Sept. 13, 1966 K. R. LEONARD 3,272,579

CRYOGENIC STORAGE VESSEL WITH STATION SELECTOR

Filed Aug. 24, 1964 2 Sheets-Sheet 1

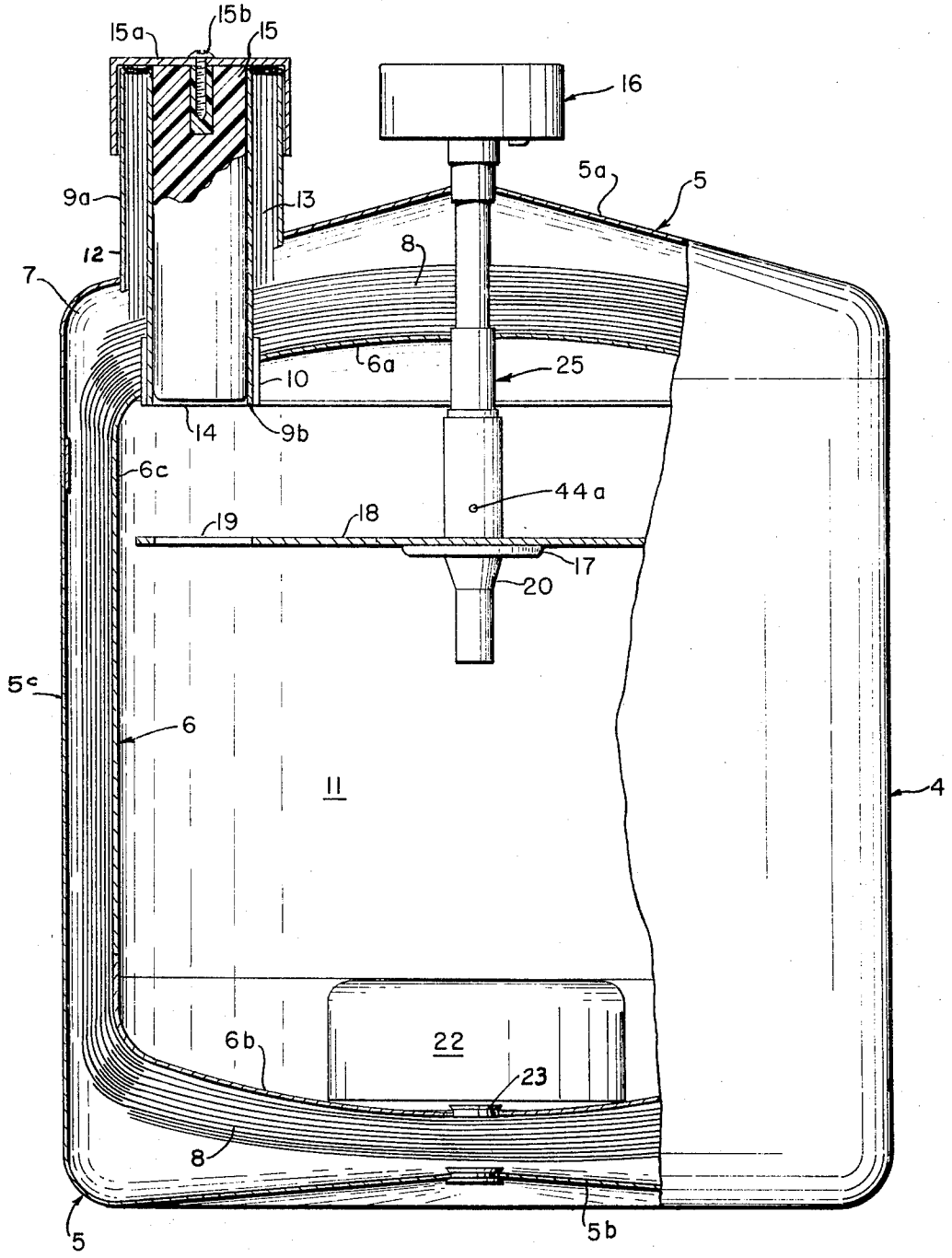


Fig. 1

INVENTOR.
Kenneth R. Leonard
BY
Mc Grew and Edwards
ATTORNEYS

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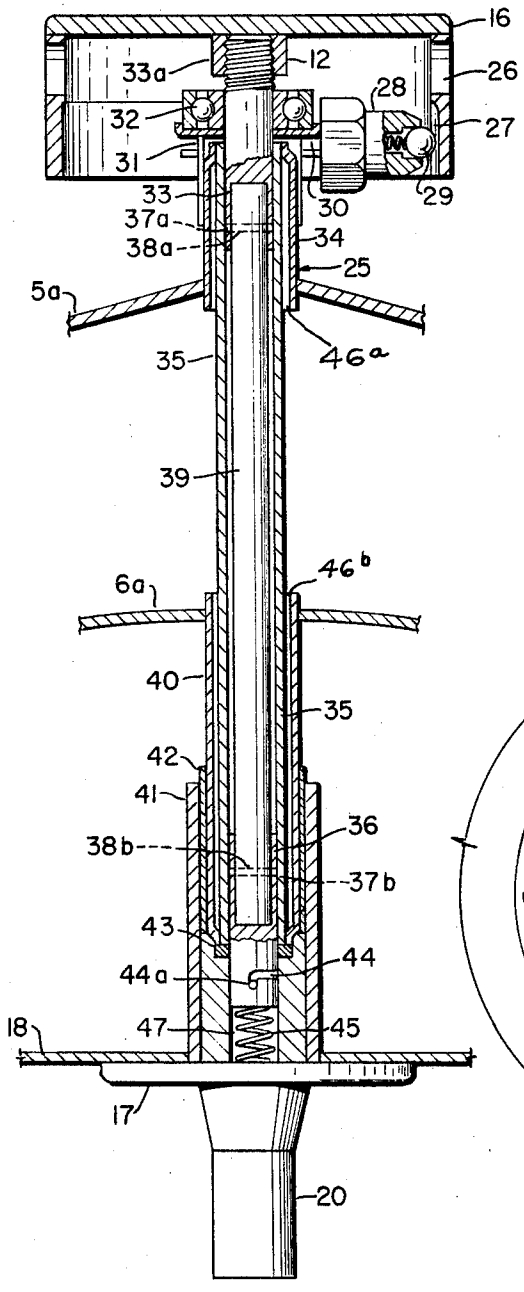


Fig. 2

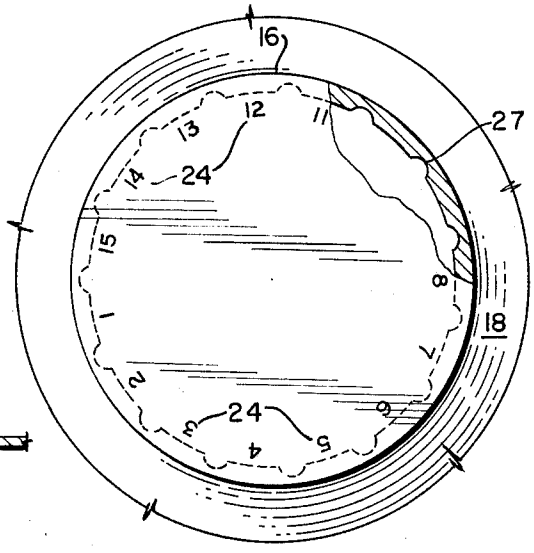


Fig. 3

INVENTOR.
Kenneth R. Leonard
BY
McGraw & Edwards
ATTORNEYS

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3,272,579

CRYOGENIC STORAGE VESSEL WITH STATION SELECTOR

Kenneth R. Leonard, Boulder, Colo., assignor to Cryogenic Engineering Company, Denver, Colo., a corporation of Colorado

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11 Claims. (Cl. 312—214)

This invention relates to cryogenic storage vessels of the upright type and relates more particularly to cryogenic storage vessels having a multiplicity of refrigerated article containers arranged for selective insertion into and withdrawal from its interior.

This application includes features disclosed but not claimed herein, which have been claimed in the copending application of Reynolds et al. Ser. No. 138,758, filed Sept. 18, 1961 for Cryogenic Type Thermally-Insulated Container, and owned by the assignee of this application.

Cryogenic storage vessels are used in the storage of biologic specimens and other perishable material which can be maintained for subsequent use by freezing or immersion in cryogenic fluids which maintain the required low temperature condition over protracted periods of time. A typical example is the storage of artificial insemination specimens in ampules which are immersed in a cryogenic fluid, such as liquid nitrogen, and preserved for a period of two or three months before usage.

Under the prior art practice known to applicant, as exemplified in U.S. Patents Nos. 3,052,370, 3,034,845 and 1,937,877, such ampules with some form of identification designation are stored in canisters submerged in the cryogenic fluid. In the Reynolds et al. application Ser. No. 138,758, a rotary article support is disclosed with individual stations of the support movable into register with an access opening extending into the inner container from an elongated neck portion mounted at the top of the outer member. Rotation of the support permits selective station positions adjacent the periphery of the article support to be brought into register with the access opening.

Under the prior art practice, if articles were to be inserted into or removed from a canister supported in a given station, the neck plug had to be removed before station selection permitting heat inleak while a desired canister was located and moved to an accessible position where ampules could be inserted or removed while the access passage remained open. Sometimes this involved considerable fishing and time delay with excessive heat transfer while the passage remained open.

The present invention is a departure from prior art practices in several respects. It provides means for bringing a preselected support station into register with the access opening before removing the plug from the opening, thus preventing heat inleak until the manipulations of inserting or removing articles is to begin. Another innovation is the provision for a suspending support of the rotary parts from the top of the container, inclusive of an external bearing arrangement eliminating internal bearings, and simplifying bearing repair or replacement.

Accordingly, it is an object of my invention to provide a simple, durable and efficient cryogenic storage container, in which interior storage positions are determinable from outside of the container, and which stations are movable into register with the access opening before such opening is unplugged for access.

Another object of my invention is to provide a novel and efficient support system for rotary parts within a cryogenic storage container.

A further object of my invention is to provide a bearing assembly for interior rotary parts which is located outside the cold zone of a cryogenic storage container, and which is accessible for service or repair from the outside of the container without change in other interior parts.

Other objects reside in novel details of construction and novel combinations and arrangements of parts, which will be set forth in the course of the following description.

The practice of my invention will be described with reference to the accompanying drawings illustrating a typical structural embodiment. In the drawings, in the several views of which like parts bear similar reference numerals:

FIG. 1 is a front elevation, partially broken to show interior parts in section, of a cryogenic storage container utilizing features of my invention;

FIG. 2 is a fragmentary, enlarged vertical section of the station selector and shaft assembly shown in FIG. 1; and

FIG. 3 is a stop plan view of the station selector of FIG. 2, partially broken to show interior structure.

As shown in FIG. 1, the cryogenic storage container **4** comprises an outer member **5** and an inner container **6** supported by and spaced from outer member **5** to define an evacuated insulation space **7** surrounding inner container **6**. Suitable insulation material, here shown as laminar insulation **8**, substantially fills insulation space **7**. Container **6** has an integral upwardly curved top portion **6***a* and an integral downwardly curved bottom portion **6***b* with interconnecting cylindrical slides **6***c*. The outer member has cylindrical sides **5***c* interconnecting an inverted dishshaped bottom portion **5***b* and an arched or peaked top portion **5***a*. This arrangement provides more thickness to the insulation space at the top and bottom of container **4** and a lesser and uniform thickness to the space along the sides of the container.

An access opening for container **6** is provided by a double-walled structure mounted on top portion **5***a*. The outer wall **9**a of this structure is secured on top **5***a* by welding and interconnects at the top with a hollow inner wall **9***b* which is welded to a sleeve **10** extending through and welded to top **6***a* of inner container **6**. Preferably the wall **9***b* is formed of a composition which is a poor heat-conductor, such as high nickel steel, sold commercially as "Hastalloy B." The lower ends of walls **9***a* and **9***b* are not connected, leaving an entrance into evacuated space **7** and the space between walls **9***a* and **9***b* is filled with suitable insulation **13** and is evacuated at the same time space **7** is evacuated. The interior passage of hollow wall **9***b* provides an access opening **14** which is normally closed by a plug member **15** of insulating material which is bolted to a cap portion **15***a* as shown at **15***b*. The cap portion **15***a* provides a convenient gripping surface for handling the plug in insertion or removal operations.

Top portions **5***a* and **6***a* are apertured centrally to contain a suspended shaft assembly **25**, arrangement of which will be described hereinafter. A station selector **16** is mounted at the upper end of the shaft assembly in overhanging relation to top portion **5***a* and a hub **17** provides a seat for a disc-like platform **18** disposed in the upper portion of inner container **6**. Platform **18** has a series of circumferentially-spaced openings **19** at its periphery which function as article-support stations. A lower end portion **20** of the shaft assembly **25** is secured on hub **17** for rotation therewith and provides additional support for platform **18** and supported canisters (not shown) which are suspended through openings **19** in platform **18**. A chamber **22** on bottom **6***b* is sealed from the interior of container **6** and has an opening **23** into insulation space **7**. A charge of absorbent getter, such as charcoal (not

shown), is placed in chamber 22 to assist in maintaining the desired vacuum in insulation space 7.

As shown in FIG. 3, station selector 16 has indicia 24 on its top surface, preferably comprising numerical designations of station positions on platform 18. Manual rotation of selector 16 will bring a designated station into register with access opening 14, and this can be done while plug 15 remains in place in the access opening, thereby preventing heat inleak during such selection. Passage 14 is normally closed by plug 15 which preferably is composed of a heat-insulating plastic, such as a foam plastic, that minimizes heat inleak when the passage is closed.

In use, the interior space 11 of inner container 6 is filled with a cryogenic liquid, such as liquid nitrogen, to approximately the level of the bottom of access opening 14. The canisters supported on platform 18 are substantially submerged in the liquid and preferably have perforate bottoms permitting free circulation of the cryogenic liquid while confining stored articles in the interior as described in Ser. No. 138,758. When a selected station 19 has been brought in register with access opening, plug 15 is withdrawn to permit insertion or removal of material, after which the plug is returned to its passage-closing position. Heat inleak is kept to a minimum because of reducing the time in which the plug is removed.

The shaft assembly and the relation of its components to the station selector 16 have been shown in FIG. 2. The selector preferably is cylindrical and closed at its top with knurled sides to facilitate grasping. Two openings 26 at approximately 180° provide access to the interior, as for lubricating, and an open bottom permits access to interior components for installation and demounting. The inner side wall of selector 16 has circumferentially spaced recesses 27 corresponding to the number of stations on platform 18 and a spring-urged ball 29 carried at the outer end of an adjustable nut member 28 is moved into selected engagement with a recess according to a determination made by viewing indicia 24.

The nut 28 is mounted on a threaded member 30 secured on a stationary bearing housing 31. Ball bearings 32 journal the upper end of a shaft adapter 33 for rotation imparted by manual turning of selector 16. The bearing housing 31 is secured on an upper adapter member 34 which is welded to the central opening in top portion 5*a*. Adapter member 34 has a fixed connection with a hollow sleeve member 35 extending into a lower adapter member 40 which provides a bearing surface for the rotary assembly. The adapter shaft portion 33 is threaded at its upper end as shown at 33*a* to engage internal threads of a nut 12 on selector 16 and is apertured at 37*a* for reception of a pin 38*a*, which connects a hollow fiber glass epoxy tube 39 for conjoint rotation, and tube 39 extends from adapter 33 into a lower shaft adapter 36 interiorly of sleeve 35. Preferably sleeve 35 is formed of high nickel steel solid commercially as "Hastalloy B."

The lower adapter member 40 is welded to the central opening in upper portion 6*a* and extends downwardly into a bearing 41 having a liner 42 which is spaced from sleeve member 35. Near its bottom adapter member 40 narrows to fit against the outer surface of sleeve 35 and has a recess 43 filled with a suitable packing material. The lower end of lower shaft adapter 36 is solid and has a bayonet joint 44, including a pin 44*a*, which is connected to hub 17. It terminates in spaced relation to hub 17 forming a recess 47 containing a coil spring 45. This arrangement permits selective insertion and removal of upper adapter 33 and lower adapter 36 and the associated tubular shaft portion 39.

Adapter member 34 is spaced from sleeve 35, and adapter member 40 is similarly spaced from sleeve 35 to provide passages 46*a* and 46*b* respectively, communicating with evacuated space 7. With this arrangement, the only heat inleak path from selector 16 into inner container 6 is along the assembly of sleeve 35 and shaft adapter 33, tube 39 and adapter 36. In comparative testing with containers having the same rated volume, one of the general type shown in Ser. No. 138,758 performed efficiently for periods of about 55 days on static load, whereas a container of the type shown and described herein performed efficiently for a period of from 75–80 days.

The change in shape of the outer container, particularly in the provision of the peaked top portion provides a better structural form for the suspending support of the inner container and its contents. The two point suspension of the inner member provides a stable assembly, and the central shaft arrangement permitted the location of bearings outside the cold zone and repair or replacement from outside without opening the interior of the container. The bottom shaping of the outer member also has been changed to permit less deflection and as a result the insulation in the bottom portion will not be compressed even after the vessel has been in service for long periods of time.

Changes and modifications may be availed of within the spirit and scope of the hereunto appended claims.

I claim:

1. A cryogenic storage vessel comprising an outer cylindrical member adapted to stand in an upright position and enclosed at its top and bottom, an inner storage container suspended within the outer member in spaced relation thereto and defining an evacuated insulation space therewith, a hollow member of low heat-conductivity fitted in sealed relation in openings in the outer member and inner container, a rotary shaft of low heat-conductivity extending through the hollow member from outside the outer member into the inner container through an upper portion of said insulation space and in spaced relation with the hollow member, an article support carried on the lower end of said shaft and having a series of support stations at its periphery, a tubular member extending from outside the outer member into the storage container in alinement with a selected station of the article support so as to provide an access passage thereto and interconnecting the outer member with the inner container as one point of suspension, the shaft providing a second point of suspension of the inner container from the outer member, a removable plug normally closing the access passage, and means at the upper end of the shaft for manual rotation to bring a selected support station in register with the access passage without removing the plug.

2. A cryogenic storage vessel comprising an outer cylindrical member adapted to stand in an upright position and enclosed at its top and bottom, an inner storage container suspended within the outer member in spaced relation thereto and defining an evacuated insulation space therewith, a hollow member of low heat-conductivity fitted in sealed relation in openings in the outer member and inner container, a rotary shaft of epoxy glass tubing extending through the hollow member from outside the outer member into the inner container through an upper portion of said insulation space and in spaced relation with the hollow member, an article support carried on the lower end of said shaft and having a series of support stations at its periphery, a tubular member extending from outside the outer member into the storage container in alinement with a selected station of the article support so as to provide an access passage thereto and interconnecting the outer member with the inner container as one point of suspension, the shaft providing a second point of suspension of the inner container from the outer member, a removable plug normally closing the access passage, and means at the upper end of the shaft for manual rotation to bring a selected support station in register with the access passage without removing the plug.

3. A cryogenic storage vessel comprising an outer cylindrical member adapted to stand in an upright position and enclosed at its top and bottom, an inner storage con-

tainer suspended within the outer member in spaced relation thereto and defining an evacuated insulation space therewith, a hollow member of low heat-conductivity fitted in sealed relation in openings in the outer member and inner container, a rotary shaft of low heat-conductivity extending through the hollow member from outside the outer member into the inner container through an upper portion of said insulation space and in spaced relation with the hollow member, an article support carried on the lower end of said shaft and having a series of support stations at its periphery, a tubular member extending from outside the outer member into the storage container in alinement with a selected station of the article support so as to provide an access passage thereto and interconnecting the outer member with the inner container as one point of suspension, the shaft providing a second point of suspension of the inner container from the outer member, a removable plug normally closing the access passage, means at the upper end of the shaft for manual rotation to bring a selected support station in register with the access passage without removing the plug, and indicia associated with the manually-operable means for designating station positions on the article support.

4. In a cryogenic storage container of the upright type having an outer member, an inner storage container supported by and spaced from the outer member and defining an evacuated insulation space therewith, a central shaft assembly extending from a point above the outer member into the interior of the inner container, said assembly including an upper hollow member fitted in sealed relation in an opening in the upper portion of the outer member and opening into the vacuum space, a lower hollow member fitted in sealed relation in an upper portion of the inner container and opening into the vacuum space, a sleeve in sealed connection with the upper hollow member at its upper end and with the lower hollow member at its lower end and axially spaced from said members to provide spaces communicating with the vacuum space, a shaft of low-heat conductive material enclosed by said sleeve and rotatable therein, an article support member carried on the lower end of the shaft, and means at the upper end of the shaft for manual rotation of the shaft to dispose articles on the article support at selected positions within the storage container.

5. In a container as defined in claim **4**, a sectional shaft comprising upper and lower tubular end portions of high nickel steel and an interconnecting glass fiber epoxy tube in bonded connection therewith.

6. In a cryogenic storage container of the upright type having an outer member, an inner storage container supported by and spaced from the outer member and defining an evacuated insulation space therewith, a central shaft assembly extending from a point above the outer member into the interior of the inner container, said assembly including an upper hollow member fitted in sealed relation in an opening in the upper portion of the outer member and opening into the vacuum space, a lower hollow member fitted in sealed relation in an upper portion of the inner container and opening into the vacuum space, a sleeve in sealed connection with the upper hollow member at its upper end and with the lower hollow member at its lower end and axially spaced from said members to provide spaces communicating with the vacuum space, a shaft of low-heat conductive material enclosed by said sleeve and rotatable therein, an article support member carried on the lower end of the shaft, and a quick-coupling connection between the shaft and the article support permitting insertion and withdrawal of the shaft through the sleeve by manipulation from outside the outer member.

7. In a cryogenic storage container of the upright type having an outer member, an inner storage container supported by and spaced from the outer member and defining an evacuated insulation space therewith, a central shaft assembly extending from a point above the outer member into the interior of the inner container, said assembly including an upper hollow member fitted in sealed relation in an opening in the upper portion of the outer member and opening into the vacuum space, a lower hollow member fitted in sealed relation in an upper portion of the inner container and opening into the vacuum space, a sleeve in sealed connection with the upper hollow member at its upper end and with the lower hollow member at its lower end and axially spaced from said members to provide spaces communicating with the vacuum space, a shaft of low-heat conductive material enclosed by said sleeve and rotatable therein, a hub member having a quick-coupling connection with the shaft, a shaft extension depending from the hub, an article support structure seated on the hub and partially supported by the shaft extension for rotation by the shaft to dispose articles supported thereby at selected positions within the storage container.

8. In a cryogenic storage container of the upright type having an outer member, an inner storage container supported by and spaced from the outer member and defining an evacuated insulation space therewith, a central shaft assembly extending from a point above the outer member into the interior of the inner container, said assembly including an upper hollow member fitted in sealed relation in an opening in the upper portion of the outer member and opening into the vacuum space, a lower hollow member fitted in sealed relation in an upper portion of the inner container and opening into the vacuum space, a sleeve in sealed connection with the upper hollow member at its upper end and with the lower hollow member at its lower end and axially spaced from said members to provide spaces communicating with the vacuum space, a shaft of low-heat conductive material enclosed by said sleeve and rotatable therein, a hub member having a quick-coupling connection with the shaft, structure on the hub having a plurality of circumferentially-spaced article support stations, tubular means extending through the tops of the inner and outer members to provide an access passage in register with selected article support stations, and means at the upper end of the shaft for manual rotation of the shaft to dispose a selected article support station in register with the access passage.

9. In a cryogenic storage container of the upright type having an outer member, an inner storage container supported by and spaced from the outer member and defining an evacuated insulation space therewith, a central shaft assembly extending from a point above the outer member into the interior of the inner container, said assembly including an upper hollow member fitted in sealed relation in an opening in the upper portion of the outer member and opening into the vacuum space, a lower hollow member fitted in sealed relation in an upper portion of the inner container and opening into the vacuum space, a sleeve in sealed connection with the upper hollow member at its upper end and with the lower hollow member at its lower end and axially spaced from said members to provide spaces communicating with the vacuum space, a shaft of low-heat conductive material enclosed by said sleeve and rotatable therein, an article support member carried on the shaft, means at the upper end of the shaft for manual rotation of the shaft to dispose articles on the article support at selected positions within the storage container, and indicia associated with the shaft rotating means for designating the position of supported articles when the shaft is rotated.

10. A cryogenic storage vessel comprising an outer cylindrical member adapted to stand in an upright position and enclosed at its top and bottom, an inner storage container suspended within the outer member in spaced relation thereto and defining an evacuated insulation space therewith, a rotary shaft of epoxy glass tubing extending from outside the outer member into the inner container through an upper portion of said insulation space, a stationary hollow member of low-heat conductivity enclos-

ing the portion of the shaft within said upper portion of the insulation space in spaced and sealed relation to prevent vacuum loss, an article support carried on the lower end of said shaft and having a series of support stations at its periphery, a tubular member extending from outside the outer member into the storage container in alinement with a selected station of the article support so as to provide an access passage thereto and interconnecting the outer member with the inner container as one point of suspension, the shaft providing a second point of suspension of the inner container from the outer member, a removable plug normally closing the access passage, and means at the upper end of the shaft for manual rotation to bring a selected support station in register with the access passage without removing the plug.

11. A cryogenic storage vessel comprising an outer cylindrical member adapted to stand in an upright position and enclosed at its top and bottom, an inner storage container suspended within the outer member in spaced relation thereto and defining an evacuated insulation space therewith, a rotary shaft of epoxy glass tubing extending from outside the outer member into the inner container through an upper portion of said insulation space, a stationary sleeve of high nickel steel enclosing the portion of said shaft within said upper portion of the insulation space in spaced and sealed relation to prevent vacuum loss, an article support carried on the lower end of said shaft and having a series of support stations at its periphery, a tubular member extending from outside the outer member into the storage container in alinement with a selected station of the article support so as to provide an access passage thereto and interconnecting the outer member with the inner container as one point of suspension, the shaft providing a second point of suspension of the inner container from the outer member, a removable plug normally closing the access passage, and means at the upper end of the shaft for manual rotation to bring a selected support station in register with the access passage without removing the plug.

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CLAUDE A. LE ROY, *Primary Examiner.*

CHANCELLOR E. HARRIS, *Assistant Examiner.*