Feb. 1, 1966 F. J. LUKETA 3,231,998

INVERTIBLE TRAWL DOOR WITH RESILIENT EDGE AND ADJUSTABLE BALLASTING

Filed April 1, 1963 14 Sheets-Sheet 1

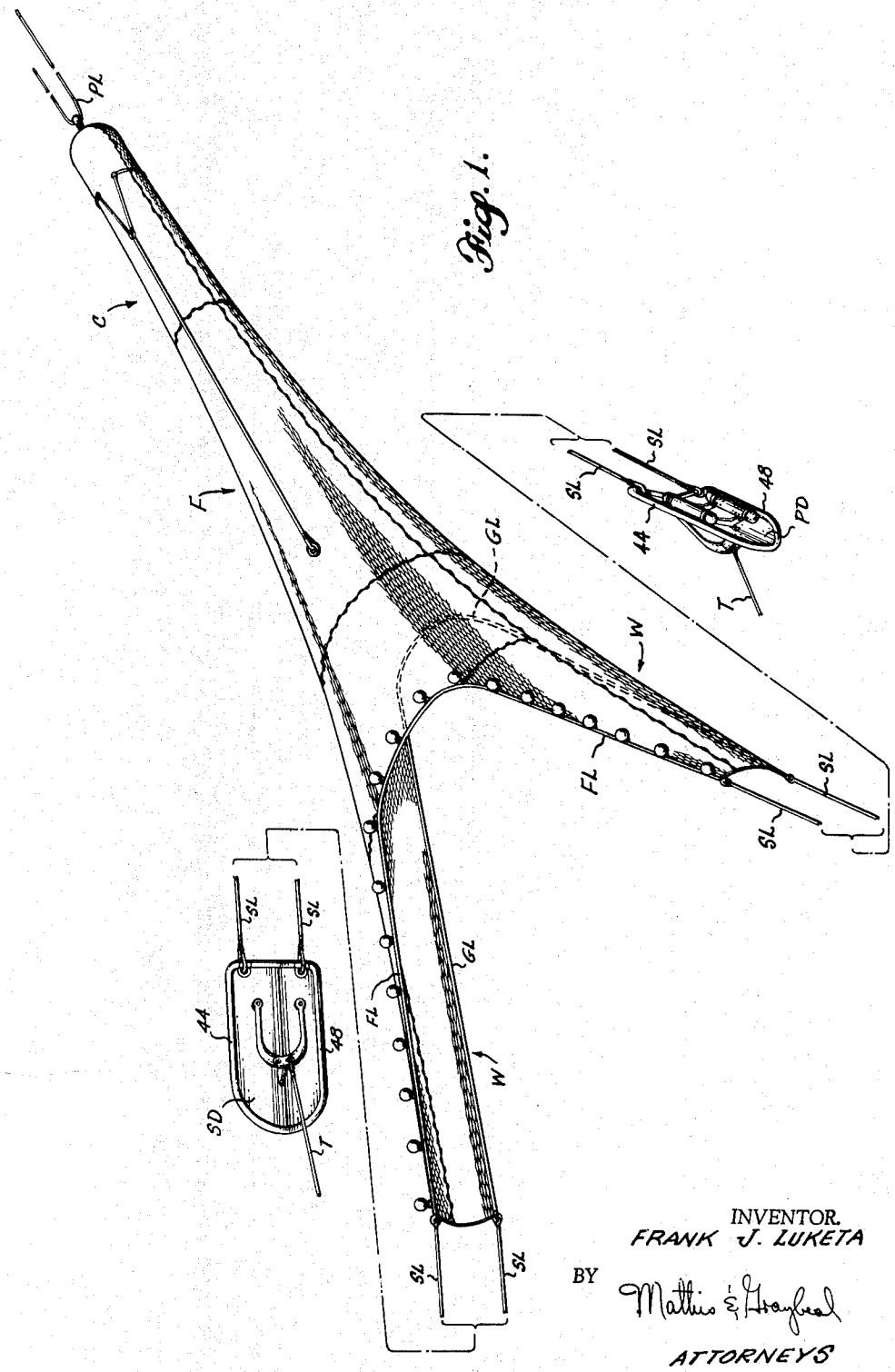


Fig. 1.

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FRANK J. LUKETA

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Feb. 1, 1966 F. J. LUKETA 3,231,998

INVERTIBLE TRAWL DOOR WITH RESILIENT EDGE AND ADJUSTABLE BALLASTING

Filed April 1, 1963 14 Sheets-Sheet 2

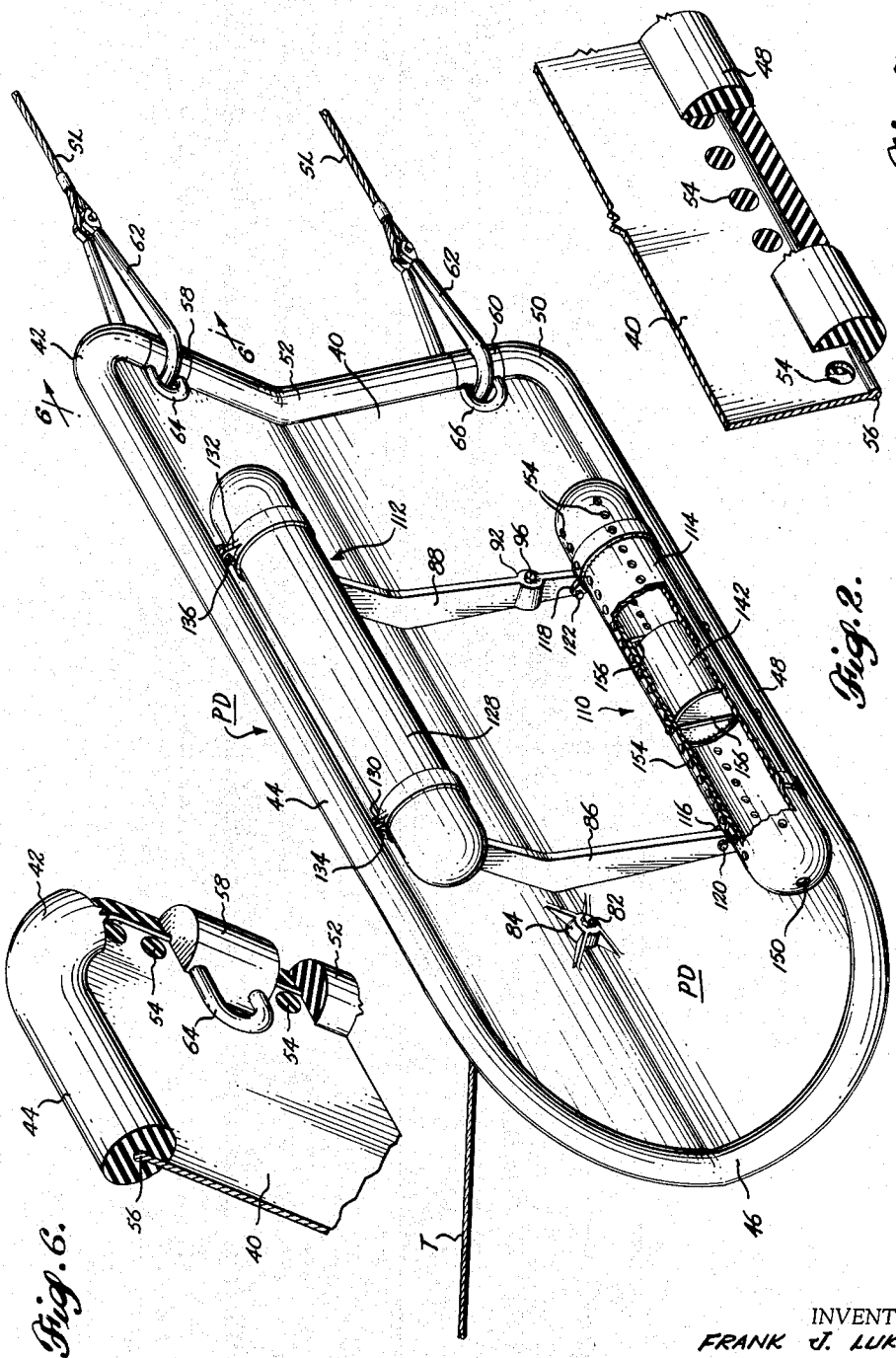


Fig. 2.

Fig. 7.

Fig. 6.

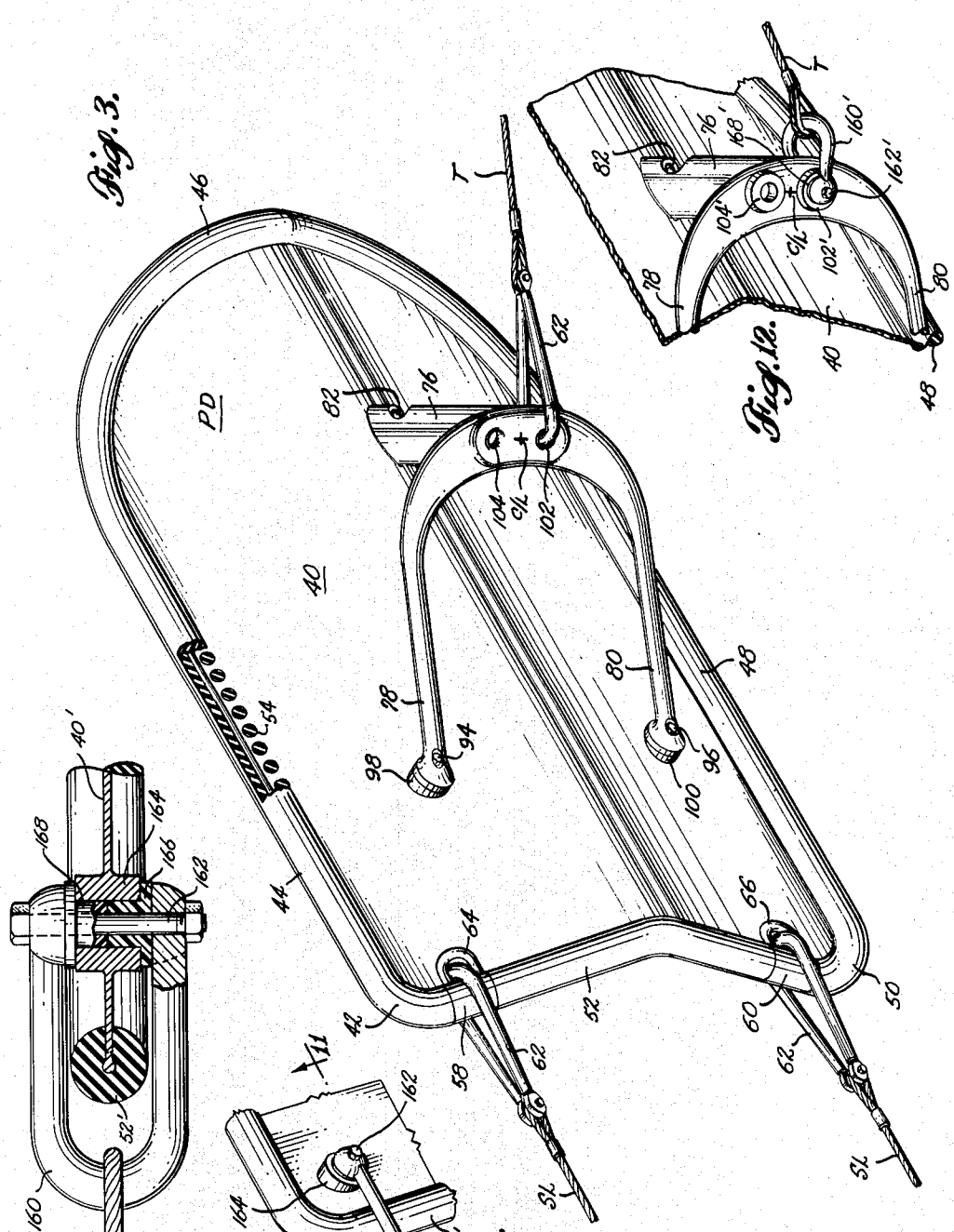
INVENTOR.
FRANK J. LUKETA

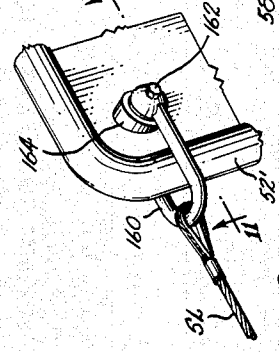
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INVERTIBLE TRAWL DOOR WITH RESILIENT EDGE AND ADJUSTABLE BALLASTING

