

[54] **CRYOGENIC LIQUID STORAGE SYSTEMS**

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[51] Int. Cl. B65d 25/00

[58] Field of Search 220/9 LG, 9 C, 15,
220/DIG. 24; 280/5 R, 5 G

[56]

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[57]

ABSTRACT

A liquid storage system which includes a double-walled container having a high capacity relative to its external dimensions and comprising an inner tank supported from an outer tank at opposite ends thereof. Associated with the container are a liquid level gauging system, an external manifold, and vent and liquid withdrawal lines.

5 Claims, 9 Drawing Figures

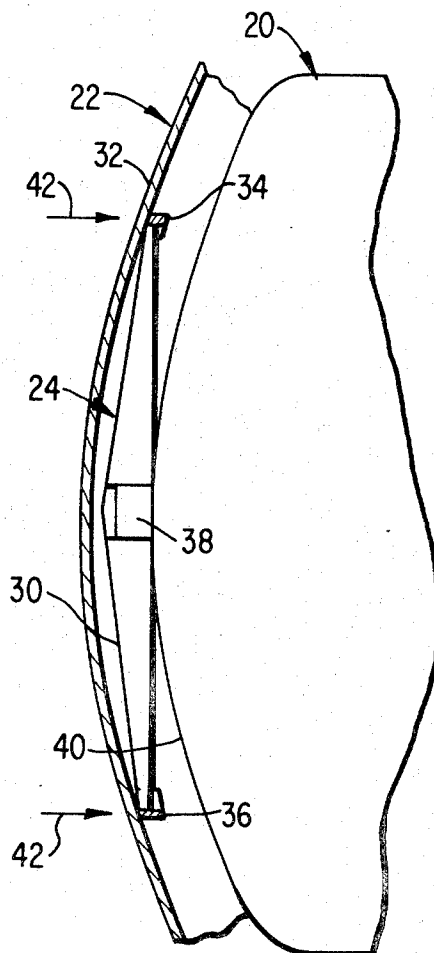


FIG. 1

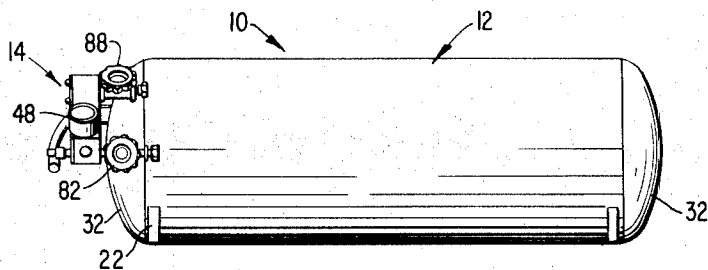


FIG. 3

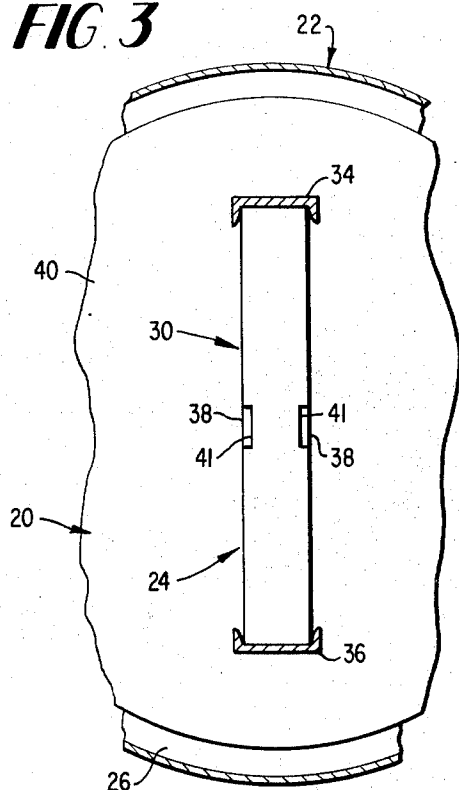


FIG. 2

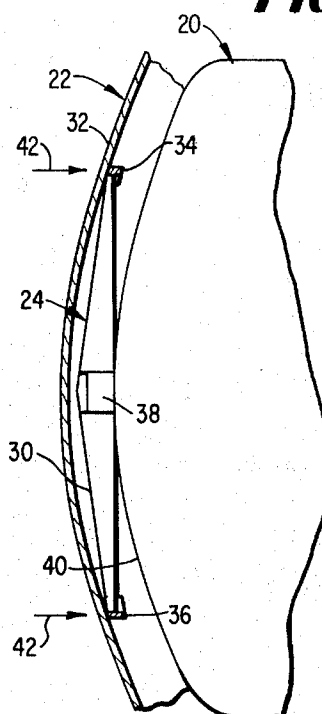
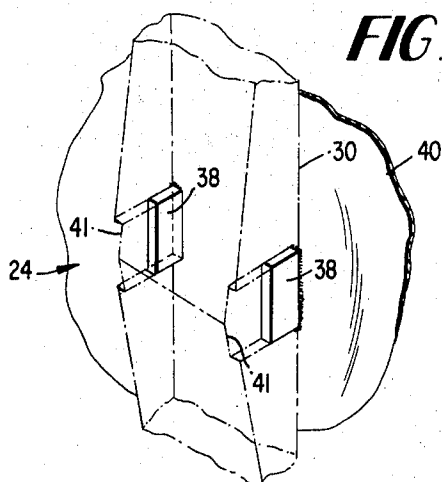
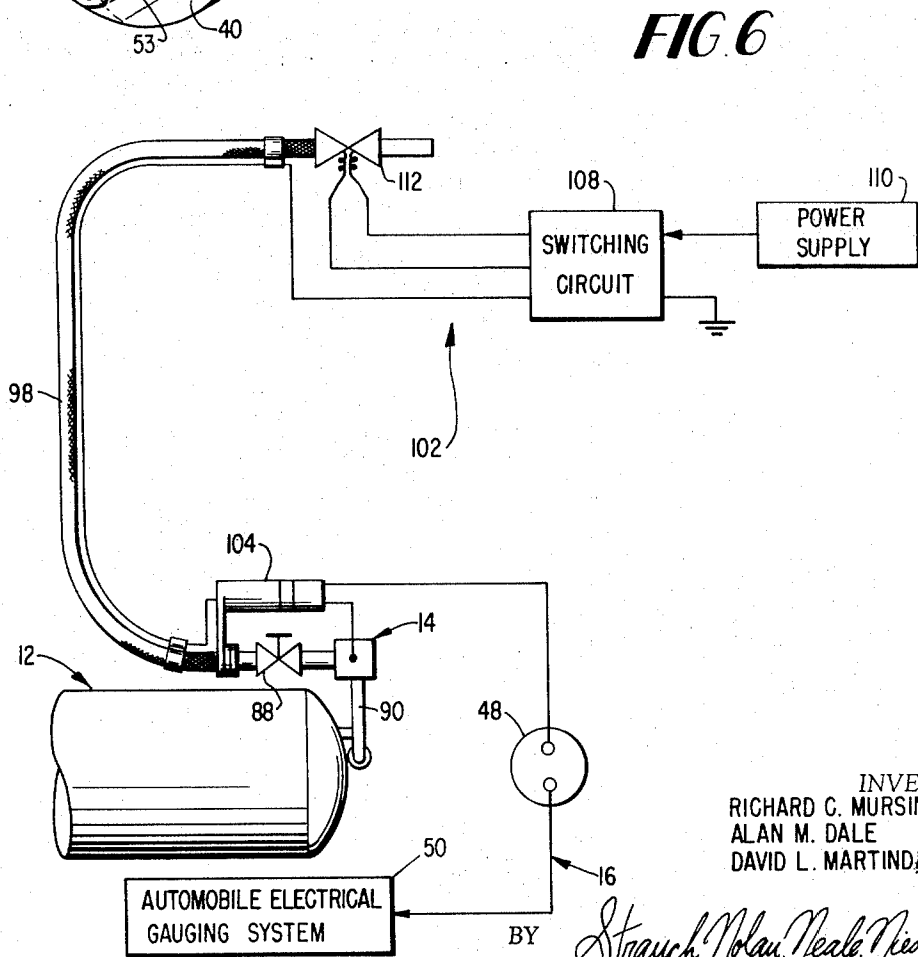
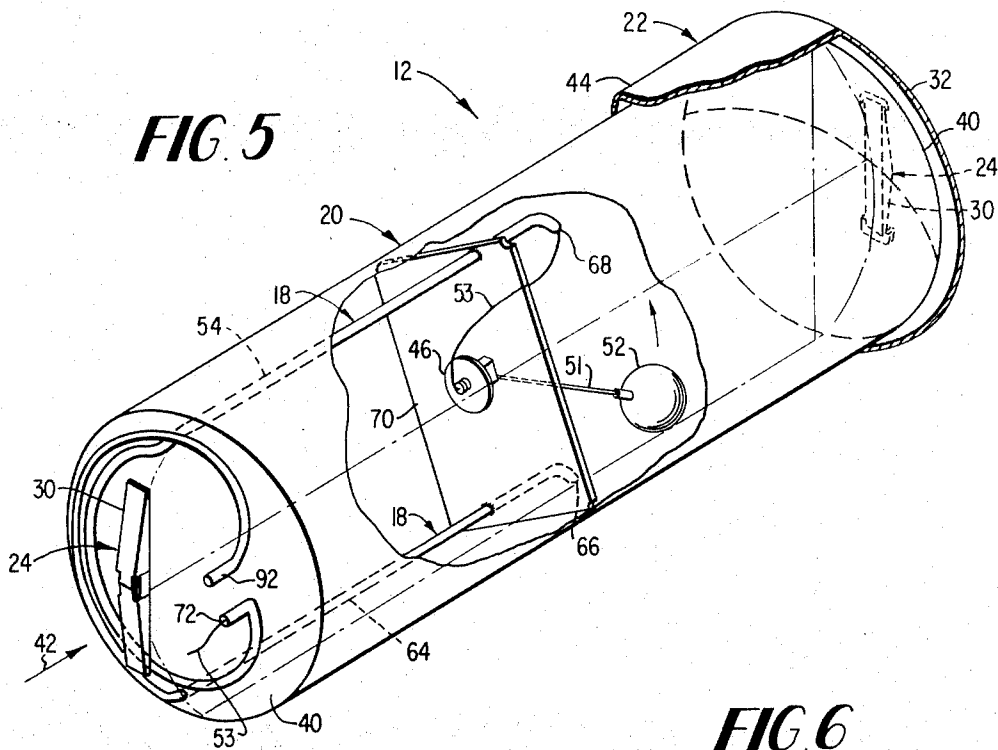


