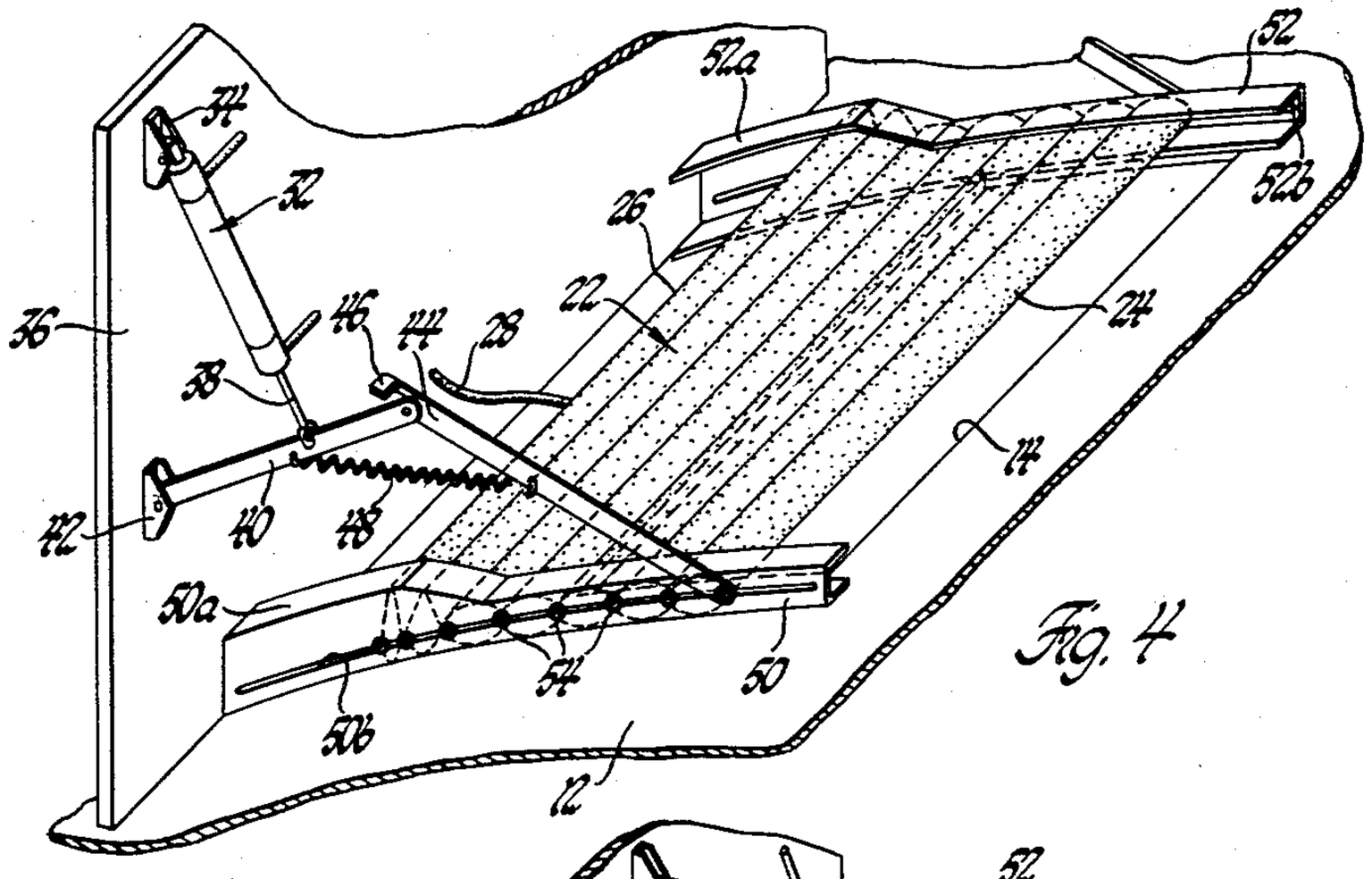


Fig. 4

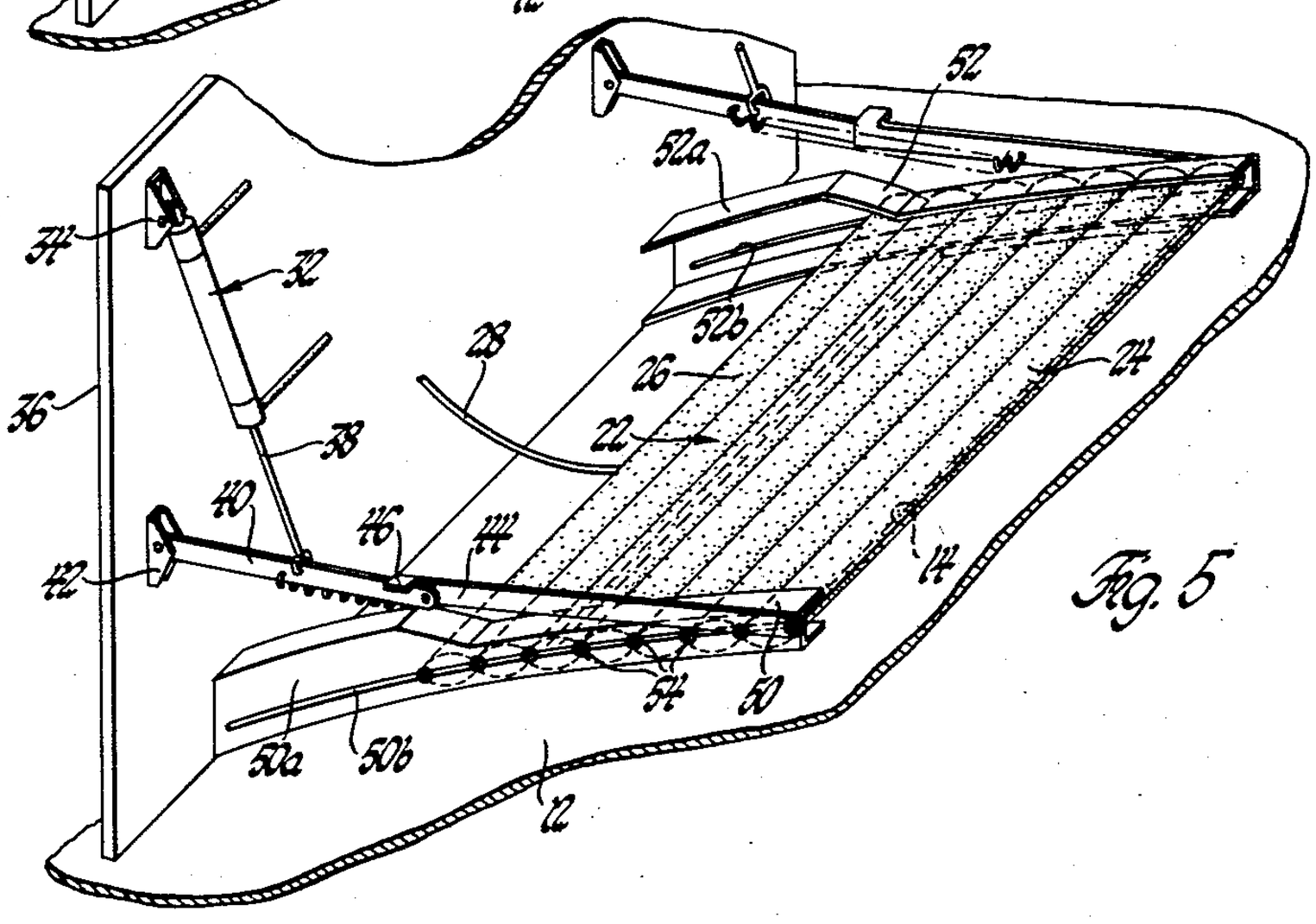


Fig. 5

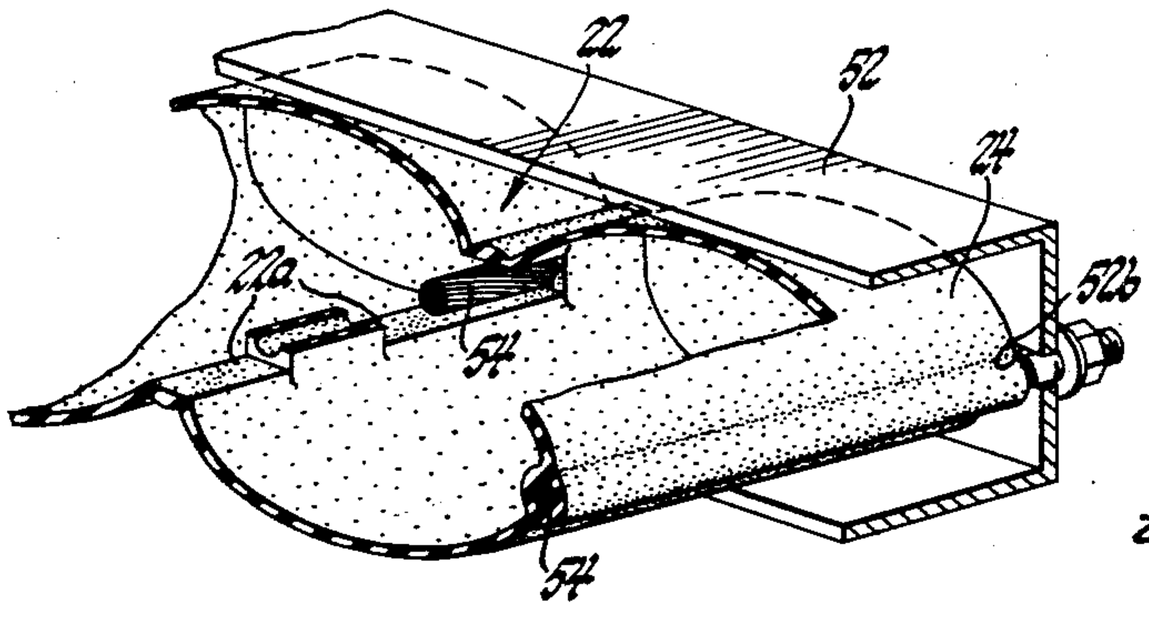


Fig. 6

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INFLATABLE CLOSURE APPARATUS

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9 Claims. (Cl. 160—84)

This invention relates to closure apparatus, and more particularly to inflatable closure apparatus for closing an opening in a body.

One feature of the invention is that it provides an improved closure for an opening in a body. Another feature of the invention is that it provides novel closure apparatus for an opening in a body, comprising a plurality of elongated inflatable cells movably mounted on the body and arranged side by side in abutting, fluid tight relationship. A further feature of the invention is that means are provided for moving said cells between a compressed deflated position adjacent an opening in the body and an expanded inflated position wherein said cells close said opening, said cells being inflated as they move toward expanded position and deflated as they move toward compressed position.

Other features and advantages of the invention will be apparent from the following description, having reference to the drawings in which:

FIGURE 1 is an isometric view of an amphibious vehicle utilizing the improved closure means to close an opening in the body which receives a retractable wheel of the vehicle.

FIGURE 2 is a view similar to FIGURE 1, but showing the parts in a different position.

FIGURE 3 is an enlarged sectional view showing a portion of the interior of the hull of the vehicle in FIGURE 1, the closure apparatus being in compressed or open position, and a control circuit being shown diagrammatically.

FIGURE 4 is a view similar to FIGURE 3, but showing the closure apparatus in partially closed position.

FIGURE 5 is a view similar to FIGURE 3 but showing the closure apparatus in closed position.

FIGURE 6 is an enlarged detail view of a portion of the apparatus, with parts of the structure being broken away.

In an amphibious vehicle which is designed to operate on land and in the water, the vehicle body comprises a hull having retractable wheels which move through openings in the hull between expanded or land operating position and retracted or water operating position. When the wheels are in retracted position it is necessary to close the openings, and this invention provides a novel and improved closure apparatus comprising a plurality of elongated, inflatable flexible cells arranged in side by side abutting, fluid tight relationship, and movable between a compressed, deflated position adjacent one side of the opening, and an expanded inflated position wherein the cells close the opening. The use of inflated flexible fluid tight air cells for this purpose provides advantages in that this closure device absorbs the shock of impact loads received from rough water because of the compressibility of the air which inflates the cells. Furthermore, the flexibility of the closure causes heavy impact loads to be transferred to the rigid hull structure without damage to the closure. The surface of the closure approximates the contour of the hull because of the fact that the closure cells are made of flexible material which is anchored to the hull along opposite ends of the wheel openings.

Referring now more particularly to the drawings, an amphibious vehicle is indicated generally as **10**, and has a hull or body **12** formed with an opening **14** through

which one of the wheels **16** of the vehicle may project. As shown in FIGURES 1 and 2, the vehicle is provided with a plurality of wheels **16**, **18** and **20**, and these wheels are movable between the extended or land operating position of FIGURE 1 and the retracted or water operating position of FIGURE 2. The opening through which each wheel moves may be closed by apparatus similar to the closure apparatus which is illustrated for the opening **14**.