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INVERTIBLE TRAWL DOOR WITH RESILIENT EDGE AND ADJUSTABLE BALLASTING

Filed April 1, 1963 14 Sheets-Sheet 4

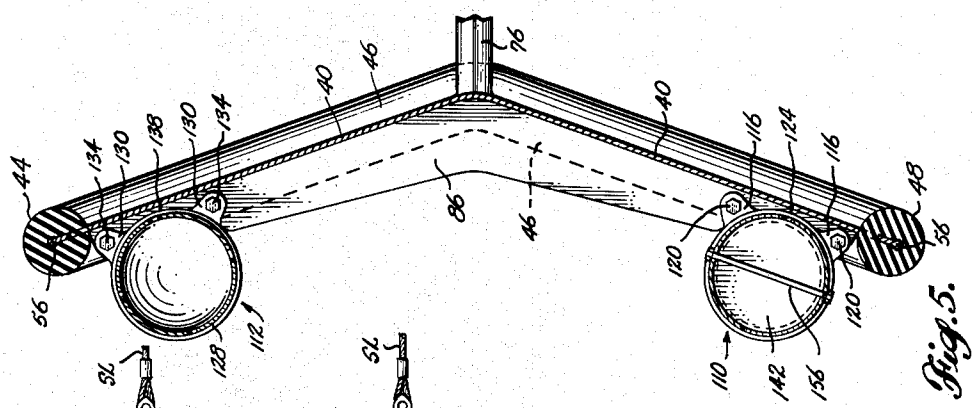


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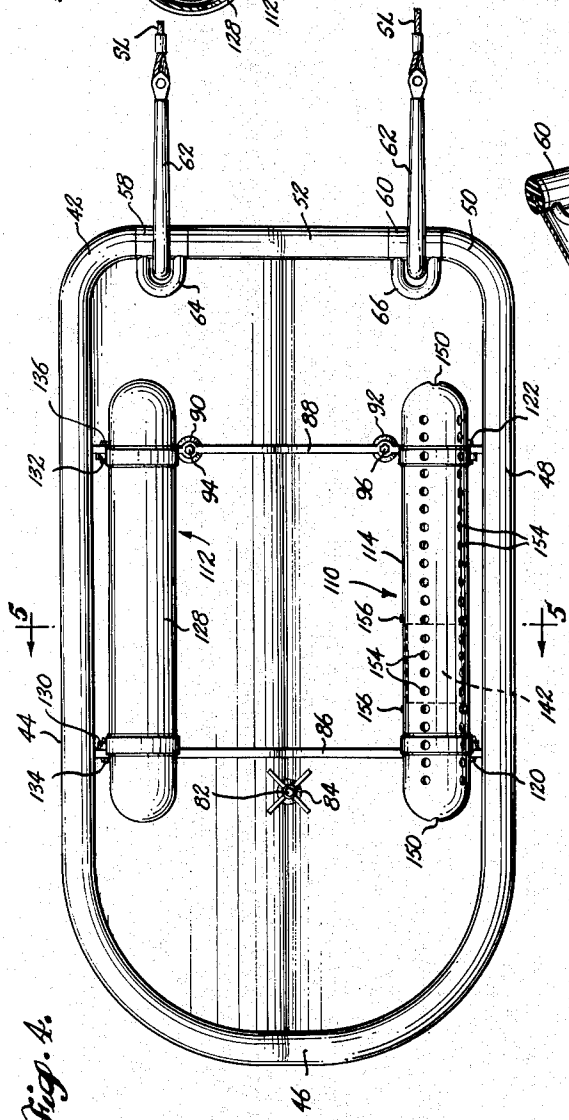


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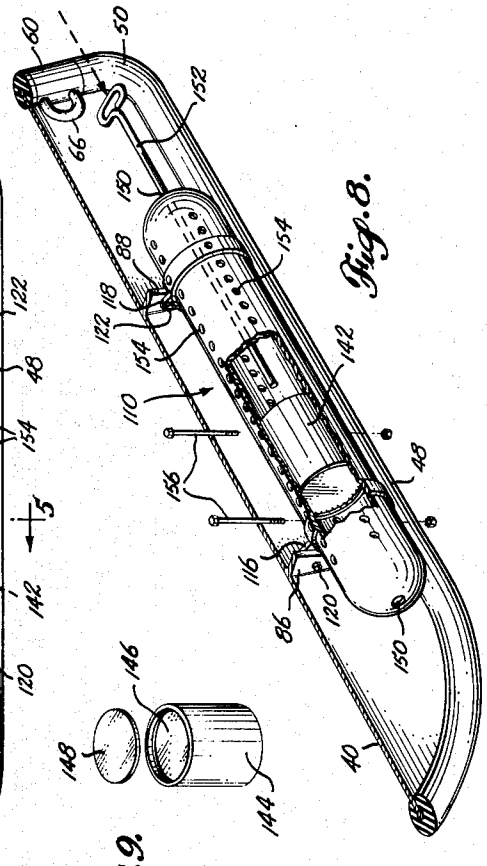


Fig. 8.

Fig. 9.

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INVERTIBLE TRAWL DOOR WITH RESILIENT EDGE AND ADJUSTABLE BALLASTING

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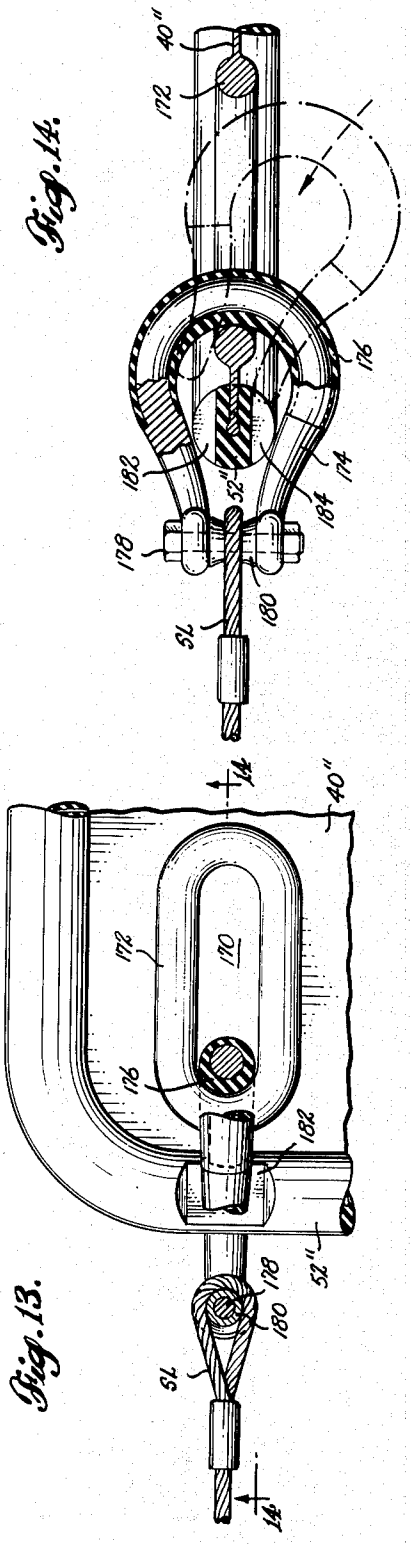


Fig. 14.

Fig. 13.

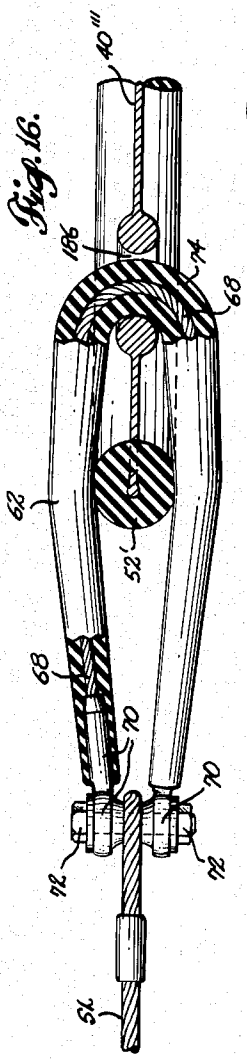


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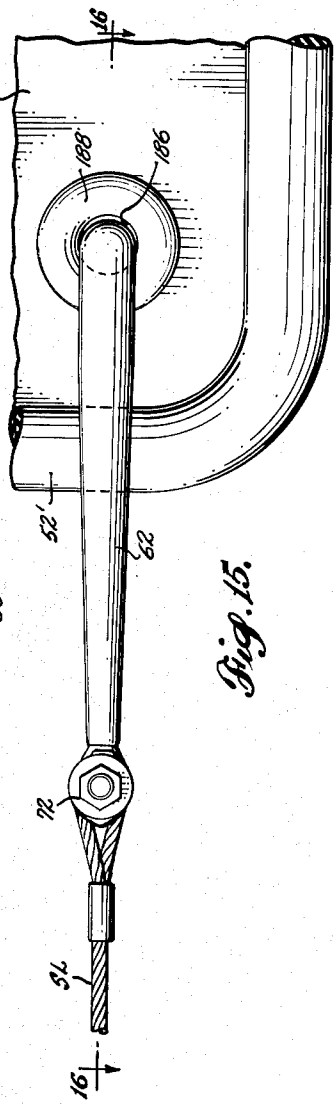


Fig. 15.

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INVERTIBLE TRAWL DOOR WITH RESILIENT EDGE AND ADJUSTABLE BALLASTING

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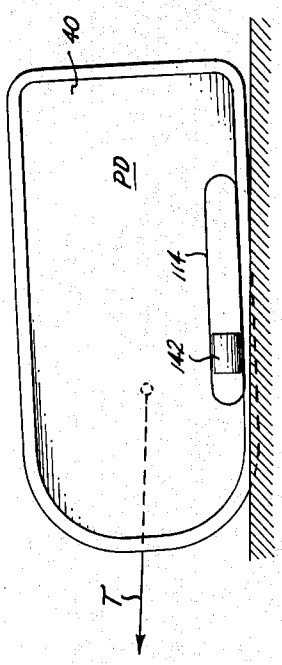


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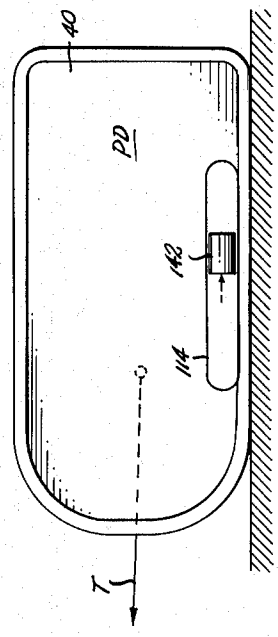


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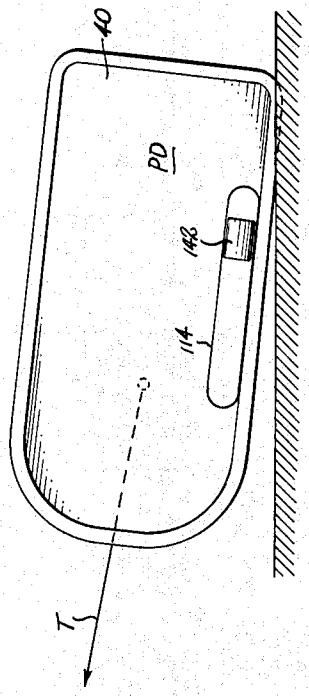


Fig. 17.

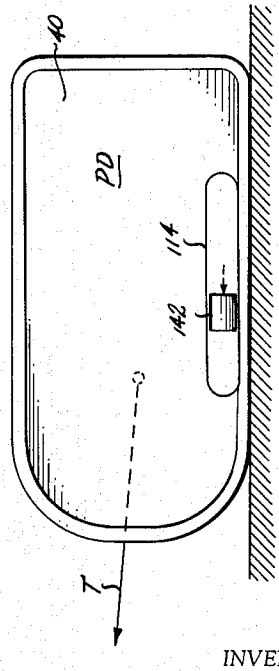


Fig. 18.

INVENTOR.
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INVERTIBLE TRAWL DOOR WITH RESILIENT EDGE AND ADJUSTABLE BALLASTING

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Fig. 22.

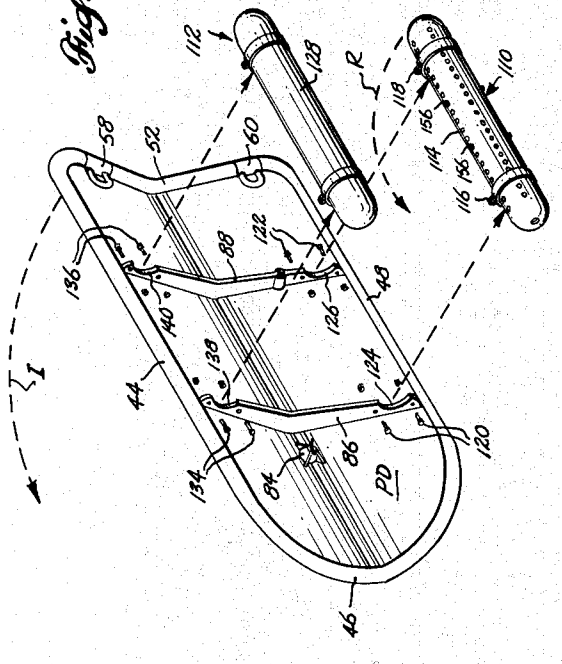


Fig. 24.

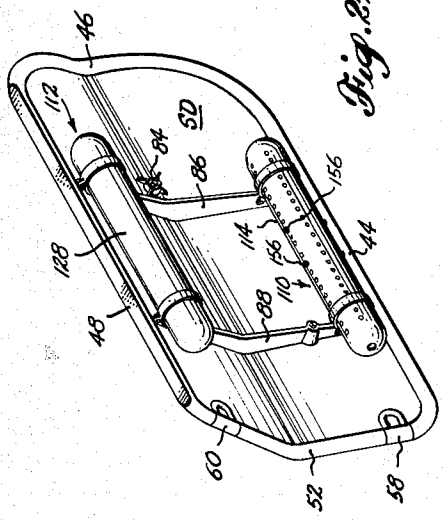


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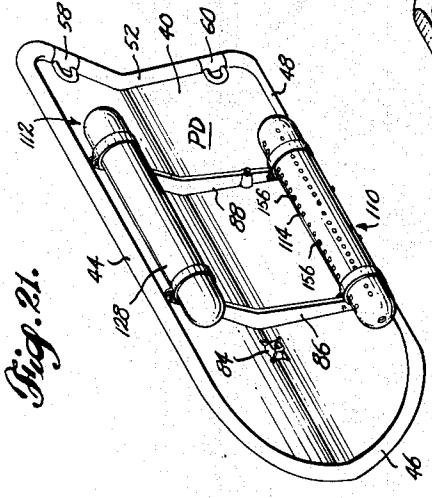
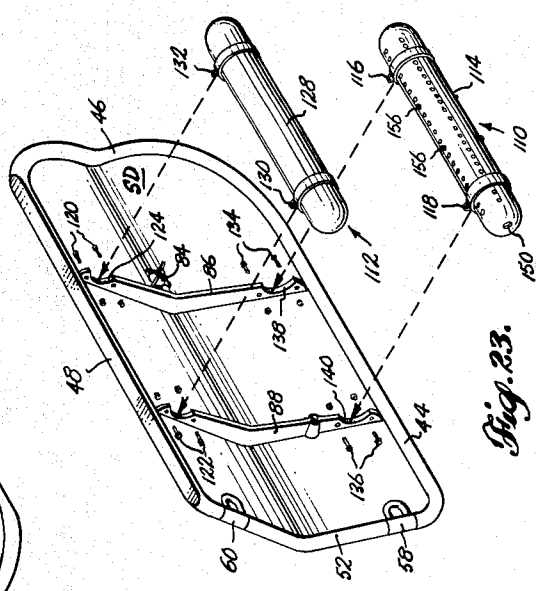


Fig. 23.



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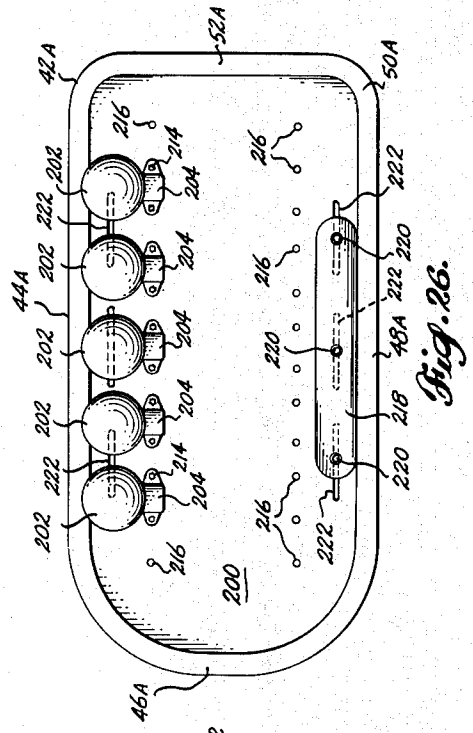


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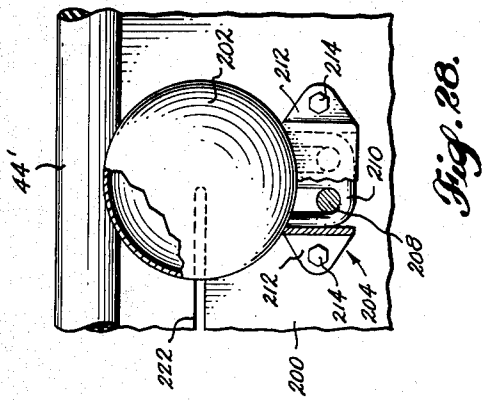


Fig. 28.

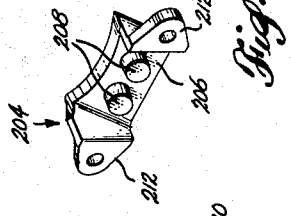


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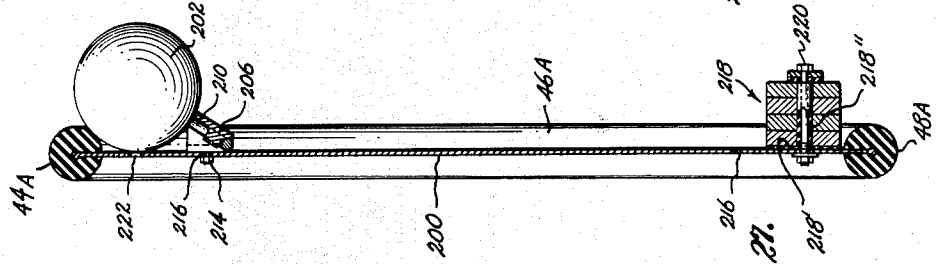


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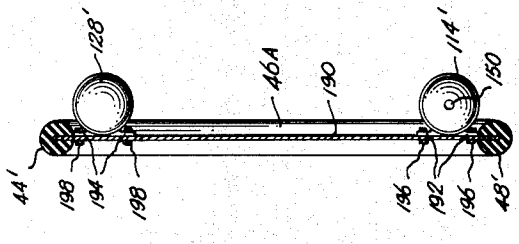


Fig. 25.

INVENTOR.
FRANK J. LUKETA

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INVERTIBLE TRAWL DOOR WITH RESILIENT EDGE AND ADJUSTABLE BALLASTING

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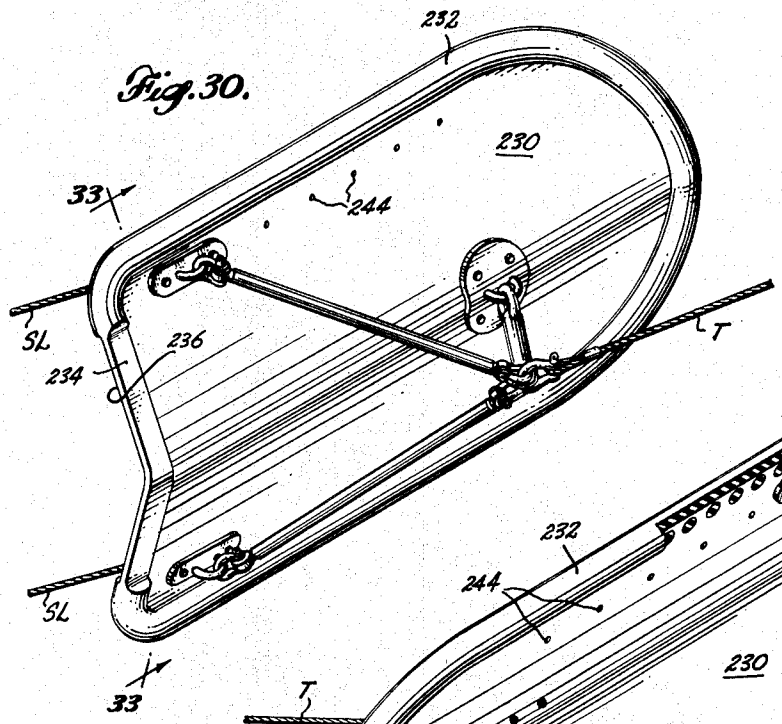


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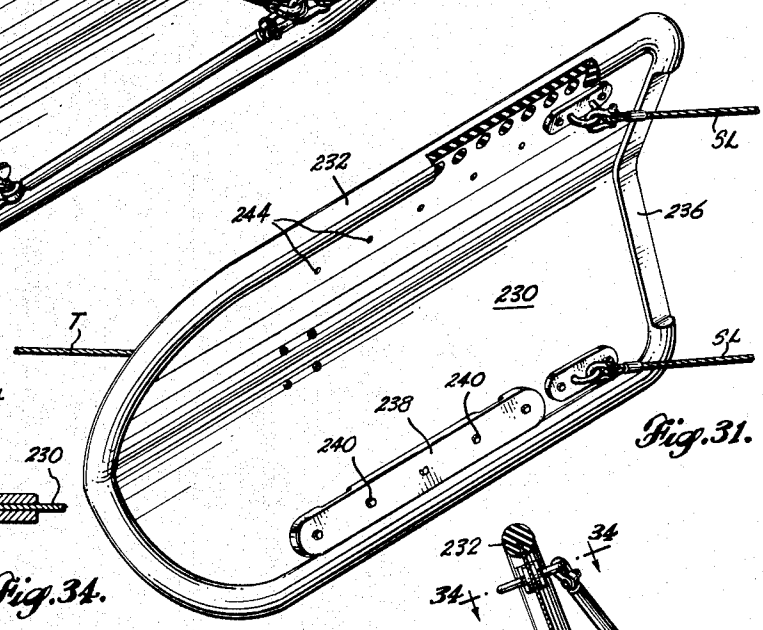


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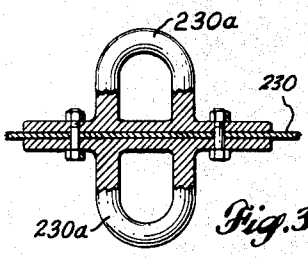


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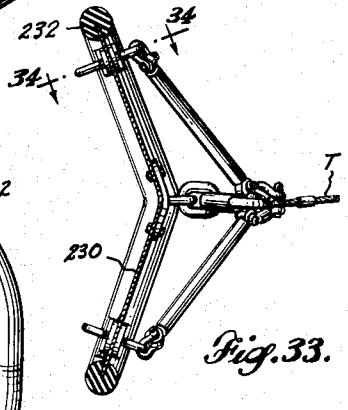


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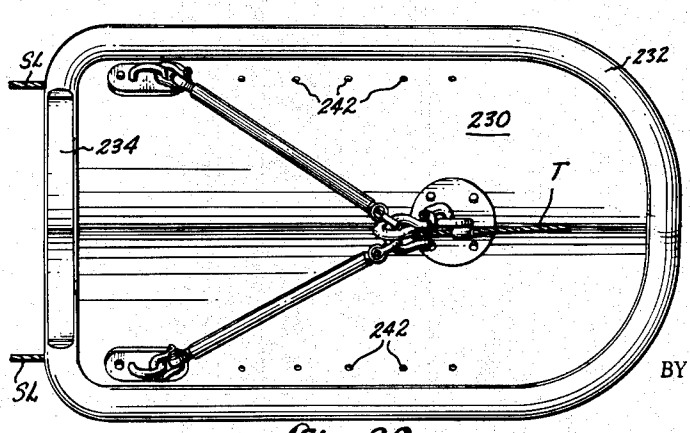


Fig. 32.

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FRANK J. LUKETA

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INVERTIBLE TRAWL DOOR WITH RESILIENT EDGE AND ADJUSTABLE BALLASTING

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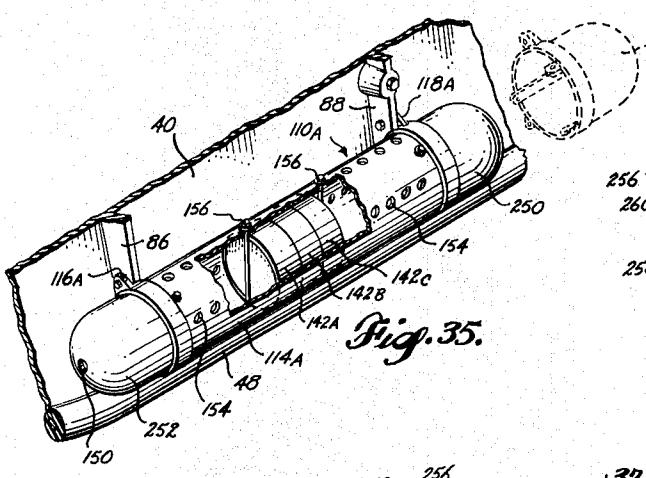


Fig. 35.

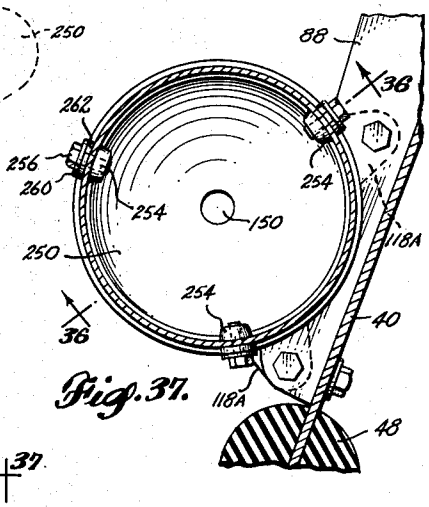


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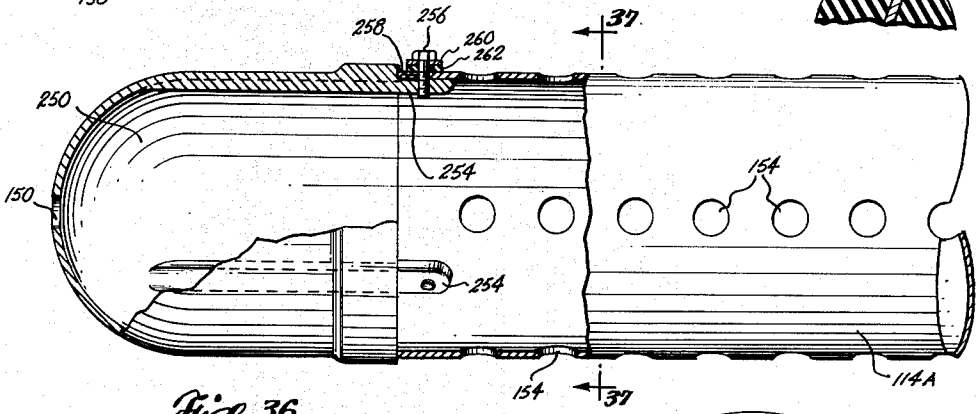


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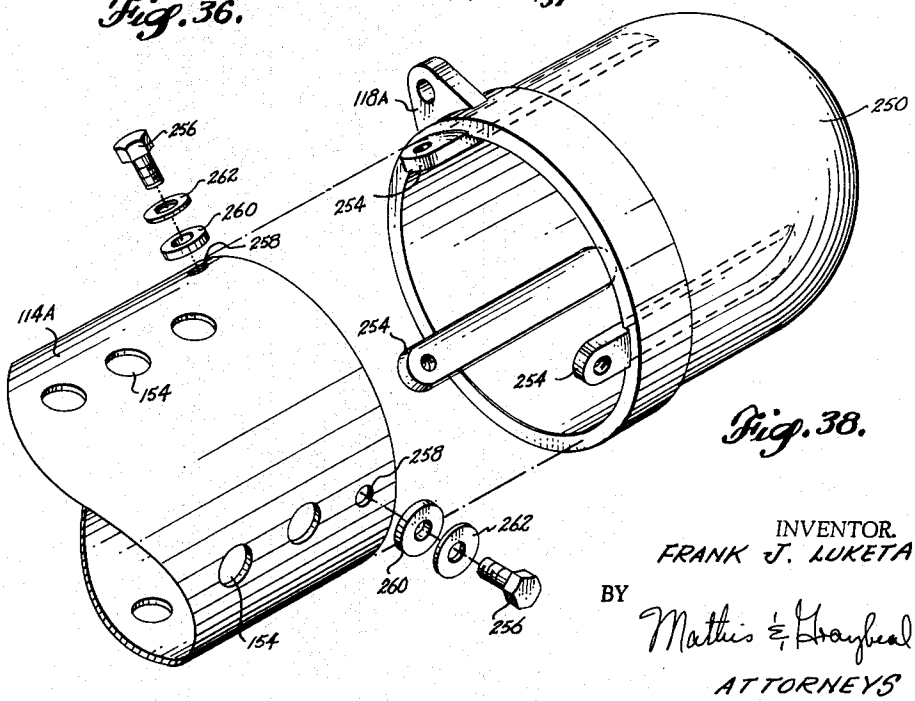


Fig. 38.

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INVERTIBLE TRAWL DOOR WITH RESILIENT EDGE AND ADJUSTABLE BALLASTING

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Fig. 39.

