

[54] VESSEL OR TANK WITH SUPPORTING SYSTEM

2,684,173 7/1954 Schmitz 220/18

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[57] ABSTRACT

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 140,121, May 4, 1971.

A vessel supported by a plurality of rigid members, each of said rigid members being supported at the bottom on a base by at least two pivots, and each of said rigid members being pivotally connected at the top to the vessel at spaced apart locations such as below or about the periphery thereof. The rigid members permit expansion and contraction of the vessel, such as during post-weld heat treatment, internal pressure testing of the vessel, or when the vessel is subjected to a wide temperature cycle during use such as for storage of a cryogenic liquid on land or in a barge or ship.

[52] U.S. Cl. 220/18, 220/69

[51] Int. Cl. B65d 25/24

[58] Field of Search 220/18, 15, 69, 5 A

[56] References Cited
UNITED STATES PATENTS

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15 Claims, 6 Drawing Figures

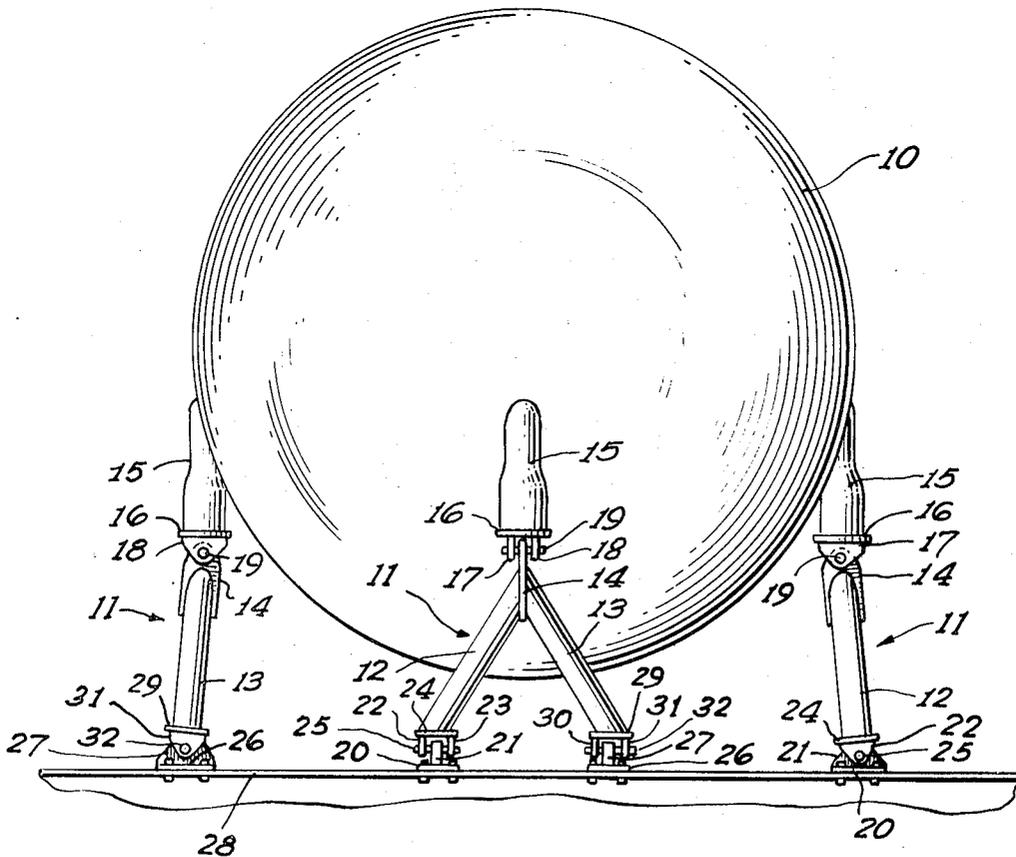


Fig. 1

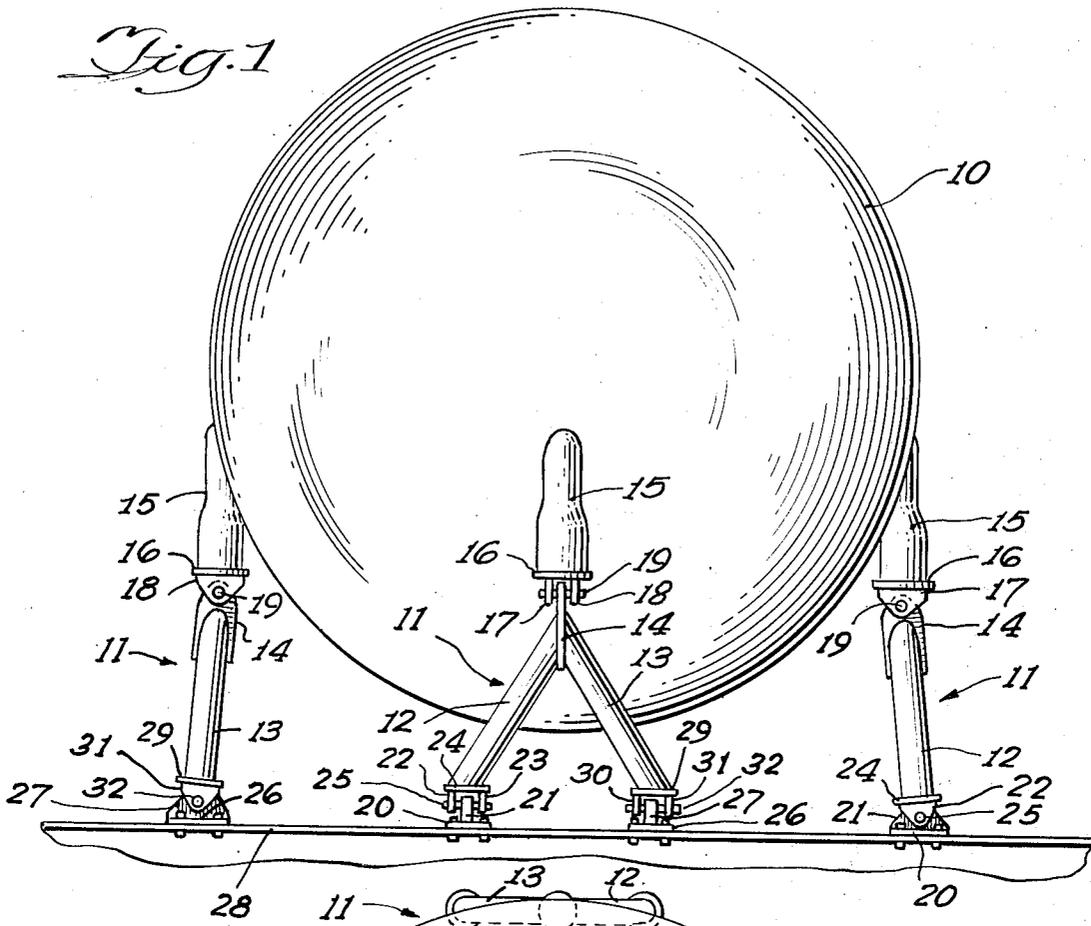


Fig. 2

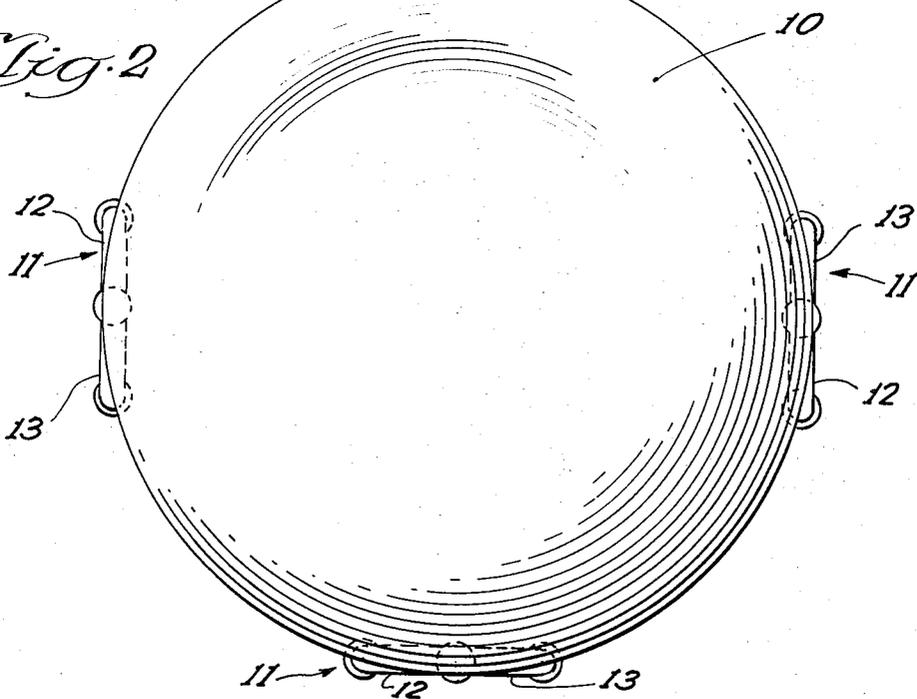
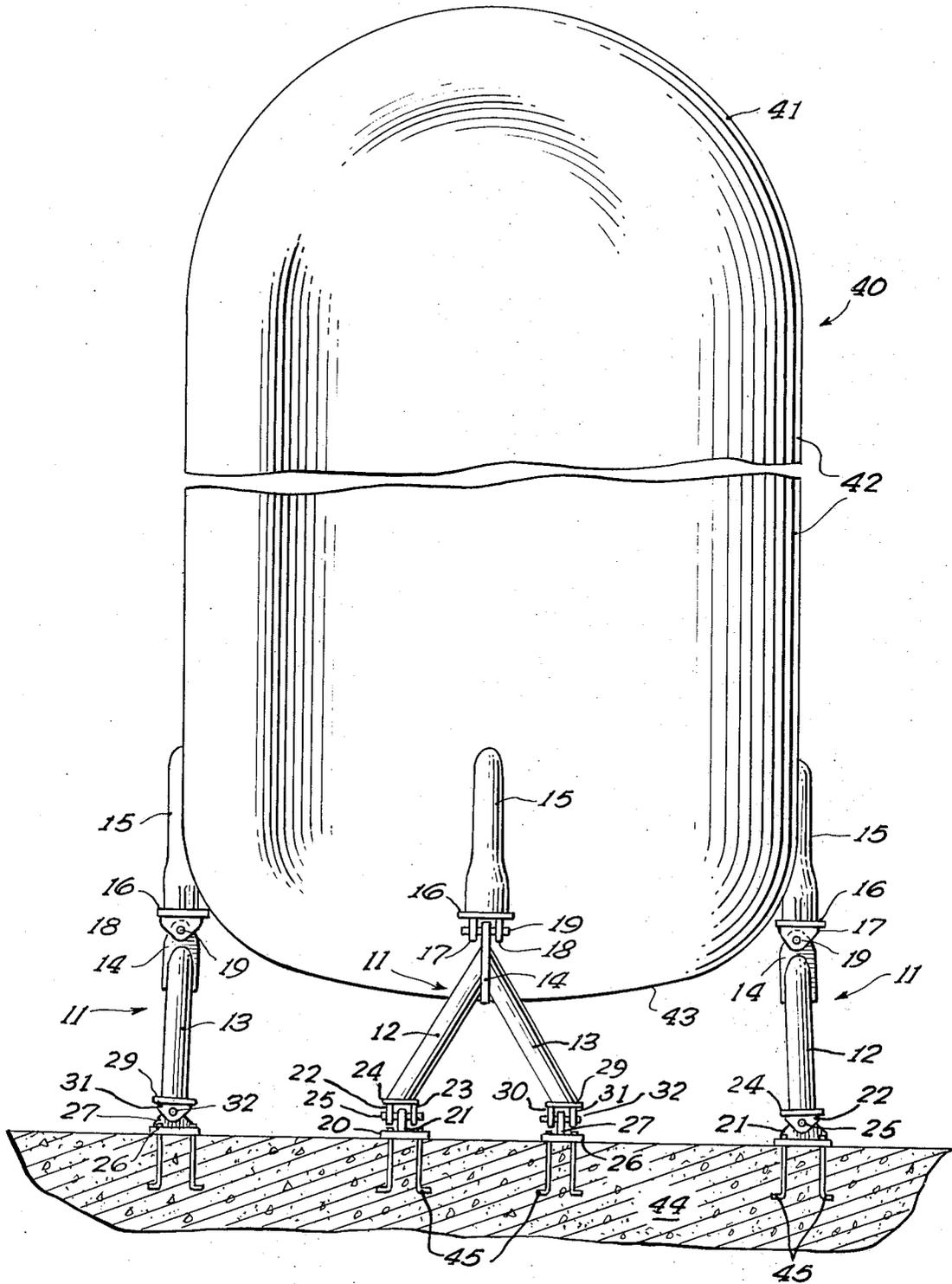