FIG. 4



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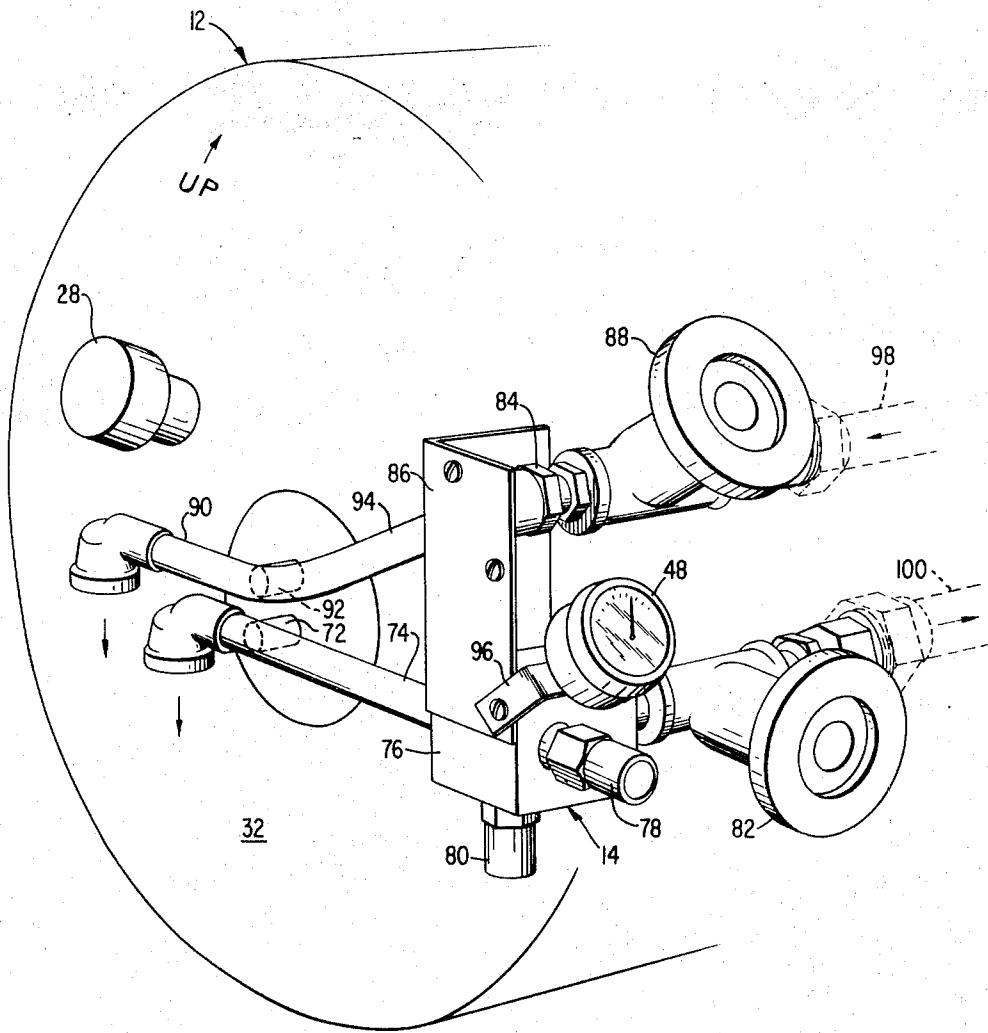
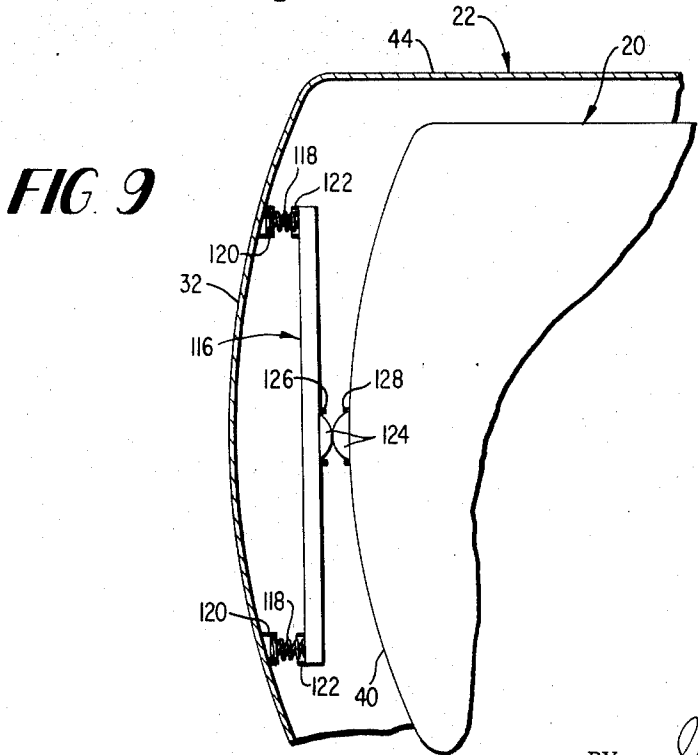
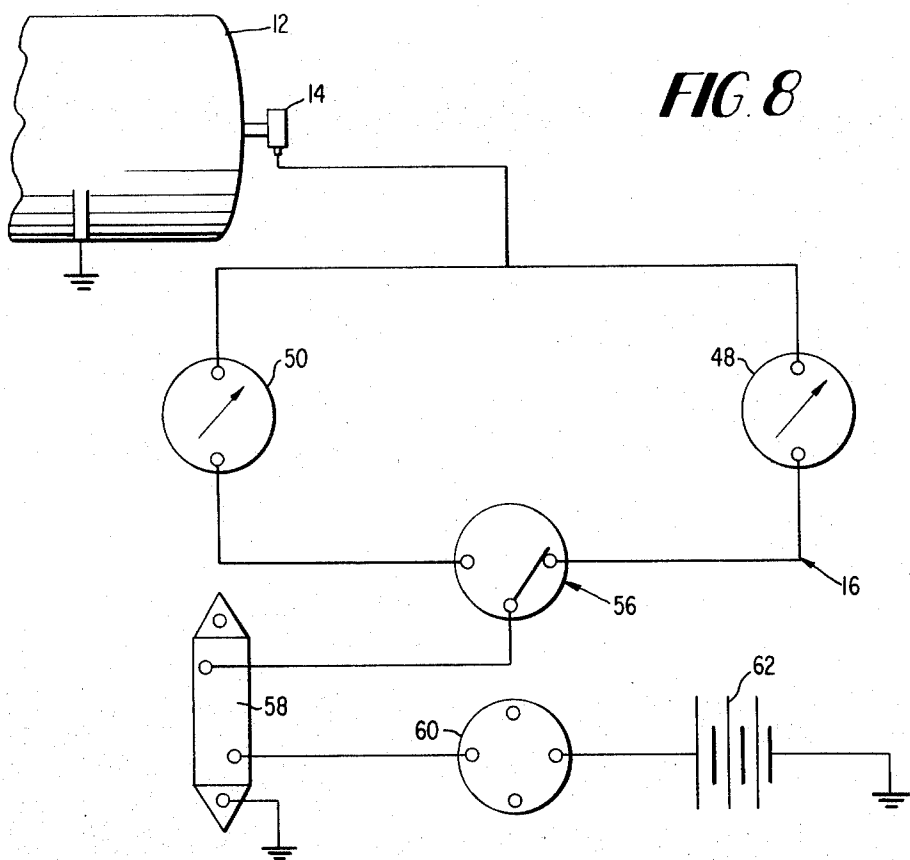