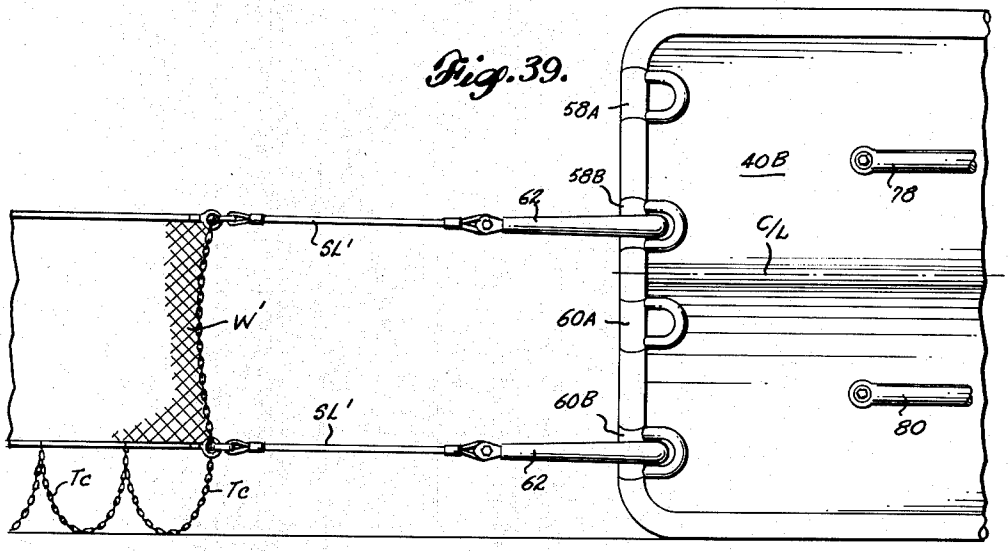
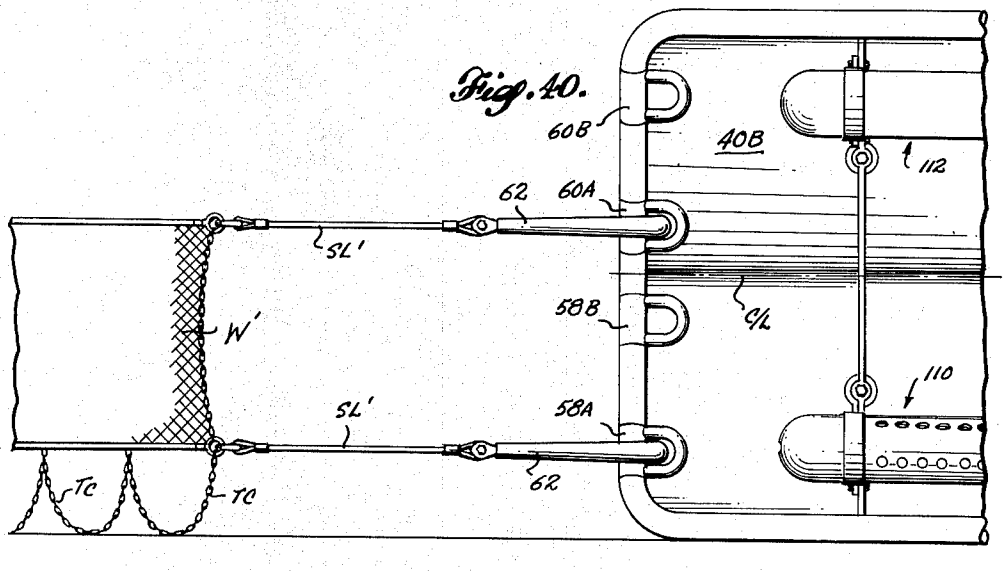


Fig. 40.



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INVERTIBLE TRAWL DOOR WITH RESILIENT EDGE AND ADJUSTABLE BALLASTING

Filed April 1, 1963 14 Sheets-Sheet 12

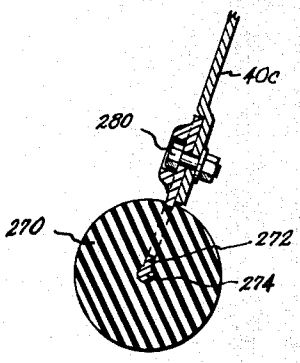


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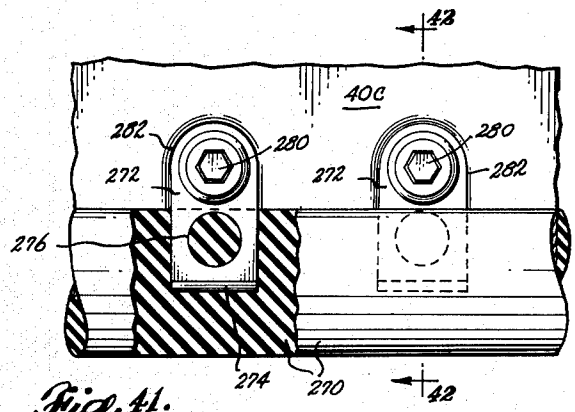


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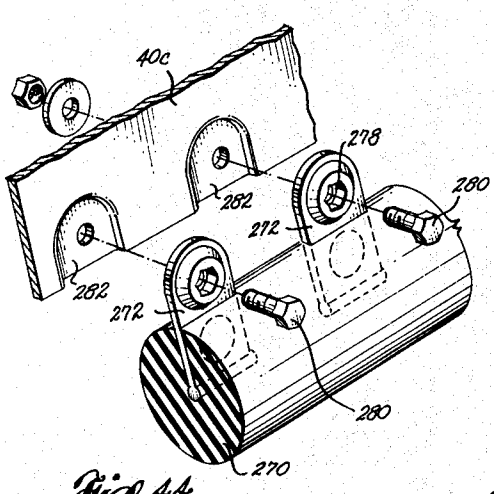


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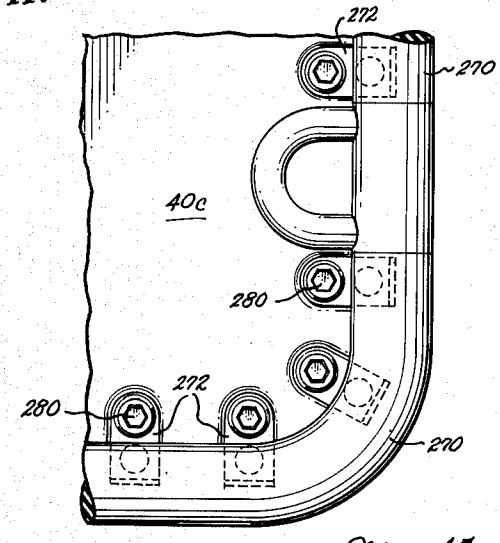


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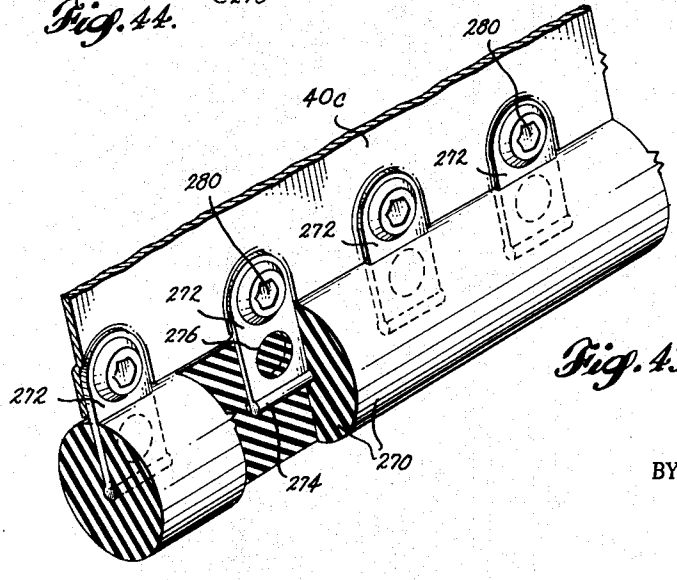


Fig. 43.

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INVERTIBLE TRAWL DOOR WITH RESILIENT EDGE AND ADJUSTABLE BALLASTING

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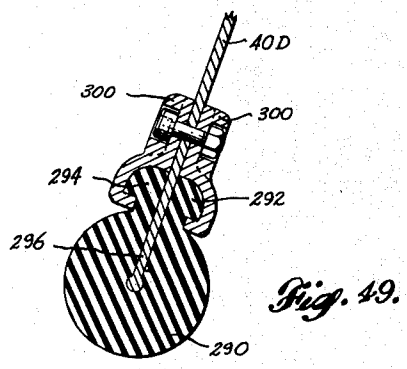


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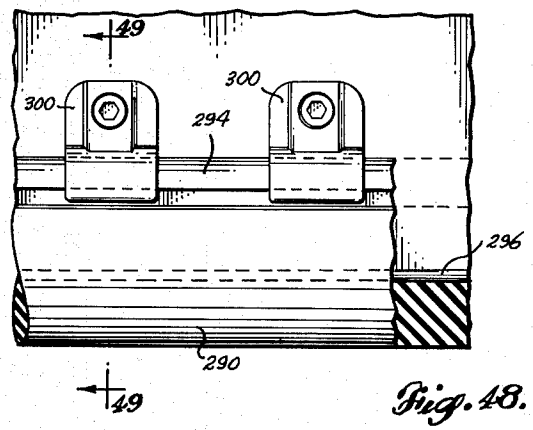


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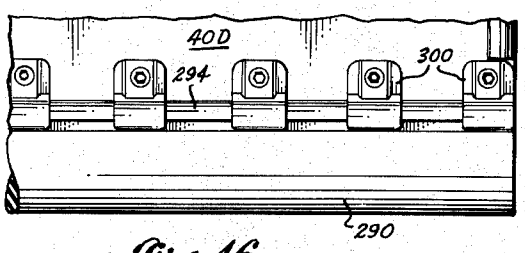


Fig. 46.

Fig. 47.

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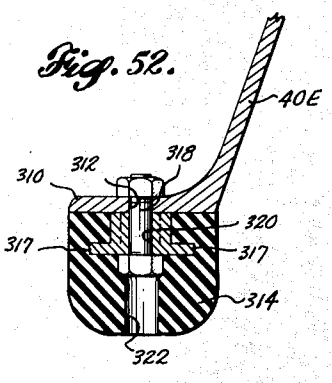
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INVERTIBLE TRAWL DOOR WITH RESILIENT EDGE AND ADJUSTABLE BALLASTING

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Fig. 52.



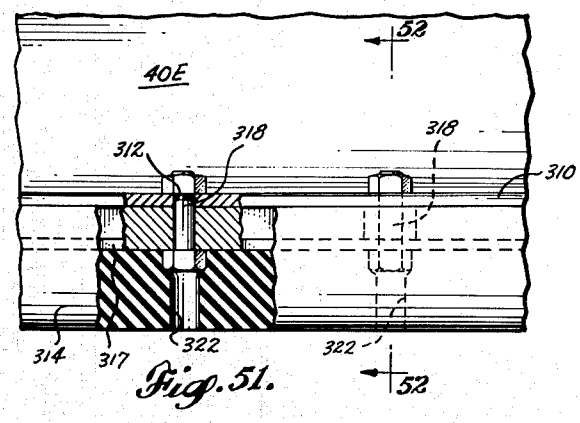


Fig. 51.

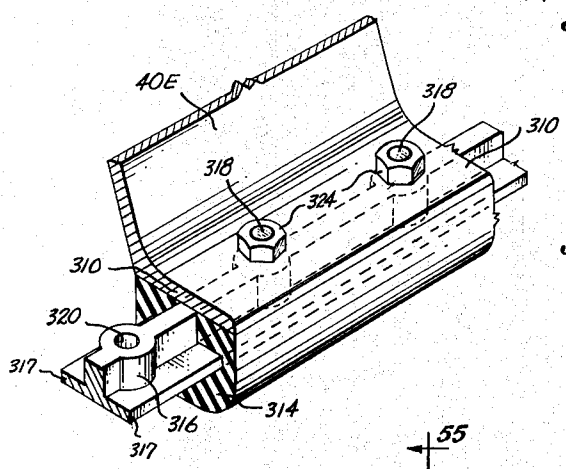
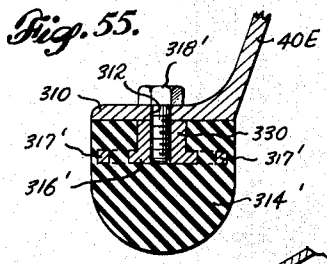
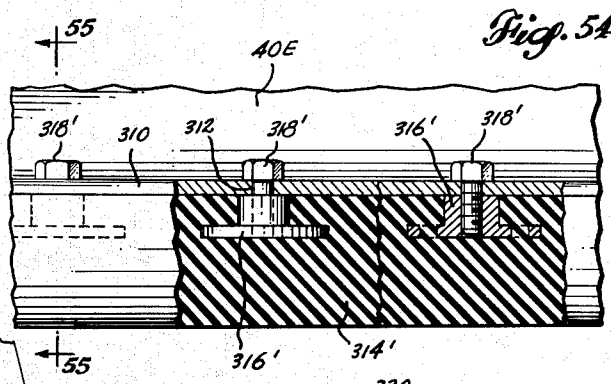


Fig. 50.

Fig. 54.

Fig. 55.





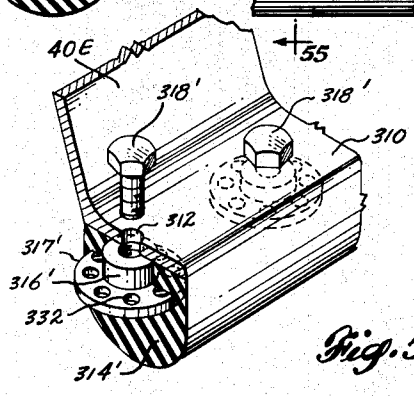


Fig. 53.

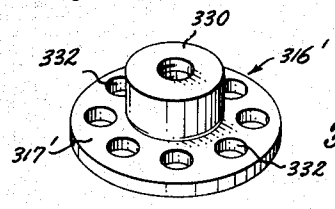


Fig. 56.