Fig. 3



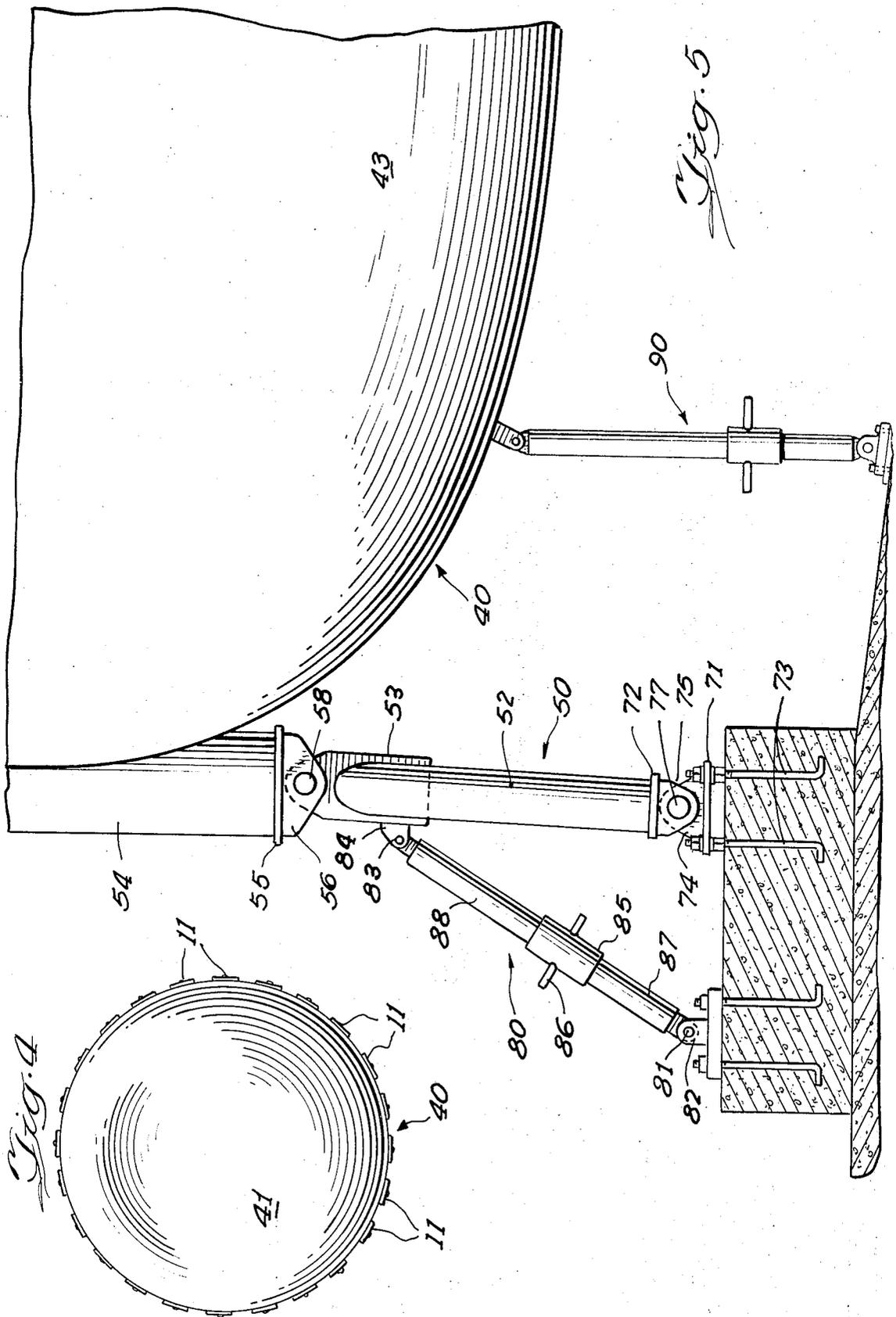
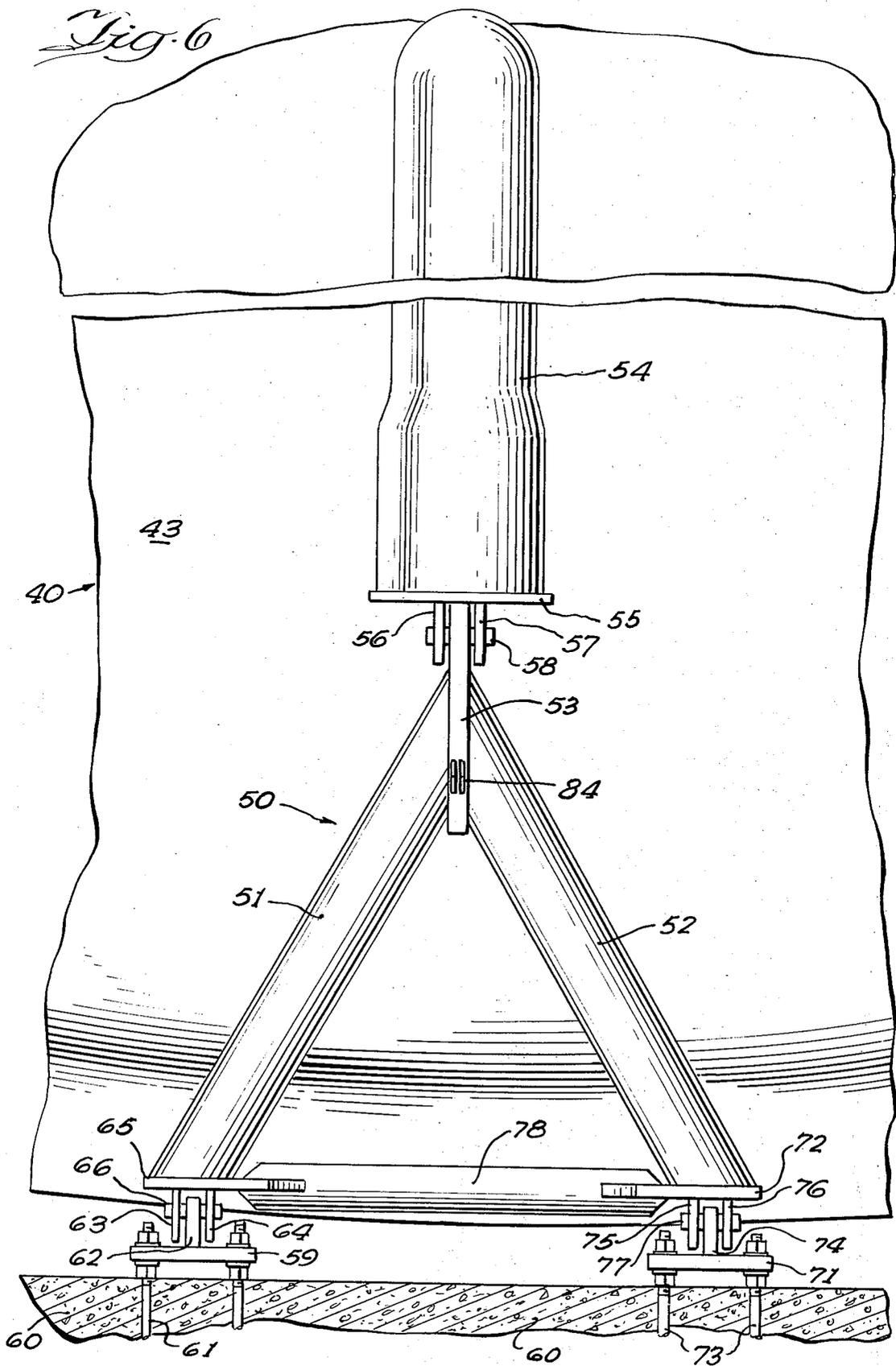