FIG. 7

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CRYOGENIC LIQUID STORAGE SYSTEMS

This invention relates to liquid storage systems, more specifically to storage systems for cryogenic liquids, and in particular to storage systems for cryogenic engine fuels.

Considerable attention is being devoted at the present time to the reduction of pollutants from automobiles and other vehicles. One approach of considerable promise is the substitution of liquified natural gas and similar cryogenic liquids for gasoline as the fuel for internal combustion engines as this reduces smog-producing emissions by as much as ninety percent.

Furthermore, liquified natural gas costs only about one-half as much as gasoline and produces only slightly lower mileage. Accordingly, fuel costs can also be reduced by using this fuel.

Cryogenic liquids present special handling and storage problems because of the extreme temperatures involved. While numerous systems for handling, storing, and transporting cryogenic liquids such as those shown in U. S. Pat. Nos. 2,858,136; 2,926,810; 2,952,380; 3,078,004; 3,080,086; 3,155,265; 3,163,313; 3,217,920; 3,240,377; 3,241,705; 3,425,585; 3,433,384; 3,446,388; 3,460,706; and 3,481,505 have been devised, these previously proposed systems are not satisfactory for use as vehicular fuel tanks, especially where dual fuel tanks are required. That is, liquified natural gas is not as yet universally available; and many vehicles converted to use this fuel are provided with dual fuel systems so that they can also be operated on gasoline when the need to do so arises. In the case of an automobile so equipped the tank for the liquified natural gas must as a matter of necessity be located in the trunk. This imposes strict requirements as far as the size of the fuel tank and other characteristics are concerned.

The novel cryogenic fuel storage and handling system of the present invention includes a cryogenic liquid storage tank of novel design which provides a maximum capacity for its size. As indicated above, this is particularly important in applications such as dual fuel passenger vehicles in which space must be found for a second fuel tank. The tanks of the present invention are so compact that they can typically be fitted in the space normally present behind the rear seat and over the rear axle of an automobile, thus utilizing what generally is more-or-less waste space.

Another advantage of our novel storage tank is that it has a very low heat leak. Also, it is less complicated than many, if not most, heretofore available cryogenic liquid storage tanks; and it is comparatively inexpensive to manufacture. Yet another advantage of this novel cryogenic liquid storage tank is that it can readily be made in sizes ranging from 5 to 2,000 gallons or more.

Our novel tank is equipped with an internal plumbing system of novel construction which minimizes fuel losses from the storage tank and also provides a back-up system to prevent overfilling of the tank during filling operations.

A further feature of the invention is a novel liquid level indicating system which is capable of operating accurately in the presence of cryogenic liquids and can provide liquid level indications both at the storage tank and at a remote location. This system is responsible for only a small heat leak into the cryogenic liquid storage

tank, which is also advantageous, and, further, is designed so that it can be employed to provide automatic shut-off of the fuel when the storage tank is filled. Furthermore, this system is simpler and less expensive than the typical liquid level indicating system currently in use in cryogenic applications.

Yet another important feature of the invention is a novel manifold arrangement which keeps frost from building up on valves, disconnects, and the like. This is important since frost on such components can cause considerable difficulty during filling operations.

From the foregoing it will be apparent that one important object of the present invention resides in the provision of novel improved systems for handling and storing cryogenic liquids.

Other more important, but more specific objects of the invention reside in the provision of novel, improved cryogenic liquid handling and storage systems:

1. that include a storage tank which has an optimized capacity-to-size ratio and can therefore be employed to particular advantage in applications where space is at a premium.
2. which, in conjunction with the preceding object, are particularly adaptable for vehicular use.
3. which are relatively simple and inexpensive to manufacture.
4. which have a very low heat leak and are therefore capable of minimizing fuel losses through boil-off or evaporation.
5. which employ a cryogenic liquid storage tank design that can be readily scaled up and down to provide tanks of different capacities.
6. which include primary and back-up systems for preventing overfilling during filling operations.
7. which include a system for automatically shutting off the flow of liquid to the storage container when it has been filled to a pre-selected level.
8. which include a novel manifold arrangement designed to prevent the build-up of frost on valves, disconnects, and other system components.
9. which include an arrangement for providing an indication of the level of cryogenic liquid in the storage container both at the container and at a remote location.
10. which have various combinations of the foregoing attributes.