INVENTOR.
FRANK J. LUKETA

BY Mattis & Hayseal

United States Patent Office 3,231,998
Patented Feb. 1, 1966

3,231,998

INVERTIBLE TRAWL DOOR WITH RESILIENT EDGE AND ADJUSTABLE BALLASTING

Frank J. Luketa, 5567 Greenwood Ave. N., Seattle, Wash.

Filed Apr. 1, 1963, Ser. No. 269,454
23 Claims. (Cl. 43—9)

This application is continuation-in-part of my copending and now abandoned application Serial No. 210,433, and entitled, V-Door For Trawling and Bridle Therefor, filed July 17, 1962, and is also a continuation-in-part of my copending and now abandoned application Serial No. 52,140, entitled, Multisection Trawl Door Construction, filed August 26, 1960.

Trawl doors of V-shaped lateral cross-section, with ballast means provided along the lower edge of the door, are disclosed in my prior U.S. Patent No. 2,816,385, issued December 17, 1957, and my prior U.S. Patent No. 3,048,936, issued August 14, 1962, for example. Partly to improve hydrodynamic stability, ballasting means have been employed in such V-doors, specifically in the component of the door making up the bottom edge thereof which skids along the sea bottom when the door is in use. In such prior door designs, wearing away of the bottom edge of the door, which wear often occurs in an uneven manner, result in change of hydrodynamic characteristics of the door, but especially lessens the door's capability to stay on or "hold bottom" which is of the essence in bottom trawling, since loss of ballast weight due to wear necessarily lessens the weight of the door and also could change its planing characteristics if the bottom edge wear were uneven in its fore and aft aspect. Compensating the loss of weight to wear by the addition of ballast weights along and just inboard of or in other words slightly above the lower edge of the door, as disclosed in my aforesaid Patent No. 3,048,936 is a partial solution to the problem, but does not prevent the further loss of essential ballast and potential unbalancing of the door as a result of further wear along the bottom edge. In fact, this wearing away or attrition of the vital ballast and its attending highly undesirable result is a continuing problem.

It has also been proposed, as in my aforesaid U.S. Patent No. 3,048,936, and in my copending application Serial No. 219,276, entitled, Trawl Doors, and filed August 24, 1962, to make a trawl door invertible by interchanging the components making up the respective upper and lower edges of the door. These prior arrangements for invertibility, however, involve either interchange of a relatively large number of door components, or interchange of elements, some of which are so worn as to function (such as for ballast) no better when relocated, so the problem giving rise to the necessity for the interchange (e.g. bottom wear) is not satisfied unless the components are replaced.

A further problem with respect to bottom ballasted trawl doors of prior design is that the ballasting means thereof is at least principally built into the bottom edge of the door and is thus not longitudinally adjustable of the door to compensate for varying conditions of use. Yet a further problem with respect to such prior door designs is that the ballast means thereof is of a dissimilar, heavier metal (e.g. steel), while the bulk of the door was of a lighter metal (e.g. aluminum), the dissimilar metals being directly exposed so as to be susceptible to electrolytic degradation.

Yet another disadvantage of prior door design is that the metal edging thereof, particularly the bottom or wear edge, was formed of metal, or at least principally of metal, so as to be relatively susceptible to wear when skidding along the bottom and encountering bottom obstacles. Metal, even though structurally relatively strong, is so

rigid as to abrade and fracture relatively easy under scraping and high stress. It is a principal object and feature of the present invention to provide a trawl door construction wherein the entire marginal edge of the door which may encounter underwater obstacles and which is subjected to wear is in the configuration of a relatively large bead composed of a wear-resistant relatively lightweight, resilient, cushioning material which is water-lubricated, which bead is composed of rubber or like elastomeric material having comparable resiliency and wear resistance. It is a related object and feature of the invention to form the rubber-like cushioning, wear resistant bead around the marginal edge of the door by molding the bead onto the metal door panel in a manner so that the cushioning material is structurally interlocked with the panel, as by providing a series of peripheral holes in the metal panel, through which the cushioning material injects and bonds by intraconnection.

Another object and feature of the present invention involves the complete isolation of the edge components of the door affected by wear from the components of the door providing ballast and buoyancy functions. As a result of such isolation, the degree of wear generated in the door edge bead as a result of use, even protracted use, does not change the hydrodynamic characteristics of the door to any significant degree. The door is thus rendered hydrodynamically stabilized independent of wear, and it is a related feature and advantage of the present invention that such a hydrodynamically stabilized door is constructed so that the ballasting means and in certain instances also the buoyancy means thereof is readily adjustable so that should the bottom edge of the door be wearing unevenly under given use conditions, the effective center of gravity of the door can be changed in a compensating manner. In this respect, it is important to note the significant distinction between use of compensating ballast weights in a hydrodynamically unstable door where the effective center of gravity is affected by wearing away of the ballast means, and the situation where, as in doors according to the present invention, the door is hydrodynamically stable so that a developing unevenness in wear along the lower edge of the door is corrected by a selective change in the center of gravity. In the latter event the error (i.e. improper center of balance) which gave rise to the uneven wear is non-recurring under given operating conditions (which is the case when a trawler continues to operate at a customary speed and a customary towing warp scope), while in the former case the error giving rise to unevenness in wear is of a recurring nature.

Yet another object, feature and advantage of the present invention is to provide a trawl door construction of an invertible nature, the inversion of which (to adapt same for port rather than starboard use, or vice versa) is simply and readily accomplished without shifting or interchanging any marginal parts, the conversion to invert the door simply involving interchange of buoyancy and ballast elements and shifting of the towing warp hookup to the bridle, for example.

Still another object and feature of the present invention resides in its use of longitudinally and selectively adjustable ballast means, the adjustability characteristics of which render practical use of a relatively forward towing warp hookup point in relation to the center of lift of the door (i.e. the water reaction center) when the relatively concentrated ballast is adjusted well forwardly on the door, thereby improving the hydrodynamic stability of the door in terms of minimizing its effective turning radius when being towed in the trawling operation. The characteristics of a pair of doors that permit a relatively sharp 180° turn when trawling, without the doors fouling one

another (causing the termination of the tow due to malfunction, necessitating the hauling in of the gear and the untangling of the doors with the resulting loss of valuable fishing time), is a capability of primary importance.

Leveling of the door, and maintenance of the door in a level attitude during use (that is, keeping the apex line of a V-sectional door, or the bottom edge or runner of a door of any configuration horizontal when towed), is accomplished under operating conditions by appropriate selective positioning of the longitudinally adjustable ballast means, rather than by reliance on a relatively close hookup of the towing warp anchorage point in relation to the center of lift, as is the case with the door design disclosed in my aforesaid U.S. Patent No. 3,048,936. In this respect, however, it is also to be noted that the improved bridle and towing warp hookup arrangement of the present invention retains all of the advantages of the earlier bridle arrangement in terms of utilizing a haul point slightly below the center line of the door to render the bottoming force a function of speed, i.e. the door is maintained in a substantially tilted attitude, laterally considered, so that the downward thrust on the upper panel portion is greater than the upward thrust on the lower panel portion.

A further object and feature of the present invention involves improved sweep line and towing warp hookup arrangements, including use of enlarged, rounded saddles forming a part of or placed contiguous to the rear edge of the door and receiving flexible eyes which are in turn connected to or form a part of the sweep lines, such saddles and eyes being relatively movable so that the sweep lines are at all times straight when under tension and pull points between the door and the sweep lines are substantially coincident with the rear edge of the door. As a related object and feature of these hookup arrangements, insulating means of rubber or like material are employed between the saddle and line eye core or between the door and saddle so that these components are not susceptible to electrolytic degradation even though constructed of dissimilar metals.

Yet another important feature and advantage of trawl doors according to the present invention is that the rubber or like door edging around all portions of the door coming into contact with the sea bottom engage and run over the bottom much more silently than when the door is metal edged. A silent running door, such as here presented, is much less likely to scare away the marine life in the path of the net being hauled and is therefore capable of significantly improving the catch. As a related object and advantage of the present door construction, certain forms of the sweep line and towing warp hookup arrangements for the door include flexible eyes or like components which are sheathed with rubber or like material at points of contact with the door so as to be more silent (i.e. not "creak") when the door is in use.

A further important feature and advantage of the cushioning, wear-resistant edge characteristic of doors according to the present invention is that the rubber or like edge thereof serves as a "bumper" and minimizes the likelihood of damage to the trawling vessel or to the door handling equipment thereof when the door is being hauled in or is on board the trawling vessel, as for stowage or rerigging.

These and other objects, features, advantages and characteristics of the present invention will be apparent from the following description of certain typical and therefore non-limitive embodiments thereof, wherein like letters and numerals refer to like parts, and wherein:

FIG. 1 is a small scale, somewhat fragmentary isometric view of a typical bottom trawl net, with the sweep lines thereof being spread and towed by trawl doors incorporating certain features of the present invention;

FIG. 2 is an isometric view on an enlarged scale of the port door shown in FIG. 1, with a portion of the ballast assembly broken away for clarity of illustration, the view being of the trailing or posterior side of the door;

FIG. 3 is an isometric view of the port door shown in FIG. 2, as viewed from the leading or anterior side thereof, with a portion of the cushioning and shafing cut away to show constructional detail;

FIG. 4 is a side view of the door shown in FIGS. 2 and 3, taken from the trailing side thereof;

FIG. 5 is a view in lateral cross-section and on an enlarged scale of the door shown in FIG. 4 taken substantially along line 5—5 thereof;

FIG. 6 is an enlarged fragmentary isometric view, taken substantially along line 6—6 of FIG. 2, with portions of the cushioning and shafing bead broken away to show constuctional detail in the area of the upper sweep line saddle;

FIG. 7 is an isometric detail view on an enlarged scale; showing a typical segment of the panel edge and the cushioning and chafing bead molded thereon;

FIG. 8 is a fragmentary isometric view of the trailing side of the door shown in FIG. 2, with an exploded showing of the ballast capsule positioning and retaining bolts, and also showing a typical ballast capsule positioning device;

FIG. 9 is an exploded isometric view of the ballast capsule, illustrating the construction thereof;

FIG. 10 is a fragmentary isometric view of a modified form of sweep line hookup arrangement characteristic of the invention;

FIG. 11 is an enlarged detail view of the sweep line connection assembly shown in FIG. 10, taken substantially along line 11—11 thereof with certain parts further broken away to show constructional detail;

FIG. 12 is a fragmentary isometric view of a modified form of towing warp hookup assembly;

FIG. 13 is a fragmentary plan view, similar to the isometric view of FIG. 10, showing a further modified form of sweep line hookup arrangement, involving an elongated slot in the door panel just inboard of the rear marginal edge thereof, the view being with certain parts in cross-section for clarity of illustration;

FIG. 14 is a cross-sectional view of the sweep line hookup arrangement shown in FIG. 13, taken substantially along line 14—14 thereof;

FIG. 15 is a fragmentary plan view of a further modified form of sweep line hookup arrangement, involving a hole in the door panel just inboard of the rear marginal edge, and use of a flexible eye joined to the sweep line;

FIG. 16 is a cross-sectional view of the sweep line hookup arrangement shown in FIG. 15, taken substantially along line 16—16 thereof;

FIG. 17 is a schematic side view of a door incorporating an adjustable ballast means such as shown in FIG. 8, the schematic showing of FIG. 17 illustrating an operating condition where the center of gravity of the door is too far aft so that the rearmost portion of the lower marginal edge is consequently receiving the most wear;

FIG. 18 is a schematic view similar to FIG. 17, illustrating the manner of adjustment of the ballast means to correct the uneven wear occurring in FIG. 17;

FIG. 19 is a schematic view similar to FIG. 17, illustrating the occurrence of uneven wear in the forward portion of the lower edge of the door;

FIG. 20 is a schematic view showing the manner of correction of the wear condition shown in FIG. 19;

FIGS. 21–24 are isometric views illustrating the disassembly of a port door and reassembly thereof as a starboard door to illustrate the invertibility of the form of door which is illustrated at FIG. 2, FIG. 21 showing the door in the form used as a port door, FIG. 22 illustrating by exploded view the removal of the ballast and buoyancy assemblies and the top for bottom reversal of the door, FIG. 23 illustrating by exploded view the reassembly of the buoyancy and ballast assemblies onto the door panel, and FIG. 24 illustrating the reassembled door ready for use as a starboard door;

FIG. 25 illustrates in lateral cross-section a modified form of door utilizing the cushioned edge and utilizing buoyancy and ballast assemblies essentially like those employed in the form of door shown in FIG. 2, the door panel in the form of door shown in FIG. 25 being flat;

FIG. 26 is another form of door arrangement characteristic of the invention, the door panel in this instance being flat, the adjustable and invertible ballast means being in the form of stacked bars, and the buoyancy means being a series of trawl net floats;

FIG. 27 is a typical view in lateral cross-section and on an enlarged scale of the trawl door shown at FIG. 26;

FIG. 28 is a fragmentary detail view on a further enlarged scale, showing further constructional detail with regard to the buoyancy means of the form of door shown in FIG. 26, with certain parts broken away for clarity of illustration;

FIG. 29 is an isometric detail view of a float clamp as employed in FIGS. 26–28;

FIG. 30 is an isometric view showing the leading face of yet another form of door incorporating certain features of the present invention;

FIG. 31 is an isometric view of the door shown at FIG. 30 showing the trailing face thereof;

FIG. 32 is a plan view showing the leading face of the door shown at FIG. 30;

FIG. 33 is a view in lateral cross-section of the door shown at FIG. 30, taken substantially along line **33—33** thereof;

FIG. 34 is a detailed sectional view of anchorage eyes taken substantially along line **34—34** of FIG. 33;

FIG. 35 is a fragmentary, isometric view with certain parts broken away, illustrating a modified form of canister type ballast means having a removable end cap and a plurality of ballast weights;

FIG. 36 is a view in side elevation and in section, showing a portion of a ballast canister shown in FIG. 35, the sectioned portions thereof being taken substantially along line **36—36** of FIG. 37;

FIG. 37 is a view in lateral cross-section of the canister shown at FIG. 36, being in part taken substantially along line **37—37** thereof;

FIG. 38 is an exploded isometric view on a further enlarged scale, showing additional detail with respect to the removable end cap of the ballast canister shown at FIGS. 35–37;

FIG. 39 is a fragmentary view in side elevation showing a modified form of door and sweep line hookup arrangement, involving alternatively used saddles;

FIG. 40 is a view similar to the view of FIG. 39, showing the sweep line hookup arrangement used in connection with the door shown at FIG. 39, with the door inverted;

FIG. 41 is a fragmentary view in side elevation, with a portion broken away for clarity of illustration, of a modified form of resilient edging and edging mounting arrangement;

FIG. 42 is a view in lateral cross-section, taken substantially along line **42—42** of FIG. 41;

FIG. 43 is an isometric fragmentary view further illustrating the type of resilient edging illustrated at FIGS. 41 and 42, and further detail as to the edging-to-panel interconnection;

FIG. 44 is an exploded isometric view similar to FIG. 43, further illustrating the edging mounting arrangement;

FIG. 45 is a side elevational view of a corner portion of a door incorporating the type of edging illustrated at FIGS. 41–44;

FIG. 46 is a view in side elevation of a modified form of resilient edging and panel-to-edging mounting arrangement;

FIG. 47 is an isometric view on an enlarged scale further illustrating the form of edging and mounting arrangement illustrated at FIG. 46;

FIG. 48 is a view in side elevation and in section, further showing the panel and edging shown at FIGS. 46 and 47;

FIG. 49 is a view in lateral cross-section, taken substantially along line **49—49** of FIG. 48;

FIG. 50 is an isometric detail view of yet another form of construction involving a resilient edging mounted to a panel edge;

FIG. 51 is a view in side elevation of the panel edge and resilient edging shown at FIG. 50, with a portion thereof broken away for further illustration;

FIG. 52 is a view in lateral cross-section taken substantially along line **52—52** of FIG. 51;

FIG. 53 is a fragmentary isometric view of still another form of panel edge and rubber edging arrangement;

FIG. 54 is a view in side elevation of the modified form of the invention shown at FIG. 53, with certain portions broken away to show interior detail;

FIG. 55 is a view in lateral cross-section taken substantially along line **55—55** of FIG. 54; and

FIG. 56 is an isometric detail view of one of the embedded anchor members shown in FIGS. 53–55.

Turning to a more particular consideration of the accompanying illustrations, FIG. 1 serves to illustrate a typical environment of use of trawl doors according to the invention. The showing of FIG. 1 is of a typical bottom trawling net comprised of a codend C closed by a purse line PL and joined to a funnel F from the forward end of which wings W diverge, the wings W being arranged between an upper float line FL and a lower ground line GL. The ends of the float line FL and ground line GL at the starboard side of the net are connected to sweep line means, involving either a single sweep line or an upper and lower pair of sweep lines SL (as shown) which in turn lead to and are hauled by a starboard door SD which planes out to starboard and along the sea bottom as the door is towed by towing warp T led from the trawling vessel, not shown. Similarly, the port ends of float line FL and ground line GL connect to sweep line means such as sweep lines SL led to a port door PD hauled by a towing warp T towed by the trawling vessel.

In general the present invention pertains to various constructional arrangements characteristic of the trawl doors SD and PD. In the first door embodiment illustrated, the port door PD being selected by way of example to show constructional arrangement and detail, it will be observed in FIGS. 2–9 that the door comprises a metal panel **40**, which in lateral cross-section is of a dihedral or shallow V configuration with symmetrical panel portions above and below an apex line or crown, the upper and lower portions of the panel **40** being swept back substantially on its leading face, the panel portions having an angle therebetween of about 140° on the trailing face of the door. Panel **40** is preferably of aluminum construction and may be either cast (e.g. in the case of relatively small doors) or fabricated from sheet stock (e.g. in the case of relatively large doors). The forward portion or nose of the door is of a rounded configuration and the trailing edge thereof is squared off, with slightly rounded corners; however, as will be apparent, the configuration of the door outline can be varied considerably as desired.

A rounded, marginal edge or bead of cushioning, abrasion resistant, lightweight material such as cured rubber extends around the nose and sides of the panel, as shown at **42, 44, 46, 48, 50**. This marginal edge is preferably although not necessarily continuous, and is often simply hereinafter termed the wear edge or rubber edge. For purposes of particular reference to certain portions of the rubber or like marginal edge in the following discussion, various portions thereof have been separately designated in the accompanying illustrations, edge portion **42** being the portion extending around the rounded upper rear corner of the panel **40**, side edge portion **44** being the straight portion along the upper edge of the panel **40**, edge portion **46** being the curved portion thereof around the nose of the panel **40**, side edge portion **48**

being the straight portion along the bottom of the door panel **40**, and edge portion **50** being that portion around the rounded lower rear corner of the panel **40**. In addition to the edge portions indicated, the door marginal edge further comprises a rear edge **52** which is also formed of a rounded, lightweight, cushioning material and is suitably of identical cross-section and constituency as the edge portions **42–50**.

The rubber or like edging **42–52** is suitably affixed to the edge of the panel **40**. A particularly advantageous manner of interconnecting the edging with the panel **40** is illustrated in the accompanying figures and involves fabrication of the panel **40** with a series of near edge holes, certain of which are indicated at **54** in FIGS. 3, 6 and 7, for example, with the edging **42–52** being pressure molded and cured in situ around the panel **40** so as to intrabond through the holes **54** and thereby be structurally integrated with the panel **40** by mechanical interconnection. The peripheral edge of the panel **40** is preferably also cross-sectionally enlarged to improve the panel-to-edging interconnection and to present a blunt edge to prevent interior cutting of the rubber as the resilient edge flexes in use, such as indicated at **56**.

As used herein, the terms "resilient, rubber-like" and "resilient, rubber-like material," as applied to edging **42–52** for example, refer to a material that has high extensibility and forcible quick retraction rather than to hard rubber. This definition is in accordance with the definition of "rubber" as set forth on pages 2 and 3 of "Engineering Uses of Rubber," edited by A. T. McPherson and A. Klemin, published 1956 by Reinhold Publishing Corp., New York, New York.

As best shown in FIGS. 2 and 6, the rear edge areas **58, 60** of the panel **40** between the respective ends of the edging portions **42, 50** and the ends of edge portion **52** are of a cylindrical configuration and cross-sectionally identical to the edge portions **42, 50, 52**. However, for purposes of mechanically strong interconnection of the door panel **40** to the sweep lines SL, these edge portions **58, 60** are constructed of metal (being preferably integrally formed with the panel **40**) and provide what may be termed saddles or saddle means which serve as anchor points for the flexible eyes **62** at the ends of the sweep lines SL, the portions of the panel **40** immediately inboard of the saddle means **58, 60** being cut out and preferably provided with enlarged edge beads **64, 66** to minimize wear on the flexible eyes **62**. Placement of the saddle means **58, 60** coaxially of the adjacent edging portions **42, 50, 52** places the lines of pull of the sweep lines in substantially intersecting relationship with the rear edge of the door. Further, the rounded surface of the saddle means **58, 60** provide that the flexible eyes **62** are free to move in any attitude angularly with respect to the door so that the door has a considerable freedom of movement with respect to the sweep lines hauled by the door.

One of the flexible eyes **62** is illustrated on an enlarged scale in FIG. 16. As shown in said FIG. 16, the flexible eye **62** comprises a steel cable core **68** onto the ends of which swage socketed eyes **70** are installed. Eyes **70** receive a connecting bolt **72** passed through the looped end of sweep line SL. The flexible cable **68** and the swage sockets of eyes **70** are covered by a rubber-like wear resistant, insulating sheath **74**. The insulation provided by sheath **74** isolates the aluminum door panel **40** and the steel members such as cable **68** used in the sweep line hookup from electrolytic degradation. The sheath **74** further functions to present a resilient thrust bearing surface to the saddle and thus minimizes rigging noise when the door is in use.

The bridle assembly to which the towing warp T is anchored is mounted on the leading face of the door and in the preferred form of door shown in FIG. 3 comprises a forward leg or strut **76** and upper and lower rear legs **78, 80**, respectively. The trawl door illustrated employs a rigid, three-legged form of bridle arrangement; however it is to be understood that any suitable type of bridle can be employed, such as the bridle arrangement disclosed in my aforesaid U.S. Patent No. 3,048,936 and employed in the modified form of the present invention as illustrated in FIGS. 30–34 and discussed below, and such as the form of bridle arrangement disclosed in my prior U.S. Patent No. 2,816,385, simply by way of further examples. In the specific form of bridle assembly shown at FIG. 3, the bridle assembly is preferably fabricated or cast of aluminum and the forward leg **76** thereof is attached as by bolt **82** to the panel **40** at a point laterally centrally placed on the panel and well forward of the center thereof, longitudinally considered. A stiffening boss **84** on the trailing side of the panel **40** (FIG. 2) receives the bolt **82**. Stiffening ribs **86, 88** extend laterally of the panel **40**, and the after stiffening rib **88** includes laterally offset bosses **90** and **92** (also note FIG. 4) receiving respective anchor bolts **94, 96** for the bridle rear legs **78, 80**, the forward face of panel **40** being also provided with two laterally offset bosses **98, 100** providing coplanar faces for the ends of the respective legs **78, 80**.

In the manner characteristic of the bridle arrangements disclosed and claimed in my aforesaid U.S. Patent No. 3,048,936, the bridle arrangement shown at FIG. 3 is hooked up to the towing warp T at a point downwardly offset from the center plane of the panel **40** in order that the door in use is tilted substantially outwardly so that the water thrust against the upwardly facing panel portion is greater than the thrust against the downwardly facing panel portion (i.e. tilted in the manner shown in FIG. 12 of said Patent No. 3,048,936). For this purpose, when the door is being used as a port door as shown at FIG. 3, the hookup to the towing warp T is to an anchor eye **102** laterally offset below (as shown in FIG. 3) the horizontal center line (designated C/L) of the door, the specific hookup shown being by means of an insulated flexible eye **62** (which is constructionally like and in fact interchangeable with the sweep line hookup flexible eyes **62** previously discussed), so that there is insulation from electrolytic degradation as between the aluminum bridle assembly and the steel towing warp T. A reversely offset anchor eye **104** is also provided for use as the hookup point for the towing warp T when the door is inverted for use as a starboard door, as more fully discussed below in connection with FIGS. 21–24.

The bridle assembly shown at FIG. 3, for example, offers various advantages over prior bridle assemblies, in that it stands out substantially from the anterior face of the panel **40**, and has no moving parts so does not wear at points of interconnection. Further, its anchor eyes **102, 104** are strongly braced and readily accessible and the entire bridle assembly is hydrodynamically "clean."

As earlier indicated, it is a significant feature of the trawl doors here presented that the ballast means of the door is separate from the portion of the door encountering wear. It is also a feature of certain of the ballasting means here presented that the ballasting means is adjustable longitudinally of the door to suitably shift the center of gravity thereof so that the wear on the door lower edge is evened. It is a further feature of certain of the present door arrangements that the ballasting means is used in conjunction with a laterally opposed buoyancy means, the ballast means and buoyancy means being interchangeable so that the door can be readily inverted for use on the opposite wing of a net.

All of these features pertain to the form of door illustrated at FIGS. 1–9. More specifically, this form of door comprises a ballasting means, generally indicated at **110**, and a buoyancy means, generally indicated at **112**. Each of the means **110, 112** is externally configured like the other and quickly attachable and removable from the trailing edge of the door inboard of the edges thereof. In the form shown, the ballast means **110** comprises a generally cylindrical, rounded end canister **114**, bolted fore and aft to the stiffening ribs **86, 88**, the bolting ar-

rangement involving external lugs **116, 118** on the canister **114** through which respective bolts **120, 122** pass. Suitable holes to receive said bolts are provided in the stiffening ribs **86, 88**, and said stiffening ribs are preferably recessed to cradle the canister **114** when in attached position, the cradling contour thereof being indicated at **124, 126**, respectively (see FIGS. 22 and 23). Similarly, the buoyancy means **112** comprises a sealed canister **128** of generally cylindrical, rounded end configuration, provided with respective fore and aft lugs **130, 132**, attached by bolts **134, 136** through holes in the ribs **86, 88** so as to be cradled against the respective recessed portions **138, 140** of the stiffening ribs **86, 88**.

As best seen in FIGS. 2 and 8, the ballast means **110** comprises a movable weight **142**, suitably in the general configuration of a cylinder of a diameter to more or less snugly fit within the ballast canister **114**. As shown in the exploded detail view of FIG. 9, the weight **142** can suitably be fabricated from an aluminum can **144** in which molten lead is poured to form a lead slug **146**, the slug **146** being sealed within the can **144** by an aluminum cap **148** suitably sealed into the mouth of the can **144**, as by welding, the prevent electrolytic action between the lead and aluminum when submerged in water. The resulting ballast weight **142** is placed within the ballast canister **114** during the assembly of the canister (i.e. before one rounded end cap thereof is welded in place) so that the ballast canister **114** and ballast weight **142** present a compact, self-contained ballasting unit.

Positioning of the ballast weight **142** longitudinally within the canister **114** (and accordingly longitudinally of the door when the canister **114** is in plate) is facilitated by end access holes **150** in the ballast canister **114**, through which a positioning rod **152** can be inserted (note FIG. 8) to change the position of the ballast weight **142**.

Multiple rows of holes, which are indicated at **154**, extend radially into the canister **114** to allow flooding of the canister. Selected opposed pairs of such holes **154** also serve to receive a pair of positioning bolts **156** which secure the ballast weight **142** in desired position within the canister. Preferably, the bolts **156** are tightened sufficiently to pinch the canister **114** against the weight **142** so that the latter is firmly retained without relative movement in the canister.

FIGS. 10 and 11 serve to illustrate a slightly modified form of saddle arrangement for connection of the sweep lines SL to the rear edge area of the door. As shown in FIGS. 10 and 11, this arrangement involves a modified form of steel saddle **160**, the return bend portion of which is encircled by the eye of the sweep line SL. The forward ends of saddle element **160** are retained by a bolt **162** passing through a boss **164** just forward of the rear edge of the panel **40'**, with flanged nylon or like inserts **166, 168** serving to insulate the saddle **160** from the door panel **40'**. The form of sweep line hookup arrangement shown at FIGS. 10 and 11 has an advantage similar to the earlier discussed sweep line hookup arrangement in that the sweep line point of thrust is placed substantially at the rear edge of the door, and is further advantageous from the point of view that the full extent of the rubber or like edging provided at the rear edge of the door panel can be continuous, as indicated at **52'**.

FIG. 12 illustrates a slightly modified aluminum bridle construction. In this arrangement, the selected anchor eye **102'** or **104'** provided in slightly offset relation from the center line CL in the juncture area of forward legs **76** and rear legs **78, 80** is connected to the towing warp T by means of a steel shackle **160'** which connects to the selected eye **102'** or **104'** in like manner as the saddle **160** connects to the holed boss **164** shown in FIG. 11, i.e. by a bolt **162'** which is insulated from the bridle eye by means of insulative, nylon or like flanged inserts, the edge of one of such inserts being shown in FIG. 12 at **168'**. As will be apparent, the steel shackle **160'** and its bolt **162'** are thus insulated from electrolytic degradation.

FIGS. 13 and 14 illustrate a further modified form of sweep line hookup arrangement wherein the door panel **40''** is provided with a continuous rear edge **52''** and a longitudinally elongated slot is provided in the panel **40''** just inboard of the rear edge. Slot **170** is provided with an enlarged edge bead **172**, the elongated nature of the slot **170** being to enable installation of a shackle **174** (the manner of installation of which is shown in phantom in FIG. 14). The shackle **174** in its return bend portion is provided with a rubber or like sheath **176** which cushions and insulates the bearing engagement of shackle **174** with the rear portion of the enlarged slot edge **172**, the latter functioning as a saddle in this arrangement in that its relation to the end of the sweep line SL through shackle **174** is directly comparable to that of the saddle elements **58, 60** in bearing engagement with the flexible eyes **62** at the ends of the sweep lines, as discussed in the form of sweep line hookup shown at FIGS. 2 and 3, for example.

As will be apparent in FIGS. 13 and 14, the shackle **174** is provided with a bolt **178** and spool **180** to connect same with the eye at the end of the sweep line SL. To facilitate the installation of shackle **174**, the rubber or like rear edging **52''** is provided with inset or cut out portions **182, 184** immediately rearwardly of the slot **170**.

FIGS. 15 and 16 illustrate yet another variation in sweep line hookup arrangement, the arrangement in this instance involving a rubber or like covered flexible eye **62** of the type previously discussed, the eye **62** passing through a hole **186** in panel **40'''** at a point just inboard of the rear edging **52'** of continuous rubber or like construction, the hole **186** being provided with an enlarged edge **188** serving in its rear portion as the saddle element for the flexible eye **62**.

FIGS. 17–20 collectively present schematic side views of a door characteristic of the invention (the type shown at FIGS. 2–9 being selected for purposes of illustration), and serve to illustrate certain considerations with respect to the adjustable ballast means afforded by the invention. In FIG. 17, a condition of use is illustrated wherein a port door PD is riding predominantly "nose up" so is receiving undue wear on the rear part of the bottom edge. Excessive wear at the rear of the bottom edge is of course indicative of the operational center of balance of the door, as influenced in part by the upward moment arm exerted by the towing warp T, being too far aft, and the indicated selective adjustment is to move the ballast weight **142** from the position shown in FIG. 17 to the position thereof shown in FIG. 18.

The converse condition where the door bottom edge is receiving excessive wear in its forward portion is illustrated in FIG. 19. Upon encountering this condition, the corrective adjustment is to move the ballast weight **142** to a more rearward position within a ballast canister **114**, as indicated at FIG. 20.

As will also be understood in the art to which the invention is addressed, the attitude of the door when planing along the sea bottom is substantially a function of bottom depth and length of towing warp (i.e. "scope"), and also a function of towing speed. Operational variation of any of the relevant factors affecting the planing attitude of the door can affect the manner in which the door rides along the sea bottom. Since it is oftentimes desirable or necessary to accommodate the trawling gear to changes in trawling speed and/or changes in towing warp "scope," it is very desirable to have readily adjustable ballasting means to compensate for changes in manner of use of the door, and it is a fundamental object and purpose of the present invention to provide a trawl door having such capabilities. Furthermore, since a door in order to be produced at reasonable cost should be standardized as much as possible, this inherent leveling capability is essential. As a case in point, in the fleet of several thousand shrimp trawlers in the Gulf of Mexico, there are for various reasons, wide variations in towing

speeds, towing warp scopes, and also in net sizes and types. The present invention enables each skipper to adjust his door ballasts to suit requirements, simply by changing postion of the ballast weight on each door, and/or using interchangeable ballast canisters equipped with lighter or heavier weights, as desired.

In regard to the ballasting weight itself, it will be noted in the door of FIGS. 2–9 that the weight **142** is of compact length and of dense material (lead); this makes for a much broader range of effective leveling capability. This capability gives rise to the possibility of designing a self-leveling door with a level-state sensor controlling the operation of a ballast positioning mechanism. The compact ballast weight of this invention is highly advantageous in such an arrangement, attaining quick response as well as a wide range of leveling response.

Another important feature of the trawl doors here presented is their capability of being readily inverted without necessity for changing any edge components and without having to make any corrective adjustment as to ballasting. The manner of inverting the form of door illustrated at FIGS. 2–9 is shown by FIGS. 21–24 (simply by way of example). In FIG. 21, the door comprising panel **40** is configured as a port door PD, with the ballast means comprising canister **114** being in a lower position (as shown) and the buoyancy canister **128** in an upper position, the marginal edge **48** being the bottom engaging edge and the marginal portion **44** being the upper edge. As sufficient wear develops along the lower edge **48** of the door PD to necessitate inverting thereof, the respective ballast and buoyancy canisters **114, 128** are removed by removal of the various bolts **120, 122, 134, 136**, the removed condition of the canister and bolts being illustrated in FIG. 22. The door PD is then inverted, as indicated at I in FIG. 22 so that (as in the inverted position shown at FIG. 23) the worn edge portion **48** becomes the upper edge and the unworn edge portion **44** becomes the lower edge. The ballast canister **114** is also reversed end for end as indicated at R, and it and the buoyancy canister **128** are then reinstalled on the ribs **86, 88** in the manner shown at FIG. 23, following which the reassembled door (as in FIG. 24) is ready for use as a starboard door (and so designated SD in FIGS. 23 and 24). As will be noted, the buoyancy and ballast distribution of the starboard door (FIG. 24) is the same as the buoyancy and ballast distribution that existed in the port door PD (FIG. 21) in that the ballast and buoyancy canisters **114, 128** have changed positions and the centers of buoyancy and gravity have been laterally reversed but have not been shifted longitudinally of the door.

The door of this invention has cost saving and convenience factors of considerable importance since only one type of door need be manufactured—the invertibility of the door permitting one type of door to serve either side. Of equal importance, the vessel need carry only one door as a spare in case of loss or damage of either standard equipment door while at sea, and the fact that the door ballast can be readily detached also assists in handling the heavy door for storage or replacement.

FIG. 25 illustrates a lateral cross-section of a modified form of door construction incorporating on a flat panel **190** a rubber or like marginal edge **44', 48'** and canister type ballasting and buoyancy means similar to the ballast canister **114** and the buoyancy canister **128** of the form of door earlier discussed. The ballast and buoyancy means comprising the canisters respectively indicated at **114'** and **128'**, are constructed identically to the canisters **114** and **118** except that they are mountable directly on the face of the panel **190**, suitable respective lugs **192** and **194** being arranged on the canisters **114'** and **128'** to abut the panel **190** and be secured thereto by respective bolts **196, 198**. As will be apparent, the canisters **114'** and **128'** are invertible in the same manner as the canisters **114** and **128** by the same procedure as illustrated in FIGS. 21–24, being removable from the panel **190** and reinstallable thereon in laterally reversed position by means of the respective bolts **196, 198**.

FIGS. 26–29 illustrate a further modified form of door construction according to the present invention. This door comprises a flat panel **200** with rubber or like edging portions **42A, 44A, 46A, 48A, 50A, 52A** extending continuously around the edge of the panel **200**. The buoyancy means in the door illustrated at FIGS. 26–29 comprises a plurality of individual floats **202**, suitably of a type conventional per se and commonly employed as trawl net floats, each of the floats **202** being clamped to one side of the panel **200** by means of a clamping member **204** (shown in enlarged detail at FIG. 29). The clamps **204** comprise a recessed central portion **206** in which a pair of bosses **208** protrude, the M-shaped anchor member **210** of each float **202** nesting around the bosses **208** (as in FIG. 28), with the end ears **212** of each clamp **204** being bolted to the face of the panel **200**, by bolts, certain of which are indicated at **214**. Rows of holes, certain of which are indicated in FIG. 26 and FIG. 27 at **216**, are arranged longitudinally along the door panel **200** to provide interchangeability of lateral position of the various floats **202**, one such row of holes being utilized when the edge portion **44'** is the upper edge and the other such row of holes being utilized when the edge portion **48'** is the upper edge of the door. Said floats **202**, as will also be evident, can be used in any desired number to the extent permitted by the number of mounting holes **216** available, and in any arrangement along a row of holes, so that a degree of adjustability is also provided as to the center of buoyancy and extent of buoyancy contributed by the floats **202**.

The ballast means employed in the form of door shown at FIGS. 26–29 comprises a plurality of weights **218** in the form of flat bars which can be constituted of lead or cast iron or other heavy metal and which are insulated from the panel by rubber pad **218'** and rubber flanged bushing **218''** encircling the bolt **220**, if the panel **200** and the weights are of dissimilar metals. Said weights **218** can be stacked, in any desired number and can be employed as either a stack set or in a plurality of stacks, each stack being bolted to the door panel **200** just inboard of the panel edging, the manner of mounting suitably involving a plurality of bolts **220**, each passing through a longitudinally extending slot **222**. The slots **222** enable adjustable placement of the weights longitudinally of the door panel **200** at any desired location. The said slots **222** are provided in laterally opposite rows so that the ballast weight **218** can be reversed in position on the door (along with the floats **202**) when the door is inverted.

FIGS. 30–34 illustrate still another form of door embodying certain features of the present invention. In FIGS. 30–34, the door panel **230** is provided with a rubber or like edging **232** extending continuously around the door, the edging **232** preferably being substantially circular in lateral cross-section except along the rear edge where cutouts **234, 236** are provided to reduce drag. The manner of interconnection of the rubber or like edge **232** to the panel **230** is identical to the manner of connection characteristic of the panel-to-edging illustrated at FIG. 7. Ballasting means such as bar **238** is mounted inboard of the lower edge of the door, as shown at FIG. 31, the mounting being by means of a series of bolts **240** arranged in a row of holes **242** (FIG. 32). A laterally opposite row of upper holes **244** permit reverse placement of the ballast means **238** when the door is inverted. The ballast means **238** may comprise a single bar, as shown, or a plurality of stacked bars, or a substitute larger or smaller bar, so as to be to a degree adjustable in the manner contemplated by the present invention.

In the form of door shown at FIGS. 30–34, the particular bridle arrangement and hookup arrangements for rigging the door with respect to the towing warp T and the sweep lines SL, and the manner of inverting the bridle assembly, are essentially disclosed in my U.S.

Patent No. 3,048,936, and need not be further here described. It is important to note, however, that the form of door shown at FIGS. 30–34 does not require any interchange of edge arranged components, as in the case with the form of door disclosed in said U.S. Patent No. 3,048,936, with the result that the present door is much simpler to adapt for inverted use.

FIG. 34 shows panel **230** disposed between opposing anchorage eyes **230***a*.

FIGS. 35–38 serve to illustrate a modified form of ballast means which is similar to the ballast means **110** shown at FIG. 2, but incorporates a constructional arrangement by which the total weight of the ballast weight means can be selectively changed as well as shifted longitudinally of the door. More specifically, as shown in FIGS. 35–38, the ballast means **110A** comprises a canister **114A** having a removable end cap member **250** and an integral end cap member **252**. Removal of the end cap **250** permits the ballast weight means **142A, 142B, 142C** (three such ballast weight means being shown simply by way of example) to be moved endwise in and out of the canister **114A**. As is the came with the ballast means **110**, the ballast canister **114A** comprises a series of flooding holes **154**, selected sets of which can accommodate weight positioning bolts **156**, and also respective side lugs **116A, 118A** associated with the end caps **252, 250**. Said side lugs **116A, 118A** are removably mounted on the lateral ribs **86, 88** of the door panel **40** and are arranged outboardly of the ribs **86, 88** in order to permit removal of only the end cap **250** when it is desired to change the number of ballast weight means in the canister **114A**.

The construction permitting the removal of end cap **250** from the cylindrical central portion of the canister **114A** can be by any suitable arrangement, such as by means of a circumferentially arranged series of lugs **254** on the end cap **250**, each of which threadedly receives a bolt **256** passing through a hole **258** in the cylindrical wall of the canister **114A**. Respective rubber and metal washers **260, 262** are preferably used with each bolt **256**, the function of the rubber washer **260** in each instance being to distribute the bolting stress to the cylindrical surface bolted to the end cap lugs **254**.

FIGS. 39 and 40 illustrate a modified form of door and sweep line hookup arrangement, particularly adapted for the situation where a relatively wide door is to be invertible and be used with a net where the sweep lines are to be maintained relatively close together and the lower sweep line near-bottom. This is a circumstance commonly involved in Gulf shrimp fishing wherein, for example, a typical sweep line separation distance is about twenty-four inches. With such a net arrangement, such as shown at FIGS. 39 and 40, a net wing W′ with bottom contacting tickler chains TC and with sweep lines SL′, the sweep line hookup arrangement can involve a door with a panel **40B** having a pair of saddles **58A, 58B** at one side of the center line C/L of the door, with a further pair of saddles **60A, 60B** at the other side of the door. When the door is used as a port door, as shown in FIG. 39, the eyes **62** at the ends of the sweep lines SL′ interconnect with the door by passing around the saddles **58B, 60B**. Then, when the door is inverted for use as a starboard door, the eyes **62** are moved to the saddles **58A, 60A**, as shown in FIG. 40. As will be apparent, a given door design can similarly involve a large number of saddles (e.g. a total of ten for example) along the rear edge of the door, if desired, in order to afford full flexibility as to the hookup arrangement with any desired sweep line arrangement. As will also be evident, the door and sweep line interconnection can involve any desired form of saddle means in appropriate laterally extending pattern, such as the other forms of saddles and associated hookup disclosed at FIGS. 10 and 11, FIGS. 13 and 14, and FIGS. 15 and 16, for example.