Fig. 6



VESSEL OR TANK WITH SUPPORTING SYSTEM

This application is a continuation-in-part of our co-pending application, Ser. No. 140,121 filed May 4, 1971.

This invention relates to systems and structures for supporting vessels, tanks and similar type objects. More particularly, this invention is concerned with a support system for vessels, tanks and the like, and especially those which expand and contract through testing and heat treatment cycles as well as vessels and tanks used to store various products including cryogenic liquids.

There are many circumstances in which vessels, tanks and similar objects expand and contract, such as when they are subjected to wide temperature cycles, as for example when cycled from ambient temperature to quite high temperatures followed by cooling of the vessel to ambient temperature or even below such temperature, as well as when subjected to a temperature cycle from ambient temperature, or above, down to a cryogenic temperature and back to ambient temperature or above. Substantial expansion is also involved when tanks and vessels are tested by subjecting them to internal pressures, especially pressures higher than design pressures. It is not a difficult problem to provide adequate support systems and structure for relatively small size vessels and tanks which go through expansion and contraction cycles since the dimensional change is quite small and can be easily accommodated by rather simple engineering structures and dimensional accommodation during the fabrication and installation thereof. In addition, the stresses created in small size vessels and tanks do not involve a serious problem.

In more recent years, the size of vessels and tanks for industrial processing operations, storage of products and utilization of such structures for safety and environmental protection purposes, such as for nuclear containment vessels, and the storage of materials such as cryogenic liquids, has necessitated that they often be extremely large. Not only are the overall dimensions of many of the vessels and tanks built today quite large, such as over 100 feet or more in major dimension, but the total weight of such objects has increased substantially, particularly due to the increased shell thicknesses and auxiliary equipment which must be utilized therewith. The expansion and contraction of such large size metal vessels or tanks through testing, heating and cooling thereof, and wide temperature cycles through which they often pass in use, makes it necessary that supporting systems and structures for such vessels and tanks be able to accommodate the dimensional changes which the vessel or tank goes through without inducing, or being subjected to, unnecessary stresses which could lead to failure or distortion of the vessel or tank or supporting structure.