Other important objects and features and further advantages of the invention will become apparent from the appended claims and as the ensuing detailed description and discussion proceeds in conjunction with the accompanying drawing, in which:

FIG. 1 is a side view of a cryogenic liquid handling and storage system in accord with the principles of the present invention;

FIG. 2 is a partial side view of a double-walled or jacketed cryogenic liquid storage container employed in the system of FIG. 1, the outer tank or container member being sectioned to show the manner in which the inner tank or container member is supported from it;

FIG. 3 is a partial end view of the storage container, the outer tank again being sectioned to show the arrangement by which the inner tank is supported from it;

FIG. 4 is a partial pictorial view of one end of the inner tank and the support arrangement;

FIG. 5 is a pictorial view of the storage container with portions of both the inner and outer tanks being broken away to show the system components located inside the inner tank;

FIG. 6 is a diagrammatic illustration of an arrangement for filling the storage container and for automatically terminating the flow of cryogenic liquid to the container when the liquid therein reaches a pre-selected level;

FIG. 7 is a pictorial view showing part of the cryogenic liquid storage container and a manifold arrangement included in the liquid handling and storage system;

FIG. 8 is a wiring diagram of a liquid level indicating arrangement incorporated in the liquid handling and storage system; and

FIG. 9 is a view similar to FIG. 2 showing an alternate arrangements for supporting the inner tank of the cryogenic liquid storage container from the outer tank thereof.

Referring now to the drawing, FIGS. 1, 5, and 6 depict a cryogenic liquid handling and storage system constructed in accord with the principles of the present invention. The major components of this system are a jacketed or double-walled cryogenic liquid storage container 12; a manifold arrangement 14 for filling and venting container 12; a system 16 for providing a visual indication of the level of liquid in container 12 and for automatically shutting off the flow of liquid to the container during filling operations when the liquid in the container reaches a selected level; and an internal plumbing system identified generally by reference character 18 in FIG. 5.

One of the novel features of the present invention is storage container 12, which is designed to have a maximum capacity for its size and which has a number of other desirable attributes including simplicity and a low heat leak and is relatively inexpensive to manufacture. Referring now to FIGS. 2-5, container 12 includes an inner tank 20 supported from an outer tank 22 by two identical support arrangements 24. The space 26 between the inner and outer tanks is filled with Superinsulation or the like and a getter (typically activated charcoal and palladium oxide) and then evacuated through a vacuum pump-out and relief port 28. This is conventional for doubled-walled cryogenic liquid containers and will accordingly not be elaborated upon herein.

Each of the novel assemblies 24 supporting inner tank 20 from outer tank 22 includes a tapered, simply loaded beam 30 end-supported from one of the heads 32 of outer tank 22 in channel members 34 and 36. Inner tank 20 is supported from the beam 30 of each support assembly by a pair of flanges 38 which are fixed to the heads 40 of the inner tank and extend into recesses 41 on opposite sides of each beam 30.

In fabricating container 12, inner tank 20 is assembled in outer tank 22 through one end of the latter (for example, the left-hand end as shown in FIG. 5). The left-hand head 32 of the outer container is then placed in position, and force is applied to it in the direction indicated by arrow 42 in FIGS. 2 and 5. This preloads the beams 30 of the two support assemblies. The head is then welded to the body 44 of the outer tank and the space 26 between the two tanks evacuated in the manner discussed above.

It will be apparent from the foregoing that heat is conducted from the ambient environment to the liquid

in inner tank 20 through the beams 30 of support systems 24. Accordingly, these beams are fabricated of a material having low thermal conductivity. One suitable material is Formica FF-95, which is fabricated from woven glass fabric bonded together by an epoxy resin.

In addition to low thermal conductivity (0.23 BTU/hr/ft/°F.) this material has high strength. As the thermal conductivity of a member is proportional to its cross-sectional area, this property further minimizes the leak of heat into inner tank 20 through the two support systems since the cross-sectional area of the beams can be kept relatively small.

Another advantage attributable to the use of a high strength material is that beams 30 may be tapered as shown in FIG. 2 to fit into the dished or annular spaces between the heads 40 and 32 of the inner and outer tanks. This minimizes the head space between the two tanks, and thereby reduces the overall size of a container needed for an inner tank of given capacity. This head space will typically be only 1 inch at the manifold end of the container and 0.75 inch at the other end.

Container 12 is intended to be mounted in a vehicle or elsewhere with the beams 30 of supporting systems 24 vertically oriented. Accordingly, these beams act as columns in supporting vertical loads. They act as simply supported beams in carrying bending loads. Bending stresses are minimized by the orientation of the maximum moments of inertia of the beams.

The beams are preloaded in the manner discussed above to accommodate the shrinkage of inner tank 20 as it is chilled by the cryogenic liquid in it. That is, the preloading of the beams deforms them to a more-or-less bowed configuration. As the inner tanks shrink, the beams tend to relax or straighten out and keep inner tank supports 38 fully seated in the recesses 41 formed in the beams.

Because of their resiliency, beams 30 also absorb axial loads, which are limited by the spacing between the beams and the heads of outer tank 22. For a container having a capacity in the range of 15-20 gallons, this distance will typically be on the order of one-eighth inch. As the capacity of the container increases, this distance will typically be larger.