The closure apparatus comprises a plurality of elongated inflatable flexible cells designated generally by the reference character **22** and including a leading cell **24**, a trailing cell **26** and a plurality of intermediate cells, all of which are interconnected between the leading cell **24** and the trailing cell **26** in abutting fluid tight relationship. As shown in FIGURE 6 at **22***a*, there are passages between each cell providing for fluid communication therebetween. The trailing cell **26** is connected to an air supply pipe **28** which communicates with a source of compressed air **30** so that the cells **22** may selectively be inflated as they appear in FIGURES 2, 5 and 6 or deflated as they appear in FIGURES 1 and 3.

Means are provided for moving the cells between their compressed deflated position adjacent one side of the opening **14** (FIGURES 1 and 3) and their expanded inflated position wherein said cells close the opening **14** (FIGURES 2 and 5), and preferably the moving means for the cells is interconnected with the fluid supply means **30** as shown diagrammatically in FIGURE 3 so that the cells are inflated as they are driven toward expanded position and are deflated as they are driven toward compressed position. By this means movement of the cells toward expanded position is aided by the force of the compressed air which is used to inflate the air cells.

As shown in FIGURES 3, 4 and 5, there is an air cylinder device designated generally as **32** pivotally mounted at one end on a bracket **34** carried by a support bulkhead **36** inside the hull **12**. The piston rod **38** of the device **32** is pivotally connected to one link **40** of a pair of toggle links connected between the bulkhead **36** and the leading cell **24** of the closure device. One end of the link **40** is pivotally connected to a support bracket **42** on the bulkhead **36**, and the other end is pivotally connected to another link **44** which is pivoted on the leading cell **24**. The link **44** has a free end projecting past the pivotal connection with the link **40**, and formed with a stop flange **46** adapted to abut an edge of the link **40** when the closure device is in expanded position to lock the device in this position. A spring **48** interconnects the links **40** and **44** to aid the motor means **32** in retracting the closure device. At the other end of the opening **14** there is a similar air cylinder motor device and linkage system which need not be described.

Guide means comprising slotted channels **50** and **52** are mounted to extend along opposite ends of the opening **14**, and each channel slidably seats one end of each of the cells **22**. As shown in FIGURES 3, 4 and 5, each of the guide channels has an expanded portion **50***a* and **52***a*, respectively, which extend past the edge of the opening **14** to receive the ends of the cells **22** when the closure device is in compressed deflated position, as shown best in FIGURE 3. Each channel is also provided with an elongated slot **50***b* and **52***b*, respectively, these slots extending throughout substantially the entire length of the channels.

Support means comprises flexible cables **54**, one of which is connected between each of the cells **22** (see FIGURE 6) and extends along the length thereof between the channels **50**, **52**. As shown in the drawings, the cables project through and are slidable along the slots **50***b*, **52***b* in the channels, so that the cables help

hold the inflated cells in the desired contour and help seal the cells at opposite sides of the opening **14**.

FIGURE 3 shows diagrammatically a control means which is connected with the motor means **32** and the cells **22** so that the cells are inflated as they are moved toward expanded position and deflated as they are moved toward compressed position. In FIGURE 3 there is a rotary valve designated generally as **60** having a rotatable body **62** provided with a first fluid passage **64** and a second fluid passage **66**. The valve has an air supply port **68**, an exhaust port **70**, an expand port **72** and a retract port **74**. The air supply port **68** is connected by a pipe **76** to the air supply **30** and the exhaust port is vented to atmosphere through a pipe **78**. The expand port **72** is connected by a pipe **80** to the pivoted end of the cylinders **32** and also to the air supply pipe **28** for the cells **22**. The retract port **74** is connected by a pipe **82** to the rod end of the cylinders **32**.

In the operation of the closure apparatus, if it is desired to change the condition of the vehicle from the land operating condition of FIGURES 1 and 3 to the water operating condition of FIGURES 2 and 5, the vehicle wheels are retracted and then the openings through which the wheels move are closed. In order to close the opening **14** the power cylinders **32** are actuated to extend the piston rods **38**, unfolding the toggle links **40, 44**, and driving the array of cells **22** from the position of FIGURE 3 toward the position of FIGURE 5. At the same time, air under pressure is admitted to the pipe **28** to inflate the cells which are connected together by air passages **22***a* in a conventional manner similar to that of air mattresses. The force of the inflating air aids in the movement of the cells from the compressed deflated position of FIGURES 1 and 3 to the expanded inflated position of FIGURES 2 and 5. This operation is accomplished by placing the valve **60** in the condition shown in FIGURE 3, wherein the valve passage **64** connects the fluid supply port **68** with the expand port **72** and the valve passage **66** connects the retract port **74** to the exhaust port **70**. When the array of cells approaches the fully expanded position of FIGURE 5 the point of pivotal interconnection of the toggle links **40, 44** passes over center and the stop flange **46** abuts the upper surface of the link **40** to provide a stop. The over center arrangement locks the cells in fully expanded position. When it is desired to convert the vehicle **10** from water operation to land operation the procedure above described is reversed, and the valve passage **66** is connected between ports **68** and **74** while the passage **64** is connected between ports **72** and **70**. The power cylinder **32** is driven in a reverse direction to retract the piston rod **38** and simultaneously the pipe **28** is opened to atmosphere so that air may be exhausted from the cells **22** as they move toward their compressed deflated position.

While we have shown and described one embodiment of our invention, it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

We claim:

1. In a vehicle body having an opening therein, closure apparatus of the character described, including: a plurality of elongated inflatable flexible cells movably mounted on said body and arranged side by side in abutting fluid tight relationship; means for moving said cells between a compressed deflated position adjacent one side of said opening and an expanded inflated position wherein said cells close said opening, comprising a linkage system connected between said body and the leading one of said cells, and motor means for operating said linkage system to drive said cells between compressed and expanded positions; and fluid supply means for inflating said cells as they are driven toward expanded position and for deflating said cells as they are driven toward compressed position.

2. Apparatus of the characted claimed in claim 1, wherein said flid supply means include control means connected with said motor means and said cells.

3. Apparatus of the character claimed in claim 1, including locking means on said linkage system for locking said cells in expanded position.

4. In a vehicle body having an opening therein, closure apparatus of the character described, including: a plurality of elongated inflatable flexible cells movably mounted on said body and arranged side by side in abutting fluid tight relationship; means for moving said cells between a compressed deflated position adjacent one side of said opening and an expanded inflated position wherein said cells close said opening, comprising a linkage system connected between said body and the leading one of said cells and motor means for operating said linkage system to drive said cells between compressed and expanded positions; means for locking said cells in expanded position; fluid supply means for inflating said cells as they are driven toward expanded position and for deflating said cells as they are driven toward compressed position; guide means comprising slotted channels extending along opposite ends of said opening, each channel slidably seating one end of each of said cells; and support means comprising a flexible cable connected to each of said cells and extending along the length thereof between said channels, said cables projecting through and being slidable along the slot in each of said channels.

5. Apparatus of the character claimed in claim 4, wherein said linkage system comprises a pair of toggle links which move between a folded position when the cells are compressed and an extended position when the cells are expanded, said links passing over center to lock said cells in expanded position.

6. In a body having an opening therein, closure apparatus comprising, a closure member including a plurality of elongated inflatable cells arranged side-by-side in abutting fluid tight relationship, means mounting said member on said body for movement relative to said opening between a retracted deflated open position wherein said cells are located to one side of said opening and an extended inflated closed position wherein said cells close said opening, means including motor means connected to at least one of said cells for moving said member between said open and closed positions thereof, and fluid supply means for selectively inflating said cells as said motor means moves said member from the open to the closed position thereof and for deflating said cells as said motor means moves said member from the closed to the open position thereof.

7. In a body having an opening therein, closure apparatus comprising, a closure member including a plurality of elongated inflatable cells arranged side-by-side in abutting fliud tight relationship, means mounting said member on said body for movement relative to said opening between a retracted deflated open position wherein said cells are located to one side of said opening and an extended inflated closed position wherein said cells close said opening, means for moving said closure member laterally to the direction of the elongation of said cells between said open and closed positions thereof, fluid supply means for selectively inflating said cells as said member is moved toward said closed position and for deflating said cells as said closure member is moved toward said open position, and guide means for guiding the movement of said closure member between said open and closed positions thereof.

8. In a body having an opening therein, closure apparatus of the character described, including: a plurality of elongated inflatable cells movably mounted on said body and arranged side-by-side in abutting fluid tight relationship; means for moving said cells between a retracted deflated position adjacent one side of said opening and an extended inflated position wherein said cells close said

opening; fluid supply means for inflating said cells as they are moved toward extended position and for deflating said cells as they are moved toward retracted position; and guide means for guiding the movement of said cells between said retracted and extended positions comprising channels extending along opposite ends of said opening, each channel slidably seating one end of each of said cells.

9. Apparatus of the character claimed in claim 8, wherein said guide channels are slotted and wherein there are support means comprising a flexible member connected to each of said cells extending along the length thereof between said channels, said flexible members projecting through and being slidable in the slot in each of said channels.

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