

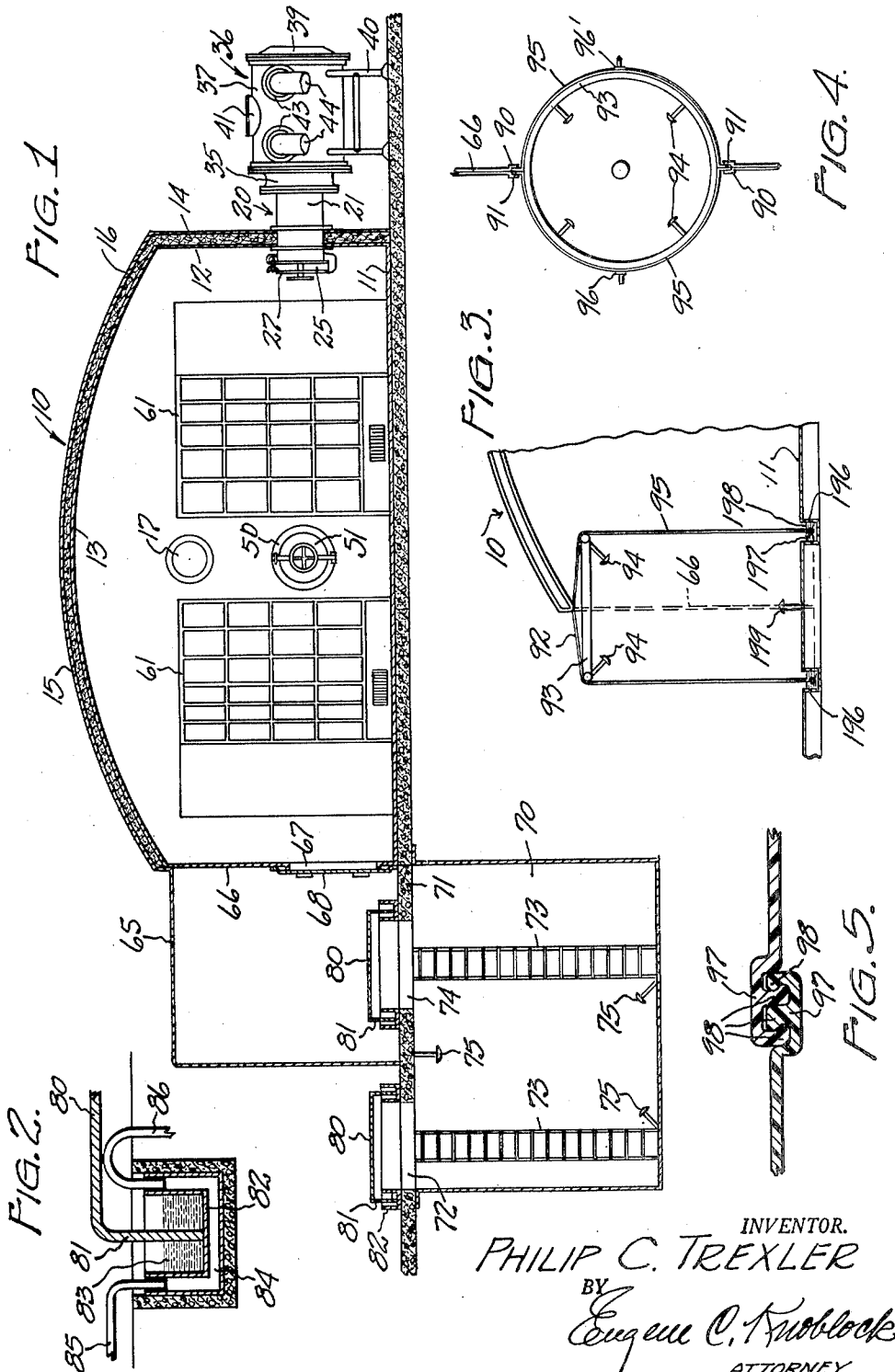
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P. C. TREXLER

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BIOLOGICAL APPARATUS

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Philip C. Trexler, Niles, Mich., assignor to University of Notre Dame du Lac, Notre Dame, Ind., a corporation of Indiana

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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, or to confine and control a contaminated environment, whether biological, chemical or radio-active.