Inner tank 20 is prevented from rotating in outer tank 22 by the engagement of flanges 38 against the opposite sides of beams 30. This arrangement, together with that by which beams 30 are supported from the heads 32 of outer tank 22 also automatically centers and aligns the inner and outer tanks as they are assembled.

As discussed above, one of the applications for which container 12 is particularly adapted is as a vehicular tank for cryogenic liquid fuels. In this application, a system capable of providing an accurate indication of the level of liquid in tank 12 is required. In addition, the connections between the interior of inner tank 20 and the ambient environment must be such as to minimize heat leaks through them into the inner container. One of the common drawbacks of liquid level gauging systems heretofore available for cryogenic containers is that they allow an excessive leakage of heat into the cryogenic liquid container.

Referring now to FIGS. 5 and 9, liquid level gauging system 16 is capable of providing an accurate indication of liquid level and of minimizing heat input into container 12. This system is of generally the same construction as the liquid level gauging system disclosed in U.S. Pat. No. 2,923,156 issued Feb. 2, 1960, to Robert

M. Young for LIQUID LEVEL INDICATING SYSTEMS. However, it differs from the latter in several important respects as will become apparent hereinbelow.

As shown in the figures just mentioned, liquid level gauging system 16 includes a float-operated rheostat type transmitter 46 disposed within inner tank 20, a tank mounted liquid level gauge 49, and a liquid level gauge 50 which is typically mounted on the dash of a vehicle, for example. The sliding contact (not shown) of transmitter 46 is connected to an arm 51 having a float 52 attached to its lower or outer end. Accordingly, as the level of liquid in inner tank 20 changes, float 52 rises and falls and varies the position of the rheostat contact to vary the magnitude of the transmitter output signal.

One of the requirements of float 52 is that it be capable of impacting against inner tank 20 without collapsing. Also, it must be capable of resisting relatively high external pressures (typically on the order of 150 psi and up) without collapse. Further, liquified natural gas and similar cryogenic liquids have a quite low density. Accordingly, the float must have a high order of buoyancy so that it will be capable of actuating the sliding contact of transmitter 46.

Also, float 52 must be capable of withstanding a wide temperature range. The interior of inner tank 20 may reach well over 300° F. while the space 26 between the inner and outer tanks is being evacuated. On the other hand, the float may be subjected to temperatures of minus 260° F. and lower after inner tank 20 is filled with cryogenic liquid.

One float found satisfactory is a 3.5 inch diameter sphere having a 0.05 inch thick wall and weighing a maximum of 3.0 ounces. This float is manufactured by the Chicago Float Works.

The single connection between the transmitter 46 of the liquid level gauging system and the exterior of container 12 is an electrical conductor 53. Furthermore, this conductor extends to the exterior of container 12 through vent line 54 and, consequently, does not require a separate connection through the walls of the container tanks. As a result, the liquid level indicating system contributes only about one-half of a BTU per hour to the input of heat into inner tank 20.

The tank-mounted and remote gauges 48 and 50 are connected in parallel between lead 53 and a signal pole, double throw switch 56. The switch is in connected through a regulator 58 and (typically) an ignition switch 60 to a vehicle power supply 62. Regulator 58 and gauges 48 and 50 of suitable construction are available from a number of sources including Teleflex Corporation. Switch 56 is provided so that either tank-mounted gauge 48 or remote gauge 50 are connected to power supply 62. By employing this arrangement rather than having both gauges continuously connected in the circuit, the power requirements of the liquid level gauging system are halved.

Liquid level gauging system 16 operates essentially in the manner described in U.S. Pat. No. 2,923,156. That is, as the level of liquid in inner tank 20 changes, the resistance across transmitter 46 changes as discussed above, producing a varying voltage signal at one of the two gauges 48 and 50 to change the reading shown by the gauge.

As will be apparent from the foregoing, reduction of heat leakage into the cryogenic liquid storage container is emphasized in our invention. This minimizes boil-off

and, consequently, the pressure in the storage container will increase slowly. This is particularly important in vehicular fuel tank applications since the vehicle can be parked for an extended period of time before the pressure will increase to the point that it will actuate the relief valves. This results in low fuel loss especially when the vehicle is not being used --4 percent per day for smaller tanks and as low as 2 percent per day for larger ones.

As is well-known to those skilled in the arts to which the present invention relates, provision must be made for withdrawing cryogenic liquid and ullage gas from the cryogenic liquid container in applications of the type disclosed herein. In addition, it is necessary to provide for venting the container to prevent excessive pressure buildup. In the present invention liquid is withdrawn from the container 12 through a liquid withdrawal conduit or line 64 which extends from a downturned inlet 66 generally parallel to the bottom of the container through its left-hand heads 40 and 32. Vent line 54 similarly extends from downturned inlet 68 through the container in parallel relation to its side wall and through heads 40 and 32. Conduits 54 and 64 together with the other components of the liquid handling and storage system will typically be made of stainless steel as this material has a high degree of structural integrity at cryogenic temperatures, but relative low heat conductivity.

The inlet 66 to the liquid withdrawal line is positioned to allow the withdrawal of the maximum amount of liquid from container 12.

The inlet 68 to vent line 54 will, in a typical application of the invention, be located at about the 90 percent full level. This maintains an optimum ullage or gas space above the cryogenic liquid in container 12. This ullage space must be left, especially in vehicular applications, to accommodate boil-off when the vehicle is parked. Moreover, the downturned inlet keeps liquid from sloshing into the vent line. This is important because liquid is a much better heat conductor than gas. Therefore if the line filled with liquid, there would be a rapid and pronounced leakage of heat into inner tank 20.

