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