Apparatus of this general character is disclosed in the patent issued to James A. Reyniers, No. 2,516,419, dated July 25, 1950. This prior apparatus discloses a chamber in which a controlled environment exists and which is normally sealed, and into which an attendant may enter while wearing a diving suit or other garment completely encasing the worker. The worker enters a chamber and, while wearing the suit, is completely immersed by a germicidal solution or the like, so that all vectors of infection which might be carried by the exterior of the suit are removed, and so that the chamber which adjoins the specimen chamber, and which must be opened into communication with the specimen chamber when the worker moves into the specimen chamber, will always be sterilized by the antiseptic material.

Devices of this character, because of the need for complete immersion of the worker, are subject to various disadvantages in use. One of the disadvantages of the apparatus in which sterilization is procured by immersion, is that the diving chamber or suit has air passing into the same and discharging from the same. The air provides a buoyant condition. Consequently, the wearer of the suit is required to perform difficult and laborious maneuvering while wearing the suit and while the immersion for effecting sterilization occurs. Another disadvantage is the fact that hydrostatic pressures are such as to cause the suit to cling to the wearer so that the suit forms in effect a very tight sheath or skin continuously adhering to the user when immersed and thus provides an uncomfortable feeling.

Still another disadvantage of the present apparatus is that the construction of the suit must be rather heavy and cumbersome in order to withstand immersion, and also it has been found that the stresses experienced by the suit incident to movement of a worker within the suit, under the conditions of hydrostatic pressure while being immersed, are quite substantial. Furthermore, it is necessary, in a suit to be subjected to hydrostatic pressure, to avoid dead air space, and the construction of a suit to be subjected to hydrostatic pressure must commonly be lacking spacer means which would otherwise provide comfort to the wearer, such as means to space the parts of the suit from the face at the helmet.

It is the primary object of this invention to provide a novel, simple and inexpensive biological apparatus in which the foregoing disadvantages are overcome or at least minimized, and in which the cost of the apparatus is held at a low figure.

A further object is to provide a device of this character in which immersion of a worker clothed in a diving suit is not necessary to effect sterilization, and, instead, germicides are sprayed upon the suit and into the chamber and effectively decontaminate both the exterior surfaces of the suit and also the air within the entry chamber adjoining the specimen chamber, so that a worker in a suit which is so sprayed can enter the working chamber with the assurance that infection of specimens within a specimen chamber will be avoided with respect to both air borne vectors and vectors of contact.

A further object is to provide a device of this character having a novel access member with seals at open-

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ings thereof communicating respectively with atmosphere and with the specimen chamber, which are simple in construction, easy to operate, and highly effective and efficient.

Other objects will be apparent from the following specification.

In the drawing:

Fig. 1 is a vertical sectional view of the apparatus with parts shown in elevation;

Fig. 2 is an enlarged detail sectional view of a seal;

Fig. 3 is a fragmentary cut-away view illustrating a modified embodiment of the invention;

Fig. 4 is a top plan view of the device shown in Fig. 3; and

Fig. 5 is an enlarged fragmentary detail sectional view of a seal employed in the embodiment of the invention illustrated in Figs. 3 and 4.

Referring to the drawing, and particularly to Figs. 1 and 2 thereof which illustrate one embodiment of the invention, the numeral 10 designates a specimen chamber or building which may be of any shape and which is here shown as of circular 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 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 (not shown) 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 such conduit 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 a conduit (not shown) 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. 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 for lights, etc., and service connections for steam, water and gas and the like, may be provided in chamber 10.

A transfer unit or clave 20 may be connected with the chamber 10. This unit preferably comprises a cylinder 21 which has a tight fit in an opening in the vertical wall of chamber 10. Any suitable means insure a substantially air-tight fit between casing 10 and cylinder 21. Opposite ends of cylinder 21 are provided with sealing closures 25, each mounted on a threaded shaft journaled in a lever 27 pivoted to a lug or ear projecting from the cylinder. A retainer pivoted to the cylinder is adapted for releasable engagement with the free end of lever 27. Conduits may communicate with a water jacket around cylinder 21 to supply water for cooling purposes, and another conduit may communicate with the interior of cylinder 21 to supply steam for sterilization purposes.

A circumferential flange projects from cylinder 21 intermediate its ends for sealed connection, by means of an adapter ring 35 and suitable cooperating sealing gas-

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kets, with one end of a transfer chamber 36. The transfer chamber preferably comprises a cylindrical body 37 having end flanges to which end closure plate 39 is 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 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 the chamber 36 without breaking the seal of said chamber. Steam connections (not shown) and air connections (not shown) 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 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 re-sealing of said closure. An operator outside of chamber 10 then reaches into chamber 36 by means of gloves 44 to manipulate 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 resealed. 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 Caesarian section in an operating unit (not shown) which is connected with the transfer unit, and delivered through the latter to chamber 10.

Another transfer unit or clave 50 having closure 51 provides convenient means for introducing food, small instruments, apparatus and the like onto chamber 10, and for removing items from the chamber.

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 air-tight. Chamber 65 is of a size to permit a man to enter and have a limited movement therein. A wall 66 separates the access chamber 65 from the specimen chamber 10 and has an access opening 67 therein adapted to be closed by closure 68 through which a man can pass. The closure is adapted to be sealed in any manner found suitable.

A well or pit 70 adjoins the access chamber 65 and has a portion thereof extending below the floor 71 of the access chamber 65. This pit in turn has an access opening 72 formed therein leading to atmosphere, that is, to a point exterior of the chamber 65 and the chamber 10. Ladders 73 or other access means may be provided, by means of which an attendant who enters through the access opening 72 may pass into the chamber or pit 70. The second ladder provides means for passage of the attendant from the pit 70 into the access chamber 65 as through an access opening 74. The pit 70 will preferably be provided with a series of spray nozzles 75 or ejection members which are so related and oriented

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with respect to each other that an operator can stand at a center position and be assured that all surfaces of his diving suit or sheath (not shown) will be treated by a spray or stream ejected from the nozzles. In instances where a liquid spray is to be employed, the spray head 75 will be connected to a source of supply of the liquid, having a pump or other pressure means associated therewith so as to insure an adequate pressure of discharge. In the event a gaseous germicidal material is being employed, the members 75 will be ejectors for discharging and directing a stream of such gas in a predetermined relation within the chamber. The arrangement in either instance will be such as to insure that any vectors of infection or germs which are upon the surface of the garment or diving suit (not shown) worn by the operator will be treated and covered by the germicide or the gas and in addition will be so arranged as to insure that the entire interior of the chamber, such as the pit 70, will be subjected to a fine spray of liquid germicide or to a gas so that no air borne vectors of infection can exist within the chamber 70 after the germicidal material has been expelled through the nozzles 75. In this connection I have made tests which assure me that, if a fine spray of liquid germicide is employed, air borne vectors of infection, as well as germs carried by the exterior of a diving suit, will be successfully attacked by the germicide so that the entire interior of the chamber 70 and its contents will be completely decontaminated.

It may be mentioned that the spray nozzles 75 may be located in the access chamber 65 instead of in a pit 70 if desired. The principal advantage of providing the same in the pit is that it makes possible the use of very simple and inexpensive removable sealing means and avoids the necessity of providing a complicated sealed access door. Thus, since the access openings 72 and 74 are formed in horizontal structures, they can be sealed by dome-like closure members 80 having annular marginal depending flanges 81. Thus an annular channel 82 which contains a liquid 83 in cooperation with the closure flange 81 will provide a completely and effectively sealed joint for the closure 80. Such closure 80 obviously can be opened by simply lifting it and moving it to a position clear of the access opening and can be reapplied by simply re-inserting it with its flange 81 in the liquid chamber 82. Since the device is intended for use by an operator who wears a diving suit to which a supply of air must be provided, it is necessary that the air line pass the seal, and means for this purpose are illustrated in Fig. 2. Such means comprise a provision of a tube 84 passing around or through the channel 82 and provided at its opposite ends for connectors (not shown) which may be of any suitable character, to which air conduits 85 leading to an air pump or the like and 86 leading to the diving suit may be connected. Assuming that the joints between the conduits 85 and 86, respectively, and the cross conduit 84 are sealed, it will be evident that the supply of air to the diving suit is not interrupted when the closure 80 is in place.

In the use of this apparatus it will be evident that the operator, having donned a diving suit or having entered the access chamber 72 within which the diving suit may be located and then having donned the suit, will close the access chamber 72 by replacing the closure 80 thereof. Thereupon by operating suitable controls (not shown) while standing in a predetermined position relative to the nozzles 75 at a time when his diving suit is completely sealed, he completely decontaminates the exterior of the suit and also decontaminates the air which may have entered from atmosphere through the access opening 72. This will be done at a time when the access opening 74 leading to the access chamber 65 is closed, and likewise at a time when the opening 67 between the access chamber 65 and the specimen chamber 10 is closed in the event the spray nozzles 75 are located in the access chamber instead of in the pit. Assuming that the nozzles 75 are located within the pit and that decontamination through the operation of and projection of a spray of gas into the pit has proceeded, the operator can wait until conditions within the pit are such that no danger of passage of a toxic atmosphere from the pit to the access chamber 65 and to the specimen chamber 10 will occur when the closures leading to those respective chambers are opened. In the case of a gas means may be provided in the nature of a conduit connected with a fan or air pump to continually evacuate

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air from the pit 70 so as to insure that germicide containing air will not pass through the access opening 74 when the closure thereof is opened. Alternatively, in case a liquid germicidal agent is used, a water spray may be provided, by means of which the diving suit may be rinsed following the spraying of the suit by a germicidal solution. In either instance, protection against the transfer of a toxic condition from the decontaminating chamber into the specimen chamber is provided. The operator having proceeded with both decontamination and avoidance of toxic conditions, can then open the closure 84 of the chamber 74 and the closure 68 for the opening 67 into the specimen chamber and may proceed with his work in attending to the specimens within the specimen cages 61. Throughout this time the closures 68 and 80 last mentioned may remain open, it being understood that the closure 80 for the access opening 72 will be closed. When the operator has completed his work within the specimen chamber, he leaves that chamber and closes the openings 67 and 74 behind him to effect a seal before he removes his diving suit or opens the closure 80 at the access opening 72.

It will be apparent that the spray or gas dispersion approach to the problem of decontaminating a diving suit totally removes all problems which ordinarily characterize a diving suit as used in a submerged condition; that is, totally eliminates all hydrostatic problems. Thus the problems of buoyant conditions due to the passage of air through such a suit when submerged are no longer present in this instance. The garment can be manufactured of light material with helmets and other spacers to hold face plates away from contact with the face; the heavy shoes which are required to insure that the user is submerged may be eliminated, thereby making it much easier for the operator to move about. A further advantage is that a return line for the air is not necessary and it is possible to provide the suit with a simple filter to vent or discharge air therefrom where that filter is treated in such a manner as to prevent the exhaust of any germs contained in the breath of the wearer through the vent. The avoidance of an air exhaust line is important because it is usually necessary to provide an air exhaust line of greater cross-sectional area than an air intake line. Also, it will be evident that the usual requirement for two lines complicates the movements of the user and makes certain manipulations necessary to avoid impeding the progress of the work.

Still another advantage of the present construction is that, where a liquid germicide is used and a rinse means is provided, danger of transmission of a toxic condition to a biological specimen is avoided. This is of great importance where germicides, such as formaldehyde, are employed which have a high toxicity.

The invention may be embodied in other forms, and one such alternative form is shown in Figs. 3, 4 and 5. In this instance the container 10 has its side wall 66 provided with an opening of size to permit a man to walk therethrough. The sides and top of this opening may be provided with channels 90 in which is continuously received, in a sealed manner, outturned seam portions 91 at the sides and top of a flexible tentlike member which defines an access chamber. The top is here shown as 92 and is held in shape by an annular member 93, preferably constituting a line leading to atmosphere and a supply of a germicidal material. The ring conduit 93 will have a plurality of spray heads 94 connected therewith and extending in divergent relation to the side walls 95 and in converging relation to each other. Side walls 95 will preferably be provided with a pair of fluid or air-tight slide fasteners 96 and 96'. The side walls 95 will be formed of a flexible material, and for this purpose a synthetic resin material, such as vinyl chloride sheeting or any other material which is air-tight and which will resist chemical reaction with germicidal material, such as formaldehyde, may be employed. Slide fasteners will preferably be of the character illustrated in Fig. 5, in which two complementary elongated clasp members 97, each having two continuous longitudinal jaws 98 having a snug fit with each other and being provided with a slider to accommodate their engagement and disengagement, will be provided. The interfit of such members is customarily tight enough to render them air-tight, especially in the two-jaw construction.

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The length of the flexible side walls 95 will be such that they extend below the level of the floor 11 of the specimen chamber 10 and into channels 196 containing a liquid 198 for reception of the lower ends of the walls which are preferably provided with weights 197. The lower marginal portion of each wall will be continuously submerged below the level of the liquid 198. One or more spray heads or germicide means 199 are located at the floor 11 to direct the discharge of the germicide upwardly.

In the use of this type of chamber, assuming that the slide fasteners 96 and 96' both are closed as the operator approaches the unit, and that the slide fastener 96 is outermost, the wearer of the diving suit will open that slide fastener 96 and enter the chamber, being sure to reseal the slide fastener 96 after he enters, and making sure also that the other slide fastener 96' is sealed. Thereupon he manipulates the controls for spraying germicide from the nozzles 94 and 99 or, alternatively, that is done by someone positioned exteriorly of the apparatus. This spraying of germicide, or dispersion thereof into the access chamber if gas is employed, is continued for a time sufficient to insure that all vectors of infection carried by the surface of the diving suit are destroyed and that the air within the chamber is decontaminated. Thereupon, after permitting the germicidal material to precipitate or become quiescent, the operator opens the slide fastener leading to the interior of the work chamber 10 and proceeds with his work in that chamber. In this connection he can either close the access chamber from the specimen chamber while he does his work or can leave it open, the latter condition, of course, necessitating that the outer closure remained sealed while he is within the apparatus.

This apparatus has all the advantages of the apparatus shown in Figs. 1 and 2, and in addition avoids the necessity for provision of one chamber above another. This is true with respect to chambers 65 and 70 of the Fig. 1 apparatus. At the same time seals for the access chamber are provided very efficiently, which are very simple in construction, inexpensive and easily operated. Full advantage is taken of the ability to use a spray or dispersion head for a gaseous germicide to decontaminate the exterior surface of a diving suit and the air contained within an access chamber during the time that access chamber is sealed from both atmosphere and from the interior of a specimen chamber.

While the preferred embodiments of the invention are illustrated herein, it will be understood that changes in the construction may be made within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. Biological apparatus comprising a normally closed 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 at an opening for communication with a specimen chamber and normally sealed therefrom by a releasable closure, a second access opening leading to said access chamber and normally sealed by a second releasable closure, and germicide discharge means within said access chamber for discharging germicide in diffused condition to permeate the atmosphere therein and treat all exposed surfaces of said diving apparatus.

2. Biological apparatus as defined in claim 1, wherein said discharge means constitute a plurality of spray nozzles for liquid germicide directed at different angles within said access chamber.

3. Biological apparatus as defined in claim 1, wherein said germicide discharge means constitute outlets for a gaseous germicide.

4. Biological apparatus as defined in claim 1, wherein liquid containers are carried by said access chamber and marginal portions of said releasable closure are immersed in said containers to define an air-tight seal of said closures at said margins.

5. Biological apparatus as defined in claim 1, wherein at least one closure member has a horizontal lower marginal portion and a liquid container receives said lower marginal portion to define a seal.

6. Biological apparatus as defined in claim 1, wherein at least one access opening is defined in a horizontal part of said access chamber, an endless liquid container opening at its top and encircling said horizontal access open-

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ing, and a closure member spanning said access opening and having an endless depending flange projecting into said container.

7. Biological apparatus as defined in claim 1, wherein at least one closure member has a horizontal lower marginal portion and a liquid container receives said lower marginal portion to define a seal, a conduit arranged in sealed relation adjacent said container, and air lines connected at opposite ends of said conduit to deliver air to a conduit within said access chamber when said closure member is sealed.

8. Biological apparatus comprising a specimen chamber having an access opening in an upright wall thereof, a flexible member having continuous sealed anchorage within said wall at the top and sides of said opening and defining an access chamber having inner and outer walls, a trough in the base of said first chamber containing a liquid and adapted to receive and immerse the lower

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marginal portions of the inner and outer walls of said access member to seal the bottom thereof, said inner and outer walls each having an elongated opening therein, and an air-tight slide fastener for closing each of said openings.

9. Biological apparatus as defined in claim 8, and means in said access chamber for discharging germicide to completely decontaminate the air and all contents in said chamber and the inner surfaces of said walls.

10. Biological apparatus as defined in claim 8, wherein a tubular member supports said flexible member in access-chamber-defining position, said tube having connection with a supply of germicide, said discharge means being connected with and supported by said tubular member.

No references cited.