In addition to supporting systems for vessels and tanks which normally go through a testing or heating and cooling cycle in routine operation, there is a need for supporting systems for vessels and tanks which must be subjected to post weld heat treatment following fabrication. Many of the engineering codes require that vessels and tanks fabricated by means of welding be subjected to a post weld heat treatment operation to eliminate internal stresses induced by the welding process. To effect such a heat treatment, it is often es-

sential to raise the tank or vessel to a temperature near 1,200°F. for extended periods of time followed by a gradual cooling thereof to ambient temperature. It can be readily appreciated that, during such heating and cooling cycle, the vessel or tank must be supported in such a way as will permit the expansion and contraction necessary for successful operation of the heat treating operation.

There is provided according to the subject invention a novel support system to be used in combination with a vessel, tank or the like which will accommodate the dimensional expansion and contraction that takes place in the vessel because of a testing or heating and cooling cycle or other temperature cycle to which the vessel or tank may be subjected in construction or use. The system is particularly useful for the support of very large vessels and the like. The system utilizes a plurality of rigid members to support the vessel. Each rigid member is supported at the bottom on a base by at least two pivots and the top of each rigid member is joined by means of a pivot to the vessel. The rigid members are advisably nonadjustable in length during use so that the distance from the bottom pivots to the top pivot remains constant. The base can be on land or a barge or on a ship.

A plurality of rigid members, and advisably at least three rigid members, is pivotally connected at the top to the vessel at spaced apart locations. While three rigid members can be used it is advisable to employ at least four; however generally many more than four will be used in practice when a large size tank or vessel is to be supported.

The rigid members spaced around the vessel, such as around or below the periphery, support it safely and securely. This system permits the vessel to expand dimensionally such as when increased in temperature, and to contract, such as when its temperature is lowered, since the rigid members adjust to such dimensional change by means of the pivotable joints. Expansion of a vessel or tank also can be accommodated in this manner when it is subjected to pressure testing, as well as subsequent contraction when the pressure is reduced. The system also supports a tank or vessel with excellent stability when lateral forces are applied such as by wind, and through rolling or pitching action of a ship or barge.

The invention will be described further in conjunction with the attached drawings in which:

FIG. 1 is an elevational view showing a spherical vessel supported by four rigid members;

FIG. 2 is a plan view of the vessel and rigid member supports of FIG. 1;

FIG. 3 is an elevational view of a tall vessel having a cylindrical shell center portion, an elliptical shell bottom and a hemispherical shell top, with the vessel supported by a plurality of rigid members;

FIG. 4 is a plan view of a large tank which is circular in horizontal cross-section and of the type shown in FIG. 3, and illustrates the positioning and number of rigid members which can be actually used to support it;

FIG. 5 is an elevational view, partly in section, illustrating a rigid member used to support a vessel, together with ancillary adjusting and temporary support means; and

FIG. 6 is a front elevational view of the rigid member of FIG. 5 with the adjusting leg removed.

So far as is practical, the same or similar elements which appear in the various drawings will be identified by the same numbers.

With reference to FIGS. 1 and 2, spherical vessel 10 is supported by four equally spaced apart rigid members 11 which are advisably of the same shape and construction. Each rigid member 11 has a leg 12 and a leg 13. The legs are joined at their upper ends to vertical plate 14. Column stub 15 is joined to the surface of spherical vessel 10. Plate 16 is joined to the bottom end of column stub 15 and vertical flanges 17 and 18 project downwardly therefrom on each side of the upper end of plate 14. A pin 19 extends through flange 17, plate 14 and flange 18 to provide a pivotal connection of the rigid member top to the base of column stub 15.

Further in regard to FIGS. 1 and 2, each leg 12 and 13 is pivotally mounted at its lower or bottom end to a base or supporting means. On plate 28, which can be on a barge or ship, or on land, is bolted plate 20 having vertically positioned flange 21. Horizontal plate 24, at the lower end of leg 12, has a pair of downwardly depending flanges 22 and 23 which straddle flange 21. Pin 25 extends through flanges 22, 21 and 23 to complete the pivotal connection between the end of leg 12 and the supporting base structure. Leg 13 is pivotally connected at its lower end to the base structure in the same way as leg 12. Plate 26 is bolted to plate 28, and from plate 26 flange 27 projects upwardly. The lower end of leg 13 has a horizontal plate 29 from which flanges 30 and 31 depend downwardly and straddle flange 27. Pin 32 extends through flanges 30, 27 and 31 to complete the pivotal connection of the lower end of leg 13 to the supporting base.