Also, as the tank is filled with cryogenic liquid and the liquid rises to the 90 percent level, the cryogenic liquid will flow into vent line 54. This provides a visual signal that the tank has been filled to the maximum level. This provides a back-up to liquid level indicating system 16 for filling operations.

As shown in FIG. 5, liquid level withdrawal line 64 and vent line 54 support a generally rectangular anti-slosh baffle 70 in inner tank 20 intermediate its ends. This baffle performs the usual function of keeping liquid from sloshing back and forth in tank 20. In addition, it supports the transmitter 46 of the liquid level gauging system.

Turning now to FIG. 7, the outlet end 72 of vent line 54 communicates with a conduit 74 through which ullage gas is supplied to the engine of the vehicle in which the cryogenic liquid handling and storage system is installed. Conduit 74 also communicates with an internal passage (not shown) in a block 76 incorporated in manifold 14. Block 76 provides communication between conduit 74 on one hand and relief valves 78 and 80 and a manual shut-off valve 82 on the other. Relief valves 78 and 80 are of conventional construction and

open automatically when the pressure in the inner tank 20 of container 12 exceeds a selected level.

As indicated above, vent line 54 may also be employed to provide a visual indication that the level of cryogenic liquid in inner container 20 has reached the selected level during filling operations. More specifically, valve 82 is opened while container 12 is being filled. When the liquid in the tank reaches the selected level, it will flow through vent line 54, ullage gas line 74, and manifold block 76 and out valve 82, providing at least a gross indication that the tank has been filled to the desired level.

Also included in manifold 14 is a fitting 84 supported from block 76 as by a bracket 86. A manual liquid fill valve 88 is connected to one end of fitting 84. The other end of the fitting is connected through a liquid fuel supply line 90 to the outlet 92 of the liquid withdrawal line 64 described above. As shown in FIG. 7, line 90 has an upwardly sloping portion 94 between the outlet end of conduit 64 and the connection to fitting 84. This provides a vapor trap which keeps frost from building up on valve 88. As indicated above, this is a feature of considerable importance since frost build-up can make it difficult to open and close valve 90 and, also, to connect the cryogenic fuel supply hose (identified by reference 98 in FIG. 7) to the valve.

In addition to performing the foregoing functions, manifold 14 also provides a convenient mount for the tank-associated liquid level gauge 48 which may be attached to manifold bracket 86 as by supporting strap 96. This is by no means critical, however; and gauge 48 may be mounted elsewhere on container 12, if desired.

To fill or charge the inner tank 20 of container 12, liquid supply and vent hoses or lines 98 and 100 are coupled to valves 88 and 82, respectively; and the valves are opened. This allows the cryogenic liquid to be pumped through hose 98, valve 88, fitting 84, line 90, and line 64 into container 20. By watching gauge 48, the operator can ascertain when the liquid in the tank has reached the desired level at which point he closes valves 88 and 82 and disconnects the fill and vent hoses. Also, as mentioned above, liquid flowing out of the vent valve through hose 100 will provide an additional indication that the tank is full.

Alternatively, the liquid level indicating system may be employed to provide a signal which will automatically shut off the supply of liquid to container 12 when the liquid in inner tank 20 reaches the desired level.

One automatic fill system in accord with the present invention is shown in schematic form in FIG. 6 and identified by reference character 102. In addition to the transmitter 46 described above, this system includes an electrical disconnect 104. In this embodiment of our invention, transmitter 46 is connected to gauges 48 and 50 through disconnect 104. When fill hose 98 is connected to valve 88 in this embodiment of the invention, disconnect 104 electrically disconnects transmitter 46 from gauges 48 and 50 and connects it through switching circuit 108 to an external power supply 110.

During the filling operation, the solenoid 112 of a shut-off valve 112 is energized from external power supply 110 through switching circuit 108. As the level in inner tank 20 reaches the desired level, the signal from transmitter 46 activates the switching circuit to interrupt the supply of electrical energy to the valve solenoid and thereby close the shut-off valve.

The details of switching circuit 108 are not part of the present invention, and a number of handbook circuits which will perform the functions just described are available. Accordingly, it is not believed necessary to describe this circuit further herein.

When shut-off valve 112 closes, disconnect 104 is uncoupled and fill hose 98 disconnected from valve 88 to complete the tank charging or filling operation. At the same time, the uncoupling of the disconnect reconnects transmitter 46 of the liquid level indicating system through the tank-mounted and remote gauges 48 and 50 to vehicle power supply 62.

Many modifications may of course be made in the exemplary embodiment of the invention described above without exceeding the scope of the invention. For example, as shown in FIG. 9, the resilient inner tank supporting beams 30 described above may be replaced with rigid beams 116 and springs employed to absorb axial loads. In the specific arrangement shown in FIG. 9, coil type springs 118 extending between seats 120 fixed to the heads 32 of outer tank 22 and seats 122 fixed to the beams are employed together with Belleville springs 124. The latter are supported by seats 126 on beams 116 and seats 128 on the heads 40 of inner tank 20. Other combinations of coil and Belleville springs or all Belleville or all coil springs may instead be employed, if desired.

