July 25, 1950 J. A. REYNIERS 2,516,419

BIOLOGICAL APPARATUS

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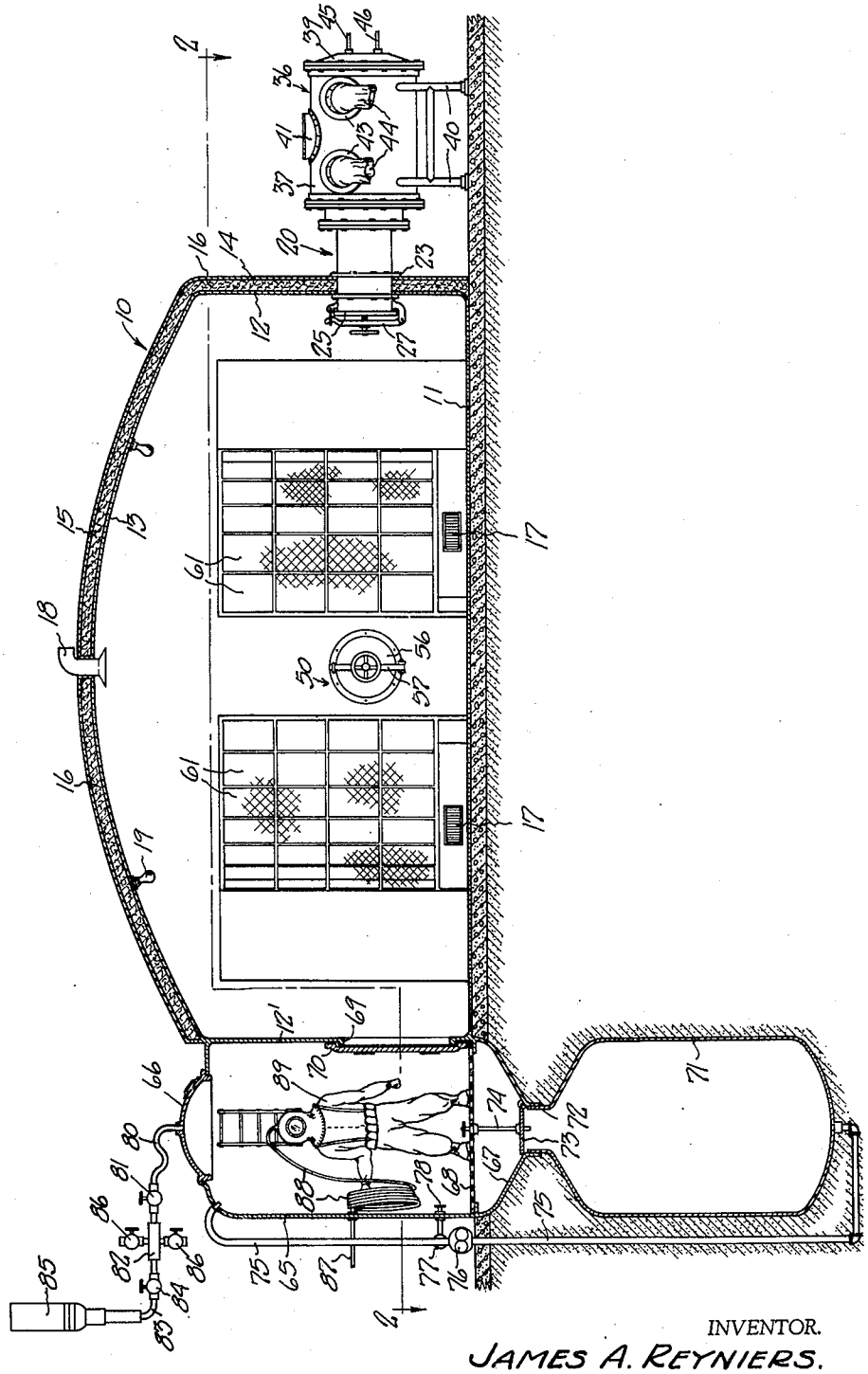


FIG. 1.

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FIG. 2.

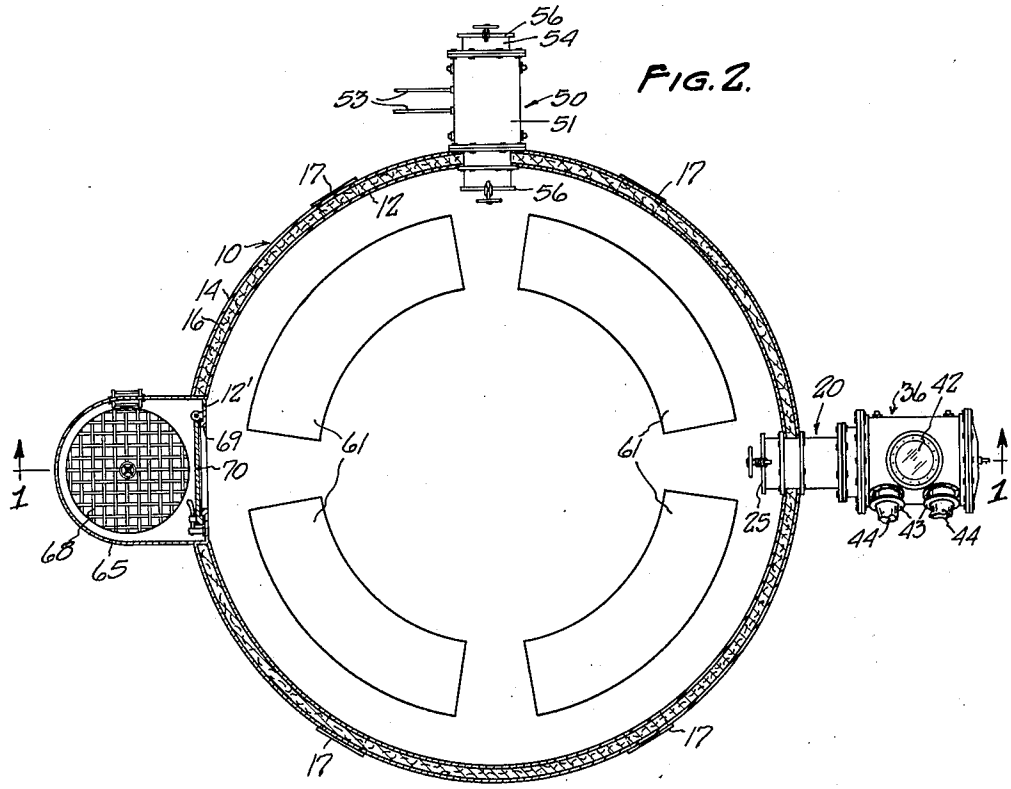
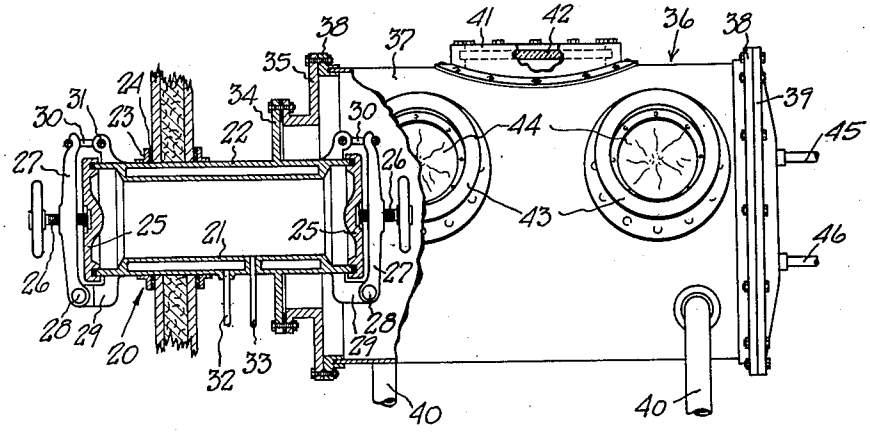


FIG. 3.



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BIOLOGICAL APPARATUS

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FIG. 4.

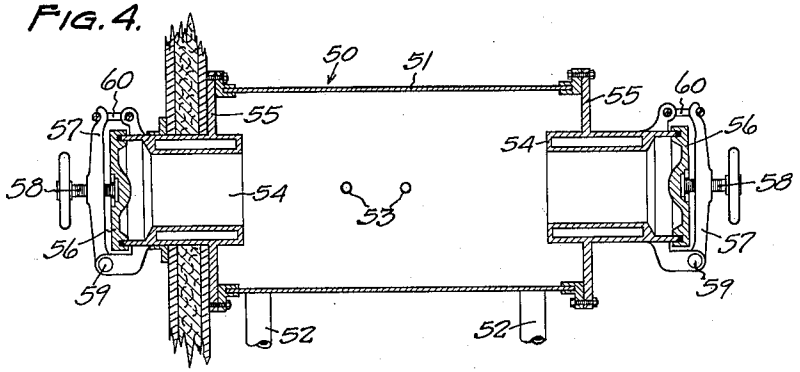


FIG. 5.

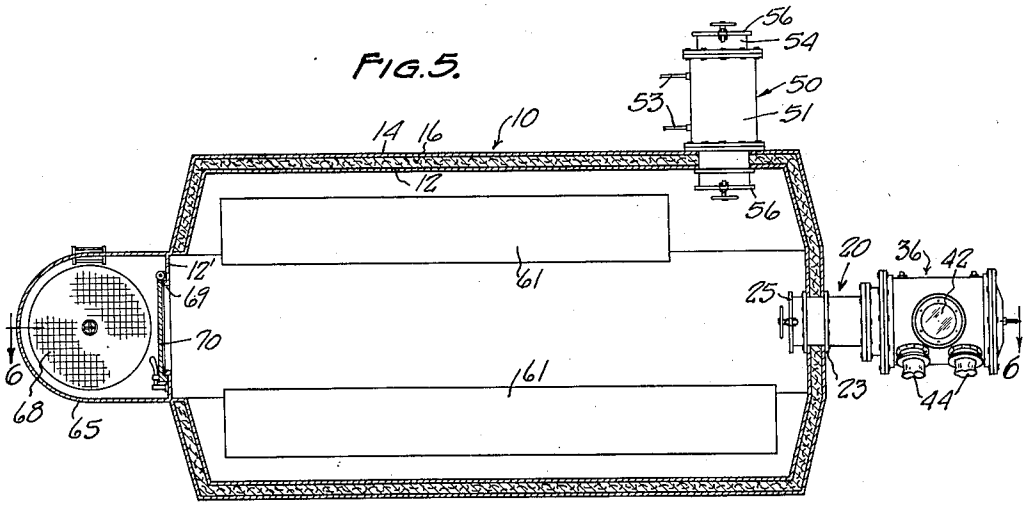
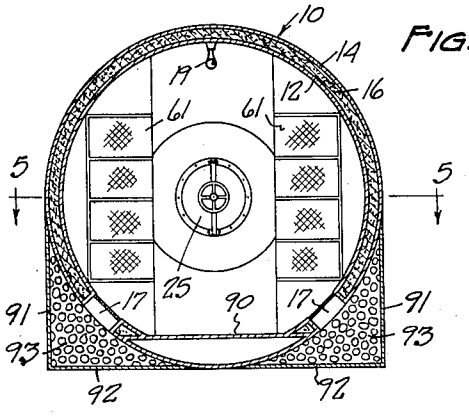


FIG. 6.



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Patented July 25, 1950 2,516,419

UNITED STATES PATENT OFFICE

2,516,419

BIOLOGICAL APPARATUS

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Application November 10, 1944, Serial No. 562,876

7 Claims. (Cl. 128—1)

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This invention relates to improvements in biological apparatus. More particularly, it relates to apparatus for maintaining and working with biological specimens in a controlled environment.

Apparatus of this general character is disclosed in my Patent No. 2,244,082, dated June 3, 1941. This prior apparatus has certain limitations, particularly limitations as to the extent and scope with which biological work can be conducted, and limitations as to the number of specimens which can be handled, maintained and treated. Especially important is the fact that the investment necessary per specimen is quite high. Also, there is some inconvenience in using such apparatus by reason of the fact that the specimens are enclosed in a restricted space, and the operator must work through restricted access openings which limit his movements in reaching in and working in said space. The manipulations of different units to prepare for a given treatment of the individual specimens consume considerable time and present a further limitation of the prior apparatus.

The primary object of this invention is to provide apparatus by which a large number of specimens can be manipulated and treated under a desired controlled environment at low cost per specimen, with the expenditure of a minimum amount of time to condition the apparatus for a given operation and wherein space limitations give the operator substantial freedom.

A further object is to provide apparatus of this character with novel access and sealing means.

A further object is to provide apparatus of this character which is adapted for control of environment to be germ-free, or to be germ-infected or germ-laden, under controlled conditions.

A further object is to provide apparatus of this character with a novel liquid trap construction employing a germicidal solution for sterilizing purposes.

Other objects will be apparent from the description, drawings and appended claims.

In the drawings:

Fig. 1 is a vertical sectional view of the apparatus taken on line 2—2 of Fig. 1, with parts shown in elevation.

Fig. 2 is a horizontal sectional view of the apparatus taken on line 2—2 of Fig. 1, with parts shown in elevation.

Fig. 3 is an enlarged side view of one portion of the apparatus, with parts broken away.

Fig. 4 is an enlarged longitudinal sectional view of another portion of the apparatus.

Fig. 5 is a horizontal sectional view of a modified embodiment of the invention, taken on line 5—5 of Fig. 6.

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Fig. 6 is a vertical sectional view taken on line 6—6 of Fig. 5.

Referring to the drawings, and particularly to Figs. 1 to 4, inclusive, which illustrate one embodiment of the invention, the numeral 10 designates a specimen chamber or building which is preferably circular in shape. This chamber is of a height to permit a man to stand erect and to move about therein. The chamber is constructed to be air-tight, and preferably comprises an inner metal or like air-impervious shell providing a floor 11, side walls 12 and ceiling 13, all joints between constituent panels being effectively sealed by welding or by any suitable air-sealing means. Around this inner shell in substantially uniform spaced relation is disposed an outer shell which preferably forms exterior side walls 14 and roof 15. Insulation material 16 is distributed uniformly between the inner and outer shells, said material being of any suitable or selected type usable for insulation against heat.

At spaced points around the walls of chamber 10, openings may be provided as illustrated at 17. These openings may be supplied with suitable filters and other means (not shown) to filter and treat the air passing therethrough. A conduit 18 open at its inner end within chamber 10 has a sealed fit in the walls or roof of chamber 10 and may be connected with an air pump (not shown), or provided with flow-resisting means (not shown). The openings 17 and 18 permit a continuous supply of fresh air to the chamber. Where germ-free conditions are to be maintained within the chamber, each of the openings 17 may be connected in a forced air supply system and conduit 18 may provide a restricted opening to atmosphere. The parts may then be controlled so that the rate of air supply, coupled with the restriction of the air outlet, will place the interior of chamber 10 under a slight positive air pressure. Hence, any air leakage in the device is in an outward direction. If it is desired to maintain a selected gaseous environment, the arrangement may be such that the rate at which air is withdrawn through the openings 17, which preferably have suitable germ barriers therein, exceeds the rate at which air is supplied through a restricted inlet 18. The latter arrangement prevents escape of gases in the event of air leakage of chamber 10 because all such leakage will be inward, due to the slightly reduced air pressure in chamber 10 as compared to atmospheric pressure.

Electric outlets as for lights 19, and service connections for steam, water and gas and the like, may be provided in chamber 10.

A transfer unit or clave 20, best illustrated in Figs. 1 and 3, may be connected with the chamber 10. This unit preferably comprises a cylinder 21 surrounded by a water jacket 22, which has a tight fit in an opening in the vertical wall of chamber 10. Any suitable means, such as fittings 23 which may include sealing gaskets 24, insure a substantially air-tight fit between casing 10 and cylinder 21—22. Opposite ends of cylinder 21 are provided with sealing closures 25, each mounted on a threaded shaft 26 journaled in a lever 27 pivoted at 28 to a lug or ear 29 projecting from the cylinder. A retainer 30 pivoted at 31 to the cylinder is adapted for releasable engagement with the free end of lever 27. Conduits 32 communicate with the water jacket around cylinder 21 to supply water for cooling purposes, and conduit 33 communicates with the interior of cylinder 21 to supply steam for sterilizing purposes.

A circumferential flange 34 projects from cylinder 21—22 intermediate its ends for sealed connection, by means of an adapter ring 35 and suitable cooperating sealing gaskets, with one end of a transfer chamber 36. The transfer chamber preferably comprises a cylindrical body 37 having end flanges 38 to which adapter ring 35 and end closure plate 39 are secured in sealed relation. Legs 40 support unit 36. The body 37 preferably has a top opening surrounded by an annular fitting 41 which has a sealed connection with the body. Fitting 41 mounts a transparent closure 42 with a sealed fit so that the interior of chamber 36 may be viewed. Two or more openings are formed at the sides of body 37, and are encircled by rings 43 having a sealed connection with the body. The rings 43 mount the open ends of long rubber gloves 44 with a sealed removable connection to provide access of the hands and arms of an operator for manipulating a biological specimen within chamber 36 without breaking the seal of said chamber. Steam connections, as 45, and air connections, as 46, serve respectively for sterilizing chamber 36 and for circulating fresh filtered air in said chamber.

The transfer unit or clave 20—36 serves as means for introducing specimens into the chamber 10, or removing specimens therefrom without danger of contamination of chamber 10 and without exposing the specimen to free atmosphere. Thus, to remove a specimen, assuming units 20 and 36 have been operatively connected to chamber 10 and to a receiving or treating chamber of any suitable type, for example, of any of the types illustrated in my prior Patent No. 2,244,082, and also assuming that all units so connected have been sterilized by steam or other means, the following sequence of operations is practiced: Closure 25 within chamber 10 is opened and the specimen is placed in cylinder 21, followed by resealing of said closure. An operator outside of chamber 10 then reaches into chamber 36 by means of gloves 44 to manipulate screw 26 and open the outer closure 25 of unit 20, and remove the specimen from unit 20 into chamber 36. The last named closure 25 can then be re-sealed. If chamber 36 constitutes a treatment chamber or operating chamber, the specimen is treated therein and then returned into chamber 10 by a reverse sequence. Alternatively, if other units are connected to chamber 36, a similar sequence is followed until the specimen has been transferred

thereto. Note that the specimen is not subjected to contaminating influences in free air during the transfer, nor is there any time when a free communication between atmosphere and chamber 10 is permitted. The same procedure is followed originally to place specimens in chamber 10. For instance, specimens may be delivered by Caesarean section in an operating unit (not shown) which is connected with the transfer unit, and delivered through the latter to chamber 10.

At another part of chamber 10 a second transfer unit 50 is connected in communication with chamber 10. This unit may be of the type shown in Fig. 4. A cylindrical body 51 is supported on legs 52 and has steam lines 53 connected therewith. A reduced outer jacketed cylinder 54 is mounted at each end of body 51, as by means of a circumferential adapter flange 55, having a sealed connection with said body. A sealing closure 56 adjustably mounted on a lever 57 by means of a screw threaded shaft 58 seals the outer end of each cylinder 54. Lever 57 is pivoted at 59 and is releasably engaged with a retainer 60. One of the cylinders 54 has a sealed fit in an opening in the wall of chamber 10, whereby one closure 56 is within the chamber 10 and the other is outside of said chamber.

Transfer unit or clave 50 provides convenient means for introducing food, small instruments, apparatus and the like into chamber 10, and for removing items from the chamber. The items are introduced into chamber 51 through the outer cylinder 54 whose closure 56 is then re-sealed. Steam is then admitted into chamber 51 to effectively sterilize the chamber and its contents, including the items introduced as above mentioned. Thereupon the inner closure 56 may be opened and the food or other items removed through inner cylinder 54 which is again re-sealed.

Within chamber 10 are arranged a plurality of cages or other receivers or retainers 61 for the biological specimens.

One of the primary features of this invention is the means provided for entry of an operator into the chamber, and movement of the operator freely within the chamber, without destroying the controlled condition therein. This means is best illustrated at the left in Fig. 1. An access chamber 65 adjoins chamber 10 and is of a construction adapted to be rendered liquid tight and air tight. Chamber 65 is of a size to permit a man to enter and having a limited movement therein. A dome-like closure 66 seals an access opening at its top, and its bottom preferably slopes centrally downwardly at 67 for drainage purposes. A perforated grate 68 is located therein at approximately the same level as floor 11 of chamber 10. The wall 12' which separates chambers 10 and 65 has an access opening 69 which is normally closed by a door 70 suitably mounted on the wall and constructed to provide a liquid and air seal when closed and locked.

Below the chamber 65 is located a liquid tank 71 preferably having the same cubic capacity as the chamber 65 and cooperating therewith to define a liquid trap. A restricted port or neck 72 connects said chamber and tank, and a liquid seal or valve 73 is provided to seal said chamber from said tank. Valve operating means 74 project from valve 73 to and into chamber 65, as through grate 68. A conduit 75 is connected at one end with the bottom of tank 71 and at its opposite end with the upper portion of chamber 65. A suitable liquid pump 76 is interposed in said

conduit. A valve 77 is also interposed in said conduit and is provided with operating means 78 extending into and operable from within chamber 65.

A conduit 80 has a sealed connection with an opening in cover 66 for chamber 65. Conduit 80 has a valve 81 therein and connects with a branch fitting 87. An air conduit 83 is connected to fitting 82 and is controlled by valve 84. Conduit 83 may be connected to an air filter 85. Check valves 86 are connected with fitting 82.

An air supply line 87 may lead directly into chamber 65 at a sealed connection therewith. An elongated flexible air hose 88 provides a connection between line 87 and a diving or impervious protective cover-all suit 89, or to a diving helmet. Suit or helmet 89 is connected to atmosphere by a second flexible tube for exhaust of air therefrom.

Access to the device is obtained as follows: First, it is assumed that chamber 10 is operatively conditioned and connected to service lines for the maintenance and practice of a germ-free technique, and that it and the transfer units 20, 36 and 50 connected therewith are sterile and sealed. To gain access, an operator enters chamber 65, dons the diving suit or helmet 89, closes and seals closure 66 and valve 73, and opens valve 77. Tank 71 contains a germicidal solution which is pumped therefrom by pump 76 and into the chamber 65. The operator controls the pump and the valve, and the germicidal solution is permitted to completely fill chamber 65, forcing air therefrom through conduit 80 and connected fittings for discharge through check valves 83, it being understood that valve 84 is closed. This sterilizes the chamber 65, the diving suit 89, tubing 88 and connected air supply tubing. Valve 76 is then closed, pump 76 is stopped and the valve 73 is opened to permit the germicidal solution to drain back into tank 71. The operator then opens closure 70 and enters the chamber 10 to work therein, wearing the diving suit or helmet continuously so that no contact or air borne vectors of infection between operator and specimens are permitted. The manner in which food and other items needed by the operator for his work are introduced into the chamber 10 without destroying the desired germ-free condition, and the manner in which specimens may be admitted to and removed from chamber 10, has been mentioned above. Air supply tubing 88 for the diving apparatus is long enough to permit the operator to move freely to all parts of chamber 10. When the operator has completed his work, he re-enters chamber 65, seals closure 70, removes the diving apparatus 89 and opens closure 66 so that he may leave the apparatus.

Where the apparatus is used for work with biological specimens in a germ-laden environment, the pressure in chamber 10 is maintained slightly below atmospheric pressure. The use of the apparatus is substantially the same as mentioned above, except that the filling of the chamber 65 with the germicidal solution is not required until the operator has completed his work in chamber 10, protected against the germ laden condition by the diving apparatus. In this instance, the germicidal solution is used to prevent both air borne transfer of germs to atmosphere when the seal 66 of chamber 65 is broken, and transfer by contact by the operator when he leaves the apparatus.

The embodiment of the device illustrated in Figs. 5 and 6 is constructed similarly to that described above, and like parts bear the same reference numerals. The primary difference is that the chamber 10 is cylindrical with its axis horizontal. Chamber 65 is connected at one end of chamber 10 for communication at openings 69 normally sealed by closure 70. Chamber 65 is associated with a germicidal tank, air supply lines, diving apparatus, and liquid transfer means, as in the Fig. 1 embodiment. Transfer unit or clave 20, 36 is connected at the opposite end of chamber 10. Food clave unit 51 is connected at a side of chamber 10. Storage cages 61 extend longitudinally of chamber 10. An elevated floor 90 is preferably mounted in the chamber 10 for convenience. Skirts 91 depending from the outer side walls 14 cooperate with a bottom panel 92 to provide chambers 93 which may house tubing, service leads, motors, pumps and the like, and which may contain insulation material.

I claim:

1. Biological apparatus comprising a sealed specimen chamber, means for controlling the environment in said chamber, a sealed access chamber adjoining said specimen chamber, a pair of releasable closures in said access chamber, one of said closures separating said chambers, diving apparatus connected at said access chamber and adapted to be worn by a person while in said specimen chamber and said access chamber, and means for filling said access chamber with germicidal solution and then draining the same to sterilize the same and its contents and the exterior of said diving apparatus.

2. Biological apparatus comprising a normally sealed specimen chamber having a controlled environment, a liquid trap including upper and lower chambers connected by a valved drain, said upper chamber having an access opening and being connected with said specimen chamber by a normally sealed opening, a closure for said access opening, and means for transferring liquid from said lower trap chamber to fill said upper trap chamber.

3. Biological apparatus comprising a normally sealed specimen chamber having a controlled environment, a liquid trap including upper and lower chambers connected by a valved drain, said upper chamber having an access opening and being connected with said specimen chamber by a normally sealed opening, a closure for said access opening, and means for transferring liquid from said lower trap chamber to fill said upper trap chamber, an air filter and a conduit connecting said filter with an opening in said access closure.

4. Biological apparatus comprising a normally sealed specimen chamber having a controlled environment, a liquid trap including upper and lower chambers connected by a valved drain, said upper chamber having an access opening and being connected with said specimen chamber by a normally sealed opening, a closure for said access opening, and means for transferring liquid from said lower trap chamber to fill said upper trap chamber, an air line connected with said access closure and including a filter, and a check valve in said line between said closure and filter to permit discharge of air from said line therethrough.

5. Biological apparatus comprising a normally sealed specimen chamber having a controlled environment, a liquid trap having a portion connected with said chamber and normally separated therefrom by a sealed closure and a portion containing a germicide, a liquid and air tight flexible garment adapted to completely encase a person, means extending into said trap for sup-

plying air to said garment, means for transferring said germicide to and from said first trap chamber, and means operable by a person wearing said garment for controlling said transfer means.

6. Access means for biological apparatus containing specimens in a controlled environment, comprising superimposed communicating tanks, the upper tank having an access opening sealed by a releasable closure and an opening leading to said apparatus and sealed by a releasable closure, valve means interposed between said tanks and having a controller within the upper tank, a conduit connecting said tanks, a pump in said conduit and having a controller within the upper tank and diving apparatus connected with an elongated flexible air line entering said upper tank.

7. Biological apparatus comprising a normally sealed specimen chamber having a controlled environment, an access chamber adapted to be

sealed and admitting an attendant in a diving apparatus, said access chamber being connected for communication with said specimen chamber and normally sealed therefrom by a releasable closure, and means controlled from the interior of said access chamber for temporarily flooding and then draining the same with a germicide for sterilizing purposes.

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REFERENCES CITED

The following references are of record in the file of this patent:

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