FIGS. 41–56 serve to illustrate further typical modifications of the resilient door edging and its manner of interconnection with the edge of the door panel. In the form illustrated at FIGS. 41–45, the metal door panel **40C** is equipped with a rubber edging **270** in which is embedded a series of metal tabs **272**, each comprising an enlarged embedded bead **274** and an embedded hole **276** in which the rubber edging **270** intrabonds. The protruding portions of each of the tabs **272** comprises a bolt receiving hole **278**, preferably configured in the manner shown to receive and non-rotatably retain the head of an associated mounting bolt **280**. Preferably, also, the face of the panel **40C** is indented at the spaced edge locations which receive the protruding portions of the tabs **272**, the said indented areas **282** of the panel **40C** being of a configuration to snugly receive the protruding portion of the associated tab **272** and maintain such rigidly so that there is no tendency for the tab to be torn out of the rubber edging **270** as a result of rotation of the tab **272** on the panel **40C**.

The rubber edging **270** and its associated tabs **272** can be fabricated with the rubber portion **270** straight and of any desired length, and can then be cut to desired length for installation on the door panel **40C**. As shown in FIG. 45, where the attachment of the edging **270** involves a curved corner, the preformed rubber edging **270** simply bends to desired curved configuration at the time of installation.

The further form of rubber edging and associated mounting arrangement shown at FIGS. 46–49 comprises a rubber edging **290** which is of like lateral cross-section throughout and which is therefore formable by extrusion. As best shown in FIGS. 47 and 49, this rubber edging **290** comprises laterally outstanding beads **292, 294** and is radially split between the said beads **292, 294**, as indicated at **296**. In this form of panel-to-edging assembly, the enlarged peripheral bead **298** of the panel **40D** is seated within the radial split **296** of the rubber edging **290** and the edging **290** mounts on the panel **40D** by means of a series of opposed pairs of metal clamps **300** bolted or otherwise attached to the door panel **40D** in metal-to-metal relation.

In the modified form of resilient edging and panel connection arrangement shown at FIGS. 50–52, the door panel **40E** comprises an edge facing **310**, of substantial lateral dimension, provided with a series of mounting holes **312**. In this arrangement, the rubber edging **314** is preformed with an embedded, longitudinally extending T-bar or like metal anchor member **316** therein. In view of the relatively rigid construction involving a longitudinally continuous anchor member **316**, this form of edging is suitably preformed in the longitudinal configuration desired to match the longitudinal configuration of the panel facing **310**. As will be apparent, the manner of interconnection of the resilient edging **314** to the panel facing **310** is by a series of bolts **318** passing through holes **320** in the anchor member **316** and through the facing holes **312**, with the interconnection being such that a metal-to-metal contact is made between the facing **310** and the anchor member **316**. To accommodate placement and non-rotational retention of the bolts **318**, the edging **314** is provided with a series of holes **322** through which the bolts **318** are inserted, the associated nuts **324** then being placed inboardly of the facing **310**, as best shown in FIG. 52.

FIGS. 53–56 illustrate an edging construction slightly modified from that shown at FIGS. 50–52. In this arrangement, the door panel **40E** with its edge facing **310** and mounting holes **312** has attached thereto a rubber edging **314′** in which is embedded a series of anchor member **316′**, the interconnection being by bolts **318′** in threaded engagement with the anchor members **316′**. Each of the anchor members **316′**, as best shown in the detailed view presented by FIG. 56, comprises a threaded boss **330** with a radially extending flange **317′**, a series of

holes 332 preferably provided in the flange 317' to receive and permit intrabonding of the rubber from which the edging 314' is formed. As will be evident, the series of spaced anchor members 316' offer an advantage over the continuous anchor member 316 in that the non-connected arrangement thereof permits a considerable degree of flexure of the edging 314' during installation so that said edging 314' can be fabricated in straight form and curved to fit curved edge contours of the door panel. As will also be apparent, both of the forms of edging assemblies shown at FIGS. 50–52 and at FIGS. 53–56 are advantageous from the point of view of providing a clamped retention of the resilient edging, i.e. portions of the resilient edging are clamped between the metal panel facing 310 and the flange 317 (or 317') of the metal anchor member(s) 316 (or 316').

From the foregoing, various further modifications, arrangements and adaptations of the present invention will occur to those skilled in the art to which the invention is addressed, within the scope of the following claims.

What is claimed is:

1. A door for use in trawl fishing comprising a non-buoyant body heavier along one side edge than the other so as to remain upright in use, a resilient, rubber-like protective edging being made from rubber-like material having high extensibility and forcible quick retraction and being of substantial thickness, and extending around at least the leading and side edges of said body, and means interconnecting said body and said rubber-like edging to secure the latter in place.

2. A trawl door comprising a body intended to be upright in use and ride along its lower edge upon the bottom, means for securement of a towing warp to the anterior face, an edging of resilient, rubber-like, wear-resistant material secured about the leading and side edges of said body, such rubber-like edging being made from rubber-like material having high extensibility and forcible quick retraction, and bearing at its lower portion upon the bottom, or alternatively at its originally upper portion upon reversal of the door top for bottom, and a ballast weight removably secured to said body in inset relation to the lower edge thereof, to ballast the door into its upright position, in use, and by its position to be protected against wear.

3. A trawl door as in claim 2, wherein said body comprises a metal panel and the said edging is composed of cured rubber affixed to the lateral edges of said metal panel.

4. A silent running trawl door comprising a water reaction panel, a resilient rubber-like edging arranged along at least the leading and lower edges of said panel, said rubber-like edging being made from rubber-like material having high extensibility and forcible quick retraction, and being of adequate thickness to absorb a substantial amount of the impact of the door edge with hard objects encountered by the door in use, said door being connected to a towing warp and further comprising interconnection means between said panel and said towing warp, said interconnection means including a load bearing, non-metallic, electrically insulative element minimizing rigging noise occasioned by movement of a part of said interconnection means relative to said panel while the door is in use.

5. A silent running trawl door comprising a water reaction panel, a resilient rubber-like edging arranged along the lower and leading edges of said panel, said rubber-like edging being made from rubber-like material having high extensibility and forcible quick retraction, and being of adequate thickness to absorb a substantial amount of the impact of the door edge with hard objects encountered by the door during use, said door having associated therewith trawl net sweep line means, and interconnection means between said panel and said trawl net sweep line means, said interconnection means including a load bearing, non-metallic, electrically insulative element minimizing rigging noise on the occasion of relative movement between said panel and said trawl net sweep line means while the door is in use.

6. A trawl door comprising a water-reaction panel and adapted for use to spread the wing of a trawl net while being towed by a trawling vessel with a towing warp from the vessel being led to and towing the door at an angle through the water and with sweep line means being led from the door to the wing of the trawl net, said door comprising a bridle on the leading face of the door panel, means interconnecting the bridle with said towing warp, and connection means connecting said sweep line means to the door panel in the rear portion thereof, said trawl door further comprising the following elements rendering the door silent running in use; a resilient rubber-like edging of rubber-like material having high extensibility and forcible quick retraction and extending around the leading and side edges of the panel, non-metallic, electrically insulative means at a point of interconnection between said bridle and said towing warp, and non-metallic, electrically insulative means at a point of interconnection between said door panel and said sweep line means.

7. A trawl door according to claim 6, wherein said rubber-like edging is substantially circular in lateral cross-section.

8. A trawl door comprising a water reaction panel and arranged to move substantially horizontally through the water when towed by a trawling vessel and in turn towing a trawling net, the said trawl door comprising laterally opposed upper and lower edges, an anterior panel face, a posterior panel face, ballast means extending longitudinally and just inboard of the lower edge of the door contiguous to the posterior panel face, and buoyancy means extending longitudinally and just inboard of the upper edge of the door along the posterior face of the panel, the said ballast means and the said buoyancy means each having associated therewith mounting means affixed to said posterior panel face and in turn mounting the said ballast means and said buoyancy means in fixed position with respect to said posterior panel face, and the ballast means mounting means and buoyancy means mounting means each being of a form so as to be interchangeable with the other so that the positions of the ballast means and the bouyancy means on the door can be reversed without structural modification of the door panel or of the ballast means or of the buoyancy means.

9. A trawl door according to claim 8, wherein said posterior panel face comprises a pair of laterally extending ribs, and the said ballast means and buoyancy means are each of generally cylindrical configuration and comprise mounting lugs standing out laterally therefrom, the said mounting lugs being removably attachable to the said panel ribs.

10. A trawl door according to claim 9, wherein said laterally extending ribs comprise cradles against which the said ballast means and said buoyancy means nest when in mounted position.

11. A trawl door having a water reaction panel and adapted to spread the wing of a trawl net while being towed by a trawling vessel with a towing warp from the vessel being led to and towing the door at an angle to the water and with sweep line means being led from the door to the wing of the trawl net, said door comprising; towing warp connection means standing out from the anterior side of said panel; saddle means at about the rear edge of the door; means defining an open area through said panel just forward of each said saddle means; eye means on each sweep line means passing around a saddle means and through the open area associated with said saddle means; and a rubber-like edging along the rear edge of the door, the said rubber-like edging being made from rubber-like material having high extensibility and forcible quick retraction, and the said saddle means being composed of metal and arranged substantially concentric with

and having a lateral contour essentially the same as that of the said rubber-like edging.

12. A trawl door having a water reaction panel and adapted to spread the wing of a trawl net while being towed by a trawling vessel with a towing warp from the vessel being led to and towing the door at an angle to the water and with sweep line means being led from the door to the wing of the trawl net, said door comprising; towing warp connection means standing out from the anterior side of said panel; saddle means at about the rear edge of the door; means defining an open area through said panel just forward of each said saddle means; and eye means on each said sweep line means passing around a saddle means and through the open area associated with said saddle means; the said panel being comprised of aluminum and the said sweep line means being of steel strand construction, and the connection arrangement between the said sweep line means and the said door panel comprising a thrust bearing element composed of an electrically insulative material.

13. A trawl door according to claim 12, wherein said thrust bearing element is arranged at a point of relative movement as between the sweep line means and the door panel so as to minimize rigging noise when the trawling gear is in operation.

14. A trawl door having a water reaction panel and adapted to spread the wing of a trawl net while being towed by a trawling vessel with a towing warp from the vessel being led to and towing the door at an angle to the water and with sweep line means being led from the door to the wing of the trawl net, said door comprising; towing warp connection means standing out from the anterior side of said panel; saddle means at about the rear edge of the door; means defining an open area through said panel just forward of each said saddle means; and eye means on each said sweep line means passing around a saddle means and through the open area associated with said saddle means; the said panel being comprised of aluminum and the said towing warp being of steel strand construction, and the hookup arrangement between the said towing warp and the said door panel comprising a non-metallic, electrically insulative thrust bearing element.

15. A trawl door according to claim 14, wherein said thrust bearing element is arranged at a point of relative movement as between the towing warp and the door panel so as to minimize rigging noise when the trawling gear is in operation.

16. A trawl door having a metallic water reaction panel and adapted to spread the wing of a trawl net while being towed by a trawling vessel with a metallic towing warp from the vessel being led to and towing the door at an angle to the water and with metallic sweep line means being led from the door to the wing of the trawl net, said door comprising; a metallic bridle standing out from the leading face of said door; connection means interconnecting said towing warp and said bridle, and connection means interconnecting the door to said sweep line means contiguously of the rear edge of said door, at least one of such connection means comprising a non-metallic, electrically insulative load bearing element which constitutes the interconnection element between two such metallic elements.

17. A trawl door according to claim 16, wherein said connection means comprises a flexible steel cable encased in a non-metallic, electrically insulative sheath.

18. A trawl door according to claim 17, wherein said connection means comprises a flexible eye comprised of a flexible metal core and a rubber-like casing around said core, eye elements at the ends of said core, and bolt means through said latter eye elements.

19. A trawl door according to claim 16, wherein said non-metallic, electrically insulative element comprises a flanged insert arranged coaxially of an eye stationary with respect to the door panel.

20. A trawl door comprising a nonbuoyant body for disposition uprightly in use, with like protective casing elements about its upper and lower edges, whereby the lower edge element assumes the wear as the door is dragged over the bottom, ballast weight means, and means to secure said ballast weight means along and inboard of the lower edge of the door, but removable for securement of the ballast weight means along and inboard of its originally upper edge when the door is inverted to present its fresh, originally upper edge casing element downwardly to wear upon the bottom in lieu of its worn, originally lower edge casing element.

21. A trawl door comprising a nonbuoyant body of polyhedral vertical cross-section substantially symmetrical of a horizontal centerline, said door comprising towing warp anchorage means on the anterior face of said body and arranged to be mounted thereon so that the point of connection of a towing warp thereto is laterally offset at either side of said centerline, and said door further comprising ballast means and means for securing said ballast means inboardly of the edges and at either side of the centerline of the body so that the door can be reversed, side for side, when the initially lower edge thereof becomes worn, such reversal being accomplished by removal of the said ballast means from one side of said door and placement thereof on the other side of said door and by movement of the point of connection of the towing warp from one side of said centerline to the other.

22. A trawl door comprising a body intended to be upright in use and to ride along its lower edge upon the bottom, means for securement of a towing warp to said body, and means for securement of sweepline means to said body, to dispose it at a given angle of attack, in use, an edging of resilient, rubber-like material having high extensibility and forcible quick retraction, such rubber-like edging being secured about said body and bearing at its lower portion upon the bottom, or alternatively at its originally upper portion upon reversal of the door top for bottom, and a ballast weight removably secured along and above the edge which is lower, to ballast the door into its upright position, in use, and by its position to be protected against wear.

23. A trawl door of the type designed to be towed along the sea bottom while spreading the wing of a travel net, said door comprising; a water reaction panel, and a resilient rubber-like edging arranged along the lower edge of said panel and constituting the bottom engaging lower edge of said door, said resilient rubber-like edging being made from rubber-like material having high extensibility and forcible quick retraction, and being of adequate thickness in its portion between the lower edge of the panel and the lower edge of the door to absorb a substantial amount of the impact of the door lower edge with hard objects on the sea bottom.

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