Although only four rigid members 11 have been shown supporting vessel 10 in FIGS. 1 and 2, a sufficient number thereof will be employed to adequately support the vessel. For clarity of illustration, however, FIGS. 1 and 2 show only four rigid members 11.

Although rigid members 11 are shown in FIGS. 1 and 2 constructed of two angled legs, it is to be understood that each rigid member 11 can be fabricated and formed in a number of ways. The shape, construction and arrangement of parts in rigid members 11 can thus vary widely and still be useful in the invention. However, regardless of the particular shape and construction of rigid members 11, each one is to be adapted and suitable for a pivotal connection at the top to a vessel and for two pivotal connections at the bottom to a base.

It should also be understood that a ball and socket pivotal connection can be used, if desired, in place of a pivot pin connection.

A vessel supported as described in connection with FIGS. 1 and 2 can be subjected to a heat treatment operation, used as a pressure vessel, the storage of a liquid, including a refrigerated liquid and particularly a cryogenic liquid, or used for other purposes. When the vessel is to be used for storage of a refrigerated liquid, and especially a cryogenic liquid, insulation can be placed all around the vessel. For example, the vessel can be mounted as described in the hold of a ship or barge with the bulkheads in close to the sides of vessel 10. Then insulation can be poured into the hold until it is completely filled thereby insulating the tank all around. Horizontal movement of the lower ends of legs 12 and 13 with respect to each other when dimensional

change is created by wide temperature cycles is accommodated by the angled position they have.

FIG. 3 illustrates in elevational view the support of a large upright vessel 40 by the same rigid members 11 described in conjunction with FIGS. 1 and 2. The rigid members 11 have accordingly been identified by means of the same reference numbers. However, as shown in FIG. 3, plates 20 and 26 are secured to concrete foundation 44 by bolts 45. Although the use of only four supporting rigid members is contemplated in the illustration of FIG. 3, the support of an immense vessel of such shape would obviously require the use of a considerably larger number of rigid member supports. For example, a vessel of the general shape shown in FIG. 3 having a hemispherical top 41 of 70 foot radius, a circular cylindrical central body 42 of 70 foot radius and 127 feet high, and an elliptical bottom 43 with a 35 foot depth, could be supported by twenty-four rigid members 11 as shown in FIG. 4. The rigid members 11 are equally spaced around the vessel periphery and from each other to provide adequate support.

FIGS. 5 and 6 show a rigid member, in the form of an A-frame 50, used with auxiliary adjustable members to support an immense vessel of the type illustrated by FIGS. 3 and 4. The rigid member A-frame 50 of FIGS. 5 and 6 has a pair of legs 51 and 52 which are joined at their top to plate 53. A column stub 54 is joined to the vessel 40 along the equator thereof where the elliptical bottom joins the cylindrical body. The column stub 54 has a plate 55 horizontally positioned at the bottom thereof to which downwardly extending flanges 56 and 57 are attached. The upper end of plate 53 extends between flanges 56 and 57. A pivot pin 58 extends through flange 56, plate 53 and flange 57 to pivotably connect the upper end of the A-frame structure 50 to the column stub 54.

A plate 59 is bolted to foundation 60 by means of bolts 61. Flange 62 extends upright from plate 59 between flanges 63 and 64 which extend downwardly from horizontal plate 65 on the lower end of leg 51. Pivot pin 66 is positioned to extend through flanges 63, 62 and 64 to complete the pivotable connection of leg 51 to the supporting base.

Base plate 71 is bolted to foundation 60 by bolts 73. Flange 74 extends upright from base plate 71 between flanges 75 and 76 which extend downwardly from horizontal plate 72 on the lower end of leg 52. A pivot pin 77 is positioned to extend through flanges 75, 74 and 76 to pivotably join the lower end of leg 52 to the supporting base. A horizontal strut 78 is joined at its ends to plates 65 and 72 on the lower end of legs 51 and 52 to render the A-frame 50 more rigid.

Support leg 80 is provided to permit adjustment of the A-frame 50 in position while the vessel is lowered and the pivot pin 58 is inserted. Once the vessel is in position and all the A-frames are pivotably attached thereto, the support arm 80 can be removed. Support arm 80 is joined by a lower pivot pin 81 at its lower end to a base plate unit 82 and by an upper pivot pin 83 to brackets 84 on plate 53 on the upper part of the A-frame 50. Central collar 85 of support arm 80 is provided with handle 86 to rotate the collar in either direction. Lower section 87 and upper section 88 of leg 80 slide into collar 85. A screw with right hand threads on one end and left hand threads on the other end is threadably screwed into nuts in sections 87 and 88. By

rotating collar 85, the length of leg 80 can be increased or decreased to tip the A-frame 50 closer to, or away from, column stub 54.

A temporary support leg 90, of similar construction to leg 80, can also be used to support the vessel while the A-frames are placed in position and joined to the vessel. Legs 80 and 90 are removed before the vessel is subjected to a heating and, advisably, cooling cycle so that the vessel can expand and contract freely without restriction, or before the vessel is placed in use.

Although ball and socket joints can be used to join the A-frames to the base and to the vessel, it is considered advisable to use cylindrical pins or long heavy bolts. When pins are used, it is advisable that they be positioned horizontal but tangential to the vessel wall, in other words, approximately perpendicular to a vessel radius projected to the center of the column stub. The pins at the bottom of the A-frame legs are advisably similarly positioned in alignment with each other.

The described support system can be used to support vessels or tanks which are spherical, elliptical, or cylindrical and particularly those with hemispherical or hemielliptical ends. It is especially useful for supporting vessels or tanks having a circular horizontal section in the area where the rigid members are pivotally connected thereto because of the equal radial expansion of the vessel or tank about its vertical axis which can be expected.

The terms "vessel" and "tank" as used herein are deemed equivalents and no distinction is intended between the terms as respects the applicability or operability of the invention thereto.

Various changes and modifications of the invention can be made and will occur to those skilled in the art;

however, to the extent such variations incorporate the spirit of the invention, they are intended to be encompassed within the scope of the following claims.

What is claimed is:

- 1. The combination of a vessel and system for supporting the vessel comprising:
 - a vessel; and
 - a plurality of rigid members supporting the vessel; each of said rigid members being supported at the bottom on a base by at least two spaced-apart pivots; and
 - each of said rigid members being pivotally connected at the top to the vessel at spaced apart locations.

- 2. The combination of claim 1 in which at least three rigid members are spaced around the periphery of the vessel, and the pivotal connections of the rigid mem-

bers to the base and the vessel are by means of horizontal pins located substantially tangential to the vessel.

- 3. The combination of claim 2 in which the vessel is metal and is substantially circular in horizontal cross-section.

- 4. The combination of claim 2 in which the base is on a barge.

- 5. The combination of claim 2 in which the base is on a ship.

- 6. The combination of claim 2 in which the vessel is a refrigerated liquid storage vessel.

- 7. The combination of a vessel and system for supporting the vessel comprising:

- a vessel; and
- a plurality of at least three rigid A-frames supporting the vessel;

- each of said A-frames being supported at the bottom on a base by at least two pivots; and

- each of said A-frames being pivotally connected at the top to the vessel at spaced apart locations.

- 8. The combination of claim 1 in which at least four A-frames are spaced around the periphery of the vessel, and the pivotal connections of the A-frames to the base and the vessel are by means of horizontal pins located substantially tangential to the vessel.

- 9. The combination of a vessel and system for supporting the vessel comprising:

- a vessel; and
- a plurality of at least three rigid frames supporting the vessel;

- each of said rigid frames having a pair of legs spaced apart wider at the bottom than at the top and rigidly connected together;

- the bottom end of each leg being pivotally supported on a base; and

- the upper end of each frame being pivotally connected to the vessel at spaced apart locations.

- 10. The combination of claim 9 in which the frames are spaced approximately about the periphery of the vessel.

- 11. The combination of claim 9 in which the vessel is supported by at least four rigid frames.

- 12. The combination of claim 9 in which the vessel is substantially circular in horizontal cross-section.

- 13. The combination of claim 9 in which the base is on a barge.

- 14. The combination of claim 9 in which the base is on a ship.

- 15. The combination of claim 9 in which the vessel is a refrigerated liquid storage vessel.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,792,795 Dated February 19, 1974

Inventor(s) Orwill G. Sikora, David W. Culver, Willis J. Kircik

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 39, change "neclear" to --nuclear--;
column 4, line 30, change "bottomm" to --bottom--;
column 6, line 22, change "claim 1" to --claim 7--.

Signed and sealed this 25th day of June 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents