Dec. 6, 1966 A. H. BENSON 3,289,721

COLLAPSIBLE VESSELS

Filed May 7, 1964 3 Sheets-Sheet 1

Fig. 1

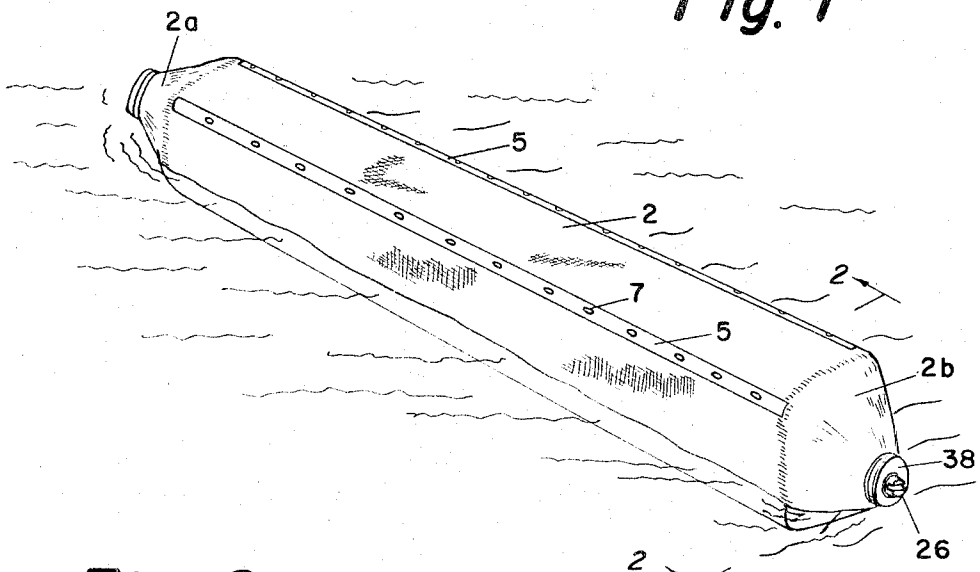
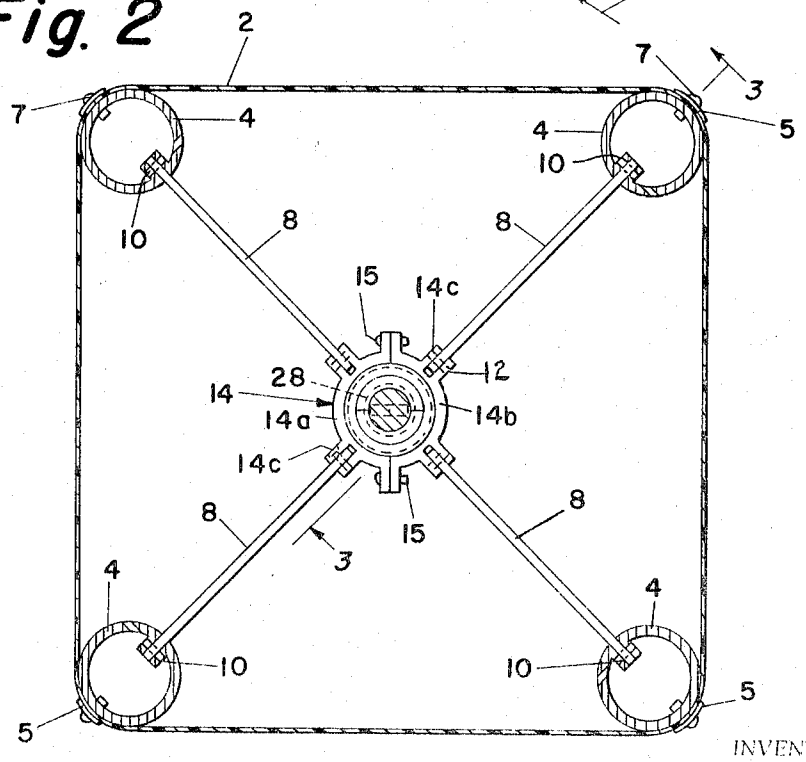


Fig. 2



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COLLAPSIBLE VESSELS

Filed May 7, 1964 3 Sheets-Sheet 2

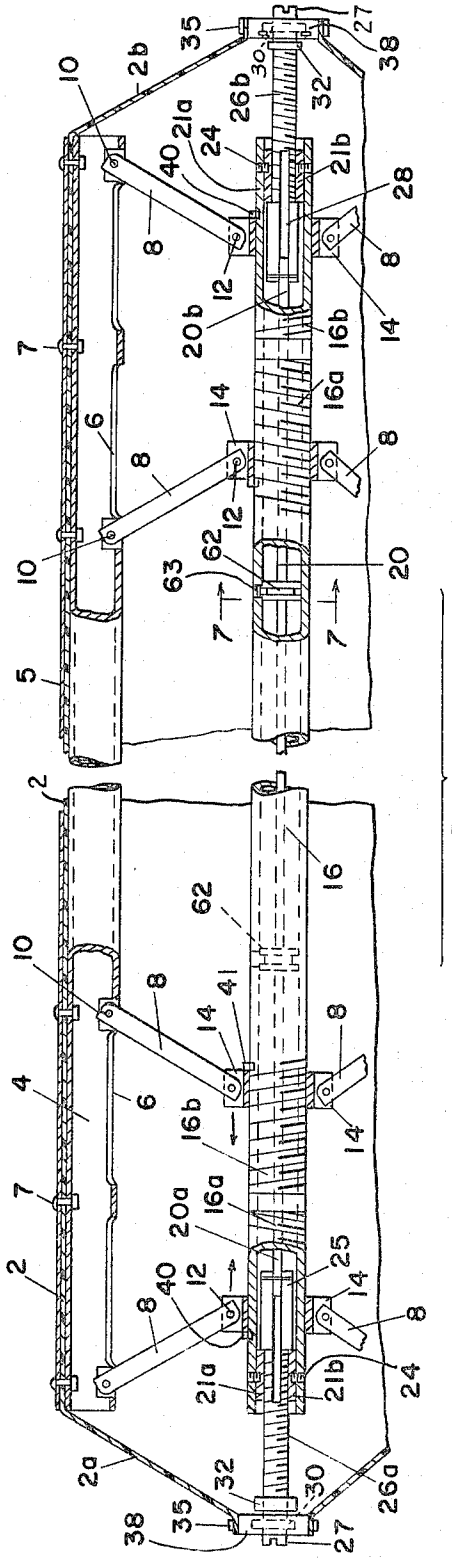


Fig. 3

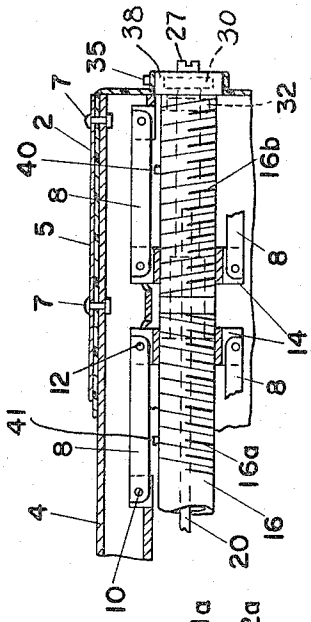


Fig. 4

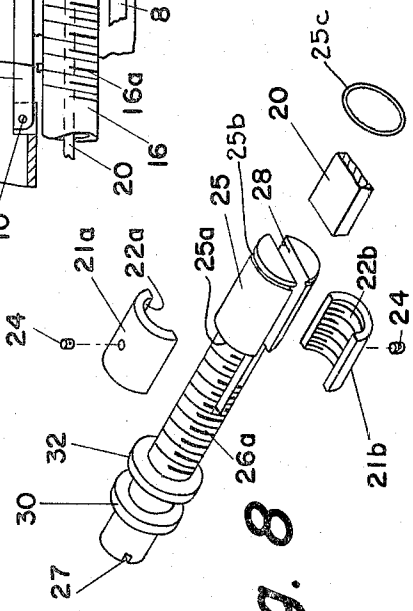


Fig. 8

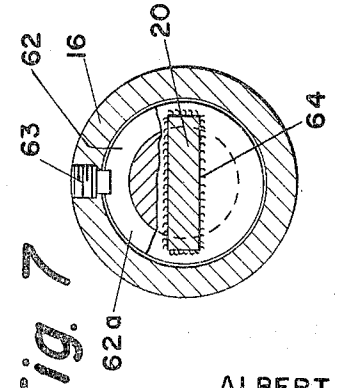


Fig. 7

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COLLAPSIBLE VESSELS

Filed May 7, 1964 3 Sheets-Sheet 3

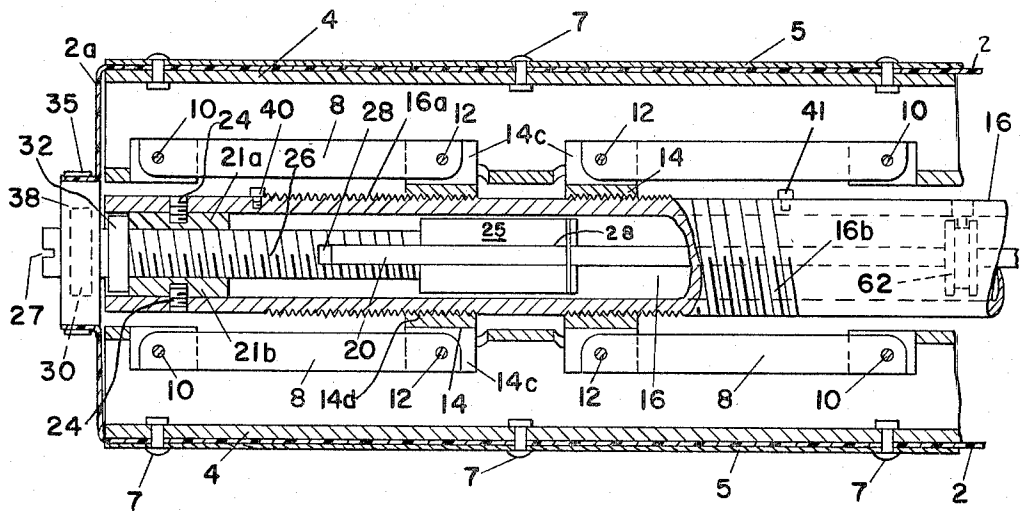


Fig. 5

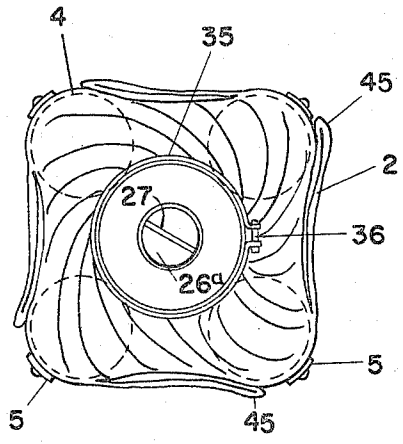


Fig. 6

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3,289,721

COLLAPSIBLE VESSELS

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Filed May 7, 1964, Ser. No. 365,760
9 Claims. (Cl. 150—.5)

This application is a continuation-in-part of application Serial No. 195,751 filed May 18, 1962, and now abandoned.

My invention relates to collapsible tanks, vessels, pontoons, and the like, which may be used for the support of vehicles or other equipment in swamps or in water.

My invention also relates to such tanks which may also be used for the storage and transportation of liquids and gases.

My invention particularly relates to such tanks which are expandable to a usable position and which may be readily collapsed to such a position that they may be easily handled and stored away.

Heretofore such tanks have either been manufactured out of rigid metallic material or have been completely deflatable in nature. There are many objections to the use of either of these forms of tanks. The rigid tanks, even though manufactured from a light metal, are hard to handle and store away by reason of their bulk and weight. The completely deflatable tanks, which are customarily made from treated canvas or from some pliable plastic material, may be inadvertently deflated by reason of accidental punctures and in addition must be folded and refolded after deflation in order to be readily handled and stored away. Further, the deflatable tanks are subject to be torn by reason of unequal pressure applied along one side and as a result sectional bulkheads must be provided therein to equalize the pressure when they are being used for support or pontoon purposes.

My invention clearly overcomes all of the objections in the prior art by providing a semi-rigid, readily collapsible tank which is positively operated through a central control system to an expanded or collapsed position.

I achieve this result by generally providing a tank or vessel having an outer covering of flexible fabric or other material which is supported by rigid ribs which in turn are linked to a central operating control element and thus affords adequate support for the cover and positive means for expanding and collapsing the same.

An object of my invention is to provide a new and improved vessel for the support of equipment in water as well as for lifting submerged ships and other objects out of water.

A further object of my invention is to provide a tank or pontoon which is semi-rigid in nature.

A still further object of my invention is to provide a semi-rigid tank which is positively operable to and from a collapsed position by a central control system.

A further object of my invention is to provide such a tank which may be easily handled and stored when the same is in a collapsed position.

These and other objects and features of my invention may be readily seen from the following description thereof in which reference is made to the figures of the accompanying drawings:

FIGURE 1 is a perspective view showing an illustrative tank construction in expanded condition,

FIGURE 2 is a sectional view taken on line 2—2 of FIGURE 1,

FIGURE 3 is a longitudinal sectional view of FIGURE 1, partly broken away, showing the linkage arms in expanded position,

FIGURE 4 is a fragmental longitudinal sectional view of the right-hand end of the tank in collapsed position,

FIGURE 5 is a fragmental longitudinal sectional view of the left-hand end of the tank in collapsed position,

FIGURE 6 is an end view of the collapsed left-hand end of the tank,

FIGURE 7 is a sectional view taken on line 7—7 of FIGURE 3, and

FIGURE 8 is an exploded perspective view of the end actuating elements at the left-hand end of the tank shown in FIGURE 3.

The present invention relates to semi-rigid tanks or collapsible vessels or pontoons which may be used for supporting or buoying of vehicles or other equipment in water, swamps, and the like. The present pontoon structure is particularly adaptable for fording or flotation of wheeled vehicles or track-laying vehicles and especially heavy type of military vehicles which must be propelled through water, mud and swamps. The pontoons may also be suitably attached to submerged or sunken vessels and the like for salvaging same. The collapsible vessels or pontoons constructed in accordance with this invention are adapted to be transported in collapsed condition and can be readily and quickly expanded while retained at the sides of any structure, such as a vehicle, so as to provide sufficient lifting force to enable the vehicle to be propelled through otherwise impassable terrain. Essentially, the collapsible pontoon consists of an outer flexible and easily foldable material 2 made of canvas or plastic material which can be mechanically expanded and collapsed by internally positioned mechanical means to form an elongated closed tank or vessel, and which may be polygonal in cross-section, as shown in FIGURE 1, and which also has closed sealed collapsible end walls 2*a* and 2*b*. The means for expanding and collapsing the flexible pontoon comprises a central control shaft 16 which extends longitudinally and medially of the vessel. A plurality of spaced wall-expansion arms 8 are pivoted to the central control shaft and the outer ends of the arms are connected to spaced rib members 4 which are attached to the flexible walls of the pontoon. When the central control shaft is rotated upon engagement with actuated end-control means extending outside of the vessel, the arms can be pivoted outwardly of the central control shaft or inwardly by suitable mechanisms hereinafter described so as to expand or collapse the pontoon.

In the form of my invention shown in the drawings, my semi-rigid collapsible vessel is provided with an outer covering 2 formed from treated canvas, plastic or any other suitable flexible and easily foldable material which forms the side walls and ends of the collapsible tank and has a series of longitudinally extending tubular ribs 4 spaced at predetermined intervals around the inner surface of said cover 2 and affixed thereto by any suitable fastening means. In the form as shown in FIGURE 2, I use a metal strip or band 5 having a similar transverse curvilinear shape as the outer surface of the rib 4 and positioned longitudinally along the exterior of the cover 2 and serves to clamp the said flexible cover 2 securely to the ribs when tightened in place by means of the rivets 7.

As shown in FIGURE 3, the inner surface of each of said ribs 4 is formed with a series of slots 6 spaced along the entire length of the same. Each slot 6 is of sufficient width and length so that it may receive therein a linkage or wall-expanding arm 8 when the tank is in the collapsed position shown in FIGURES 4 and 5 and each of said linkage arms 8 assumes a horizontal position. Each of said linkage arms 8 is pivotaly connected to the under surface of a rib 4 by means of a conventional pin 10. As shown, each linkage arm 8 is positioned adjacent to either the forward or rear edge of the slot 6 with which it is associated. In order to create opposing pressures to raise the linkage arms 8, I alternately position one linkage arm 8 adjacent to the forward edge and the next linkage arm 8 adjacent to the rear edge of the next adjacent slot 6 with which each is associated. It is also

preferable to have the most forward linkage arm **8** facing the front and the most rearward linkage arm **8** facing the rear so that proper corners will be formed when the tank is expanded.

I may form both my ribs **4** and linkage arms **8** from aluminum, but any suitable, light, strong and rigid metallic or plastic material may be used. In the form of my invention shown I form my ribs **4** of tubing but they also may be formed from solid stock without affecting the character of my invention.

Each of the linkage arms **8** extend generally inwardly from the rib **4** with which it is associated and is pivotally mounted by pins **12** or any other conventional means to a split collar **14** which consists of two internally threaded segments **14***a* and **14***b* fastened together by bolts **15** as shown in FIGURE 2. The segments **14***a* and **14***b* are provided with spaced ears **14***c* for receiving the ends of arms **8** which are retained therein by pins **12**. Each collar **14** is mounted on the tubular central control shaft **16** and is movable longitudinally along the same. Each collar **14** is further connected to each of said ribs **4** by means of a linkage arm **8** so that there is a series of said linkage arms **8** pivotally mounted at spaced intervals around the circumference thereof.

The central control shaft **16** is tubular or hollow in shape and extends longitudinally for substantially the entire length of the vessel. It is rotatable in said collars **14**. The shaft **16** terminates at the front end in a front expanding control member **26***a* and at the rear in a rear expanding member **26***b*.

Each collar **14** has threads **14***d* formed in the interior surface thereof so as to operatively engage the respective threads **16***a* and **16***b* which are formed along the exterior surface of the control shaft **16**. (See FIGURES 3 and 5.) As shown in FIGURE 5, the threads **16***a* and **16***b* formed on the exterior of the central control shaft **16** are formed so that they provide alternately left and right hand threaded sections. The internal threads **14***d* on the collar **14** associated with each of said sections are formed to match the threads in the section. In this way I provide opposed pairs of collar **14** moving in oposite directions when the central control shaft **16** is rotated. Further the movement of each of said collars **14** is limited by the extent of the threaded section with which it is associated. Stop members **40** and **41** are postioned adjacent each end of central shaft **16**, as shown in FIGURE 1, in order to limit the travel of the collars **14** when the arms are expanded.

In order to collapse and expand the end portions **2***a* and **2***b* of the vessel, I provide rotatable end-control members, the left-hand one being designated as **26***a* and the right-hand one as **26***b*, at each of the respective ends of the central control shaft **16**. Each of these end-control members, as shown in FIGURE 8, consists of a cylindrical shaft which is externally threaded at **26***a*, the threads **26***a* being right-handed at the left end of FIGURE 3, and threads **26***b* being left-handed at the right end of FIGURE 3. The shaft **26***a* is provided with an enlarged integral cylindrical end or stop portion **25** which is adapted to be slidably received within each of the ends of central shaft **16**, as shown in FIGURE 3. The end **25** is provided with an inwardly axially extending slot **28** which continues partially into the shaft **26***a*. A peripheral groove **25***a* is provided adjacent and encircling the free end of member **25** which is adapted to receive therein a fastening strap **25***b* which serves to prevent the free split end of member **25** from springing apart under stress. The other end of shaft **26***a* is provided with a stop member **32** and a seal member **30**. The outer end of left-hand member **26***a* is provided with a slot or kerf **27** which is adapted to receive a crank or other tool for rotating same. Likewise, the right-handed end control member **26***b* is identical in structure with the left-hand control member **26***a* except that the right-hand member **26***b* is provided with right-handed threads.

End members **26***a* and **26***b* are retained at the ends of the central shaft **16** by split bushings or collars **21***a* and **21***b* which are positioned at each end of control shaft **16** as shown in FIGURE 3 and are fixedly retained on shaft **16** by set-screws **24**. The internal surfaces of the bushings **21***a* and **21***b* are threaded at **22***a* and **22***b* respectively to engage with the threads **26***a* of the end control member **26**. The complemental combined split bushings **21***a* and **21***b* also serve as stop members which are adapted to be engaged selectively at their ends by either stop member **32** or cylindrical end member **25** of the end control members **26***a* or **26***b*, as will be explained later.

The extending end of the front end control member **26***a* is accessible from the exterior of the tank, and as described previously, is kerfed at **27** for receiving a crank or other suitable actuating means. It rotates in a conventional pressure seal housing **38**. The housing has an outer race which cooperates with a tightly drawn metal strap band **35**, the ends of which are retained by bolt **36**, as shown in FIGURE 6, to draw in and retain the adjacent areas of the cover **2** in a sealed relationship thereto. A sealing member **30** is affixed on the end control member **26***a* and rotates with it, and is retained in housing **38**, and in addition serves to pull the end walls of the cover **2** in or out as the end control member **26***a* moves in or out of the central control shaft **16**. Likewise, a sealing member **30** is provided on end member **26***b* to serve a similar function in the opposite direction.

The rear expanding member **26***b* is also preferably formed from aluminum and its exterior surface is provided with external threads which are formed so that they operatively engage the threads which are formed on the inside of the split bushings **21***a* and **21***b* and move the rear expanding member **26***b* in and out of said shaft **16** when said member **26***b* is rotated. The threads **26***b* are in opposite direction to threads **26***a* of front member **26** and are left-hand threads.

The extending end of the rear expanding member **26***b* is provided with a seal member **30** which is retained in housing **38**. A metal strap **35** also serves to compress the adjacent areas of the ends **2***a* and **2***b* of the cover **2** in a sealed relationship thereto.

A rotatable elongated torsion bar **20** which is rectangular in cross-section as shown in FIGURE 7 is supported within the hollow center of control shaft **16** as shown in FIGURE 3. Bar **20** is provided with a plurality of spaced cylindrical bearing members **62** which are peripherally grooved at **62***a* and suitably fastened thereto such as by welding or brazing at contacting medial portions **64**, as shown in FIGURE 7.

Stop screws **63** carried by control shaft **16** extend into the peripheral grooves **62***a* of members **62** so as to prevent longitudinal sliding movement of the bar **20** but will permit its rotation within the control shaft **16**.

Each of the ends of bar **20** is adapted to extend partially within the slots **28** of end members **26***a* and **26***b* as shown in FIGURE 3. It will be apparent that rotation of end control members **26***a* and **26***b* towards and from the ends of control shaft **16** will move the enlarged end portions **25** within control shaft **16** to the extent that threaded shafts **26***a* and **26***b* are rotated. At the same time as left-hand member **26***a* is rotated, the longitudinal bar **20** will be rotated and will in turn rotate the right-hand member **26***b*. The diameter of the cylindrical ends **25** of each end member **26***a* and **26***b* is of such dimension as to permit the ends **25** to move within the hollow ends of the control shaft **16**.

In using the previously described pontoon, when it is desired to collapse the pontoon from its fully expanded position shown in FIGURE 3, a suitable crank or other tool is engaged with the slot **27** of end member **26***a* so as to rotate same inwardly of the end of the central shaft **16**, thereby collapsing the end portion **2***a* of the pontoon. At the same time torsion bar **20** will be rotated because

the left-hand end 20*a* thereof is engaged in slot 28 of portion 25 which is integral with end member 26*a* and will therefore rotate with it. The right-hand end 20*b* of bar 20 being engaged in the slot of right-hand end member 26*b* will cause rotation thereof and thus retract same within the right-hand end of control shaft 16 and thus collapse end 2*b*. When stop 32 is brought within the end of control shaft 16 so as to engage with the adjacent portion of split bushings 21*a* and 21*b*, further turning torque applied to end of member 26*a* will cause the control shaft 16 to rotate therewith. The respective pairs of collar members 14 will then be moved toward each other as indicated by the arrows in FIGURE 3 so as to cause the arms 8 to move toward the slots 6 of ribs 8 until they assume their final flat collapsed position within slots 6, as shown in FIGURE 4. The end portions 2*a* and 2*b* of the cover 2 will thus be simultaneously and automatically pulled into a predetermined folded position. The side portions of the cover 2, which are creased at 45, also assume a predetermined position as shown in FIGURE 6.

When it is desired to expand the pontoon from its collapsed position, a crank or other tool is applied to the end of member 26*a* and it is rotated in the opposite direction when the pontoon is collapsed. The end members 26*a* and 26*b* will first be moved simultaneously outwardly out of the respective ends of control shaft 16, thereby expanding the ends 2*a* and 2*b* of the cover 2. During this expansion of the ends the control shaft 16 itself will not be rotated but will be stationary. When the end members are withdrawn outwardly until the enlarged end or stop 25 of end members 26 will engage with the inner end of the fixed split bushings 21*a* and 21*b*, whereby rotation of the control shaft 16 will occur, thus causing the pairs of sleeves 14 to move apart and thereby expand the arms 8 outwardly until the covering 2 is fully expanded. The stops 40 and 41 at each end of control shaft 16 serve to limit the outward travel of the pairs of collars 14. When fully expanded the arms 8 come to a complete stop and are locked there by reason of the action of the coacting threads on control shaft 16 and collars 14. If additional locking means are desired they can readily be formed from any conventional device. It will thus be understood that the ends of the split combined bushings 21*a* and 21*b* function as stop members fixed located at each inner end of the central control shaft 16 and that the stop 32 and end member 25 integral with end control member 26 serve as spaced stop members which are adapted to be selectively engaged with the split bushings 21*a* and 21*b* for rotating the central control shaft 16; and when the stop members are not engaged, rotation of the end control members 26 will not rotate central control shaft 16. It will thus be seen that means are provided for first simultaneously expanding or collapsing the flexible end walls of the vessel while the side walls are not moved and then expanding or collapsing the side walls by the simultaneous movement of the expanding arms.

I may also provide suitable valves in the vessel walls which may be operable so as to maintain atmospheric pressure in the vessel. Valves may also be used if desired to support an increased pressure in the vessel. I may also provide fittings for the introduction of liquids or gases into the tank when the tanks are used for the storage and transportation of the same. The above description merely shows one illustrative embodiment of my device. For instance, I may eliminate the expanded front and rear portions of the tank and thus avoid the use of the front control member and the rear expanding member. The specific structural details of the various elements previously described may also be replaced by equivalent functional means. Other changes and alterations may readily be seen and it is not my intention to have the scope of the following claims strictly limited to the above description.

I claim:

1. A semi-rigid collapsible tank for retaining a fluid therein comprising an outer continuous covering of foldable flexible material forming a closed chamber when expanded having side walls, front and rear end portions, ribs extending longitudinally along the inner surface of said covering and affixed thereto at predetermined intervals therearound, a central control shaft, a plurality of collars movably mounted on said central control shaft, linkage arms pivotally mounted at predetermined intervals along said ribs and pivotally mounted on the other end to the collars movably mounted on said control shaft, means associated with said central control shaft and with said collars for moving said collars along said control shaft when said central control shaft is actuated and causing said linkage arms to move outwardly therefrom, said central shaft having means associated and movable therewith and expanding the front and rear end portions of said tank.

2. A flexible collapsible elongate closed vessel substantially polygonal in transverse cross-section comprising side walls and end portions for retaining a fluid therein formed from a foldable flexible material, means for expanding said vessel to maximum capacity and for collapsing same, said means comprising a central control shaft extending longitudinally and medially of said elongate vessel, a plurality of rib members connected to the inner surface of said flexible material, a plurality of spaced wall-expanding and collapsing linkage arms each having one end thereof hinged to said control shaft and each of the respective other end thereof connected to said rib members, means for actuating said central control shaft to move said wall-expanding linkage arms in opposed directions and outwardly of said central shaft to expand said flexible material to full capacity, means to retain said linkage arms in locked position and means to swing said linkage arms in collapsed position aligned substantially parallel to said central control shaft and adjacent thereto to collapse said vessel.

3. A flexible collapsible vessel as defined in claim 2, wherein actuating means are provided to first expand the end portions of said vessel in opposite directions to a predetermined extent and then to expand the side walls of said vessel to maximum capacity.

4. A flexible collapsible vessel as defined in claim 3, wherein stop means are provided to limit the outward expansion of the side walls of said vessel.

5. A flexible collapsible vessel as defined in claim 2, wherein the central control shaft is provided on its exterior surface with a plurality of alternately spaced right and left threads, a plurality of complementally internally threaded collars engaging said right and left threads and movable longitudinally on the exterior of said central control shaft, said cover-expanding linkage arms being pivoted to said movable collars, and means to rotate said central control shaft whereby said collars are moved longitudinally along said central shaft to pivot the cover-expanding linkage arms from and toward said central shaft in opposite directions.

6. A flexible collapsible vessel as defined in claim 1, wherein the central control shaft is hollow and is provided with internally threaded portions adjacent its ends, an end-control member received at each end of said central control shaft, said end-control member being externally threaded at its inner end and mating with the internally threaded portions at the end of the central control shaft for rotation therein, the other end of said end-control member being received in a housing carried by the end portions of the chamber, and means for rotating said end-control members to expand and collapse the end portions of the chamber.

7. A collapsible vessel as defined in claim 6, wherein the central control shaft is provided with stop members adjacent each inner end thereof, the inner end of each of said end-control members being provided with a keyed

slot extending for a substantial distance inwardly from the inner end thereof, a rotatable torque bar supported within the control shaft, the ends of said torque bar being slidably received in said slots, spaced stop members on said end-control members adapted to selectively engage said stop members in the central control shaft whereby upon engagement of said stop members and rotation of said end-control members said central control shaft member will rotate.

8. A flexible collapsible vessel as defined in claim **6**, wherein each end of the central control shaft is provided with an internally threaded bushing adapted to receive therein the threaded portions of the end-control members.

9. A flexible collapsible vessel as defined in claim **8**,

wherein each end-control member is provided with spaced stop members, said stop members being adapted to be selectively engaged with the respective adjacent ends of the said bushing.

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