Still other modifications of the illustrated structure will readily occur to those skilled in the arts to which the present invention relates. To the extent that such modifications are not expressly excluded from the appended claims, they are fully intended to be covered therein.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by Letters Patent is:

1. A double-walled fluid container, comprising: an inner tank; an outer tank surrounding and completely spaced from the inner tank; and first and second means for supporting said inner tank from said outer tank at opposite ends of the inner tank and for accommodating axial movement of said inner tank relative to said outer tank as the temperature of the inner tank relative to that of the outer tank decreases and the inner tank contracts relative to the outer tank; said first and second supporting means each comprising an elongated beam of elastically deformable material having low thermal conductivity disposed midway between opposite sides of and extending across the inner and outer tanks at said one end of said fluid container, the ends of said beam being spaced radially inwardly from opposite edge portions of the end of the outer tank; support means fixed to the inner tank and free of attachment to but so engaged with said beam intermediate its ends as to support said inner tank from and prevent it from rotating with respect to the beam; and means fixed to the outer tank and engaged with said beam at the opposite ends thereof to support said beam from and to prevent it from rotating with respect to the outer tank, said

beam being elastically deformed toward the outer tank intermediate the ends of the beam to an extent such that, as the inner tank contracts and the distance between the inner and outer tanks increases, said beam can restore toward its undeformed configuration to an extent sufficient to maintain the engagement between said beam and the supporting means fixed to the inner tank.

2. A double-walled fluid container, comprising: an inner tank; an outer tank surrounding and completely spaced from the inner tank; and means supporting said inner tank from said outer tank at opposite ends of the inner tank and for accommodating axial movement of said inner tank relative to said outer tank as the temperature of the inner tank relative to that of the outer tank decreases and the inner tank contracts relative to the outer tank; the supporting means at at least one end of the fluid container comprising a vertically extending, elongated beam of elastically deformable material having low thermal conductivity disposed between said inner and outer tanks and located midway between the sides of the container; and support means fixed to the inner tank and free of attachment to but so engaged with said beam intermediate its ends as to support said inner tank from and prevent it from rotating with respect to the beam; and means fixed to the outer tank and engaged with said beam at the opposite ends thereof to support said beam from and to prevent it from rotating with respect to said outer tank, said beam being elastically deformed toward the outer tank intermediate the ends of the beam to an extent such that, as the inner tank contracts and the distance between the inner and outer tanks increases, said beam can restore toward its undeformed configuration to an extent sufficient to maintain the engagement between said beam and the supporting means fixed to the inner tank.

3. A double-walled fluid container, comprising: an inner tank; an outer tank surrounding and completely spaced from the inner tank; and means for supporting said inner tank from said outer tank at opposite ends of the inner tank and for accommodating axial movement of said inner tank relative to said outer tank as the temperature of the inner tank relative to that of the outer tank decreases and the inner tank contracts relative to the outer tank; the supporting means at at least one end of the fluid container comprising a vertically extending, elongated beam of elastically deformable material having low thermal conductivity disposed between said inner and outer tanks and located midway between the sides of the container; a pair of laterally spaced sup-

ports extending from the inner tank toward the outer tank, said supports being free of attachment to but so engaged with said beam at opposite sides thereof as to support said inner tank from and prevent it from rotating with respect to said beam; and a pair of vertically spaced apart support members fixed to the outer tank, the ends of said beam being engaged with said support members to support said beam from and to prevent it from rotating with respect to said outer tank, said beam being elastically deformed toward the outer tank intermediate the ends of the beam to an extent such that, as the inner tank contracts and the distance between the inner and outer tanks increases, said beam can restore toward its undeformed configuration to an extent sufficient to maintain the engagement between said beam and the supporting means fixed to the inner tank.

4. A double-walled fluid container, comprising: an inner tank; an outer tank surrounding and completely spaced from the inner tank; and means for supporting said inner tank from said outer tank at opposite ends of the inner tank and for accommodating axial movement of said inner tank relative to said outer tank as the temperature of the inner tank relative to that of the outer tank decreases and the inner tank contracts relative to the outer tank; the supporting means at at least one end of the fluid container comprising an elongated beam of elastically deformable material having low thermal conductivity disposed midway between opposite sides of and extending across the inner and outer tanks at said one end of said fluid container, the ends of said beam being spaced radially inwardly from opposite edge portions of the end of the outer tank; support means fixed to the inner tank and free of attachment to but so engaged with said beam intermediate its ends as to support said inner tank from and prevent it from rotating with respect to the beam; and means fixed to the outer tank and engaged with said beam at the opposite ends thereof to support said beam from and to prevent it from rotating with respect to said outer tank, said beam being elastically deformed toward the outer tank intermediate the ends of the beam to an extent such that, as the inner tank contracts and the distance between the inner and outer tanks increases, said beam can restore toward its undeformed configuration to an extent sufficient to maintain the engagement between said beam and the supporting means fixed to the inner tank.

5. The container of claim 3, wherein the space between said inner and outer tanks is evacuated.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,764,036 Dated October 9, 1973

Inventor(s) Richard C. Mursinna et al

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

Column 3, line 22, after "system: insert --10--.
Column 4, line 62, change "9" to --8--.
Column 5, line 7, change "49" to --48--.
Column 6, line 29, after "line" insert --64--.
Column 7, line 24, change "90" to --88--.
Column 7, line 61, after "solenoid" cancel --112--.
Column 8, line 57 (Claim 1) change "opposite" to --opposite--.
Column 8, line 58 (Claim 1) change "said one" to --the
associated--.
Column 9, line 22, after "container" delete --and--.
Column 10, line 48 (Claim 5) change "claim 3" to --claim 4--.

UNITED STATES PATENT OFFICE Page 2
CERTIFICATE OF CORRECTION

Patent No. 3,764,036 Dated October 9, 1973

Inventor(s) Richard C. Mursinna et al

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

Column 5, line 37, delete "of"(second occurrence).

Column 5, line 47, "in" should be deleted.

Column 6, line 42, after "therefore" insert a comma (,).

Column 7, line 28, correct the spelling of "convenient".

Signed and sealed this 7th day of May 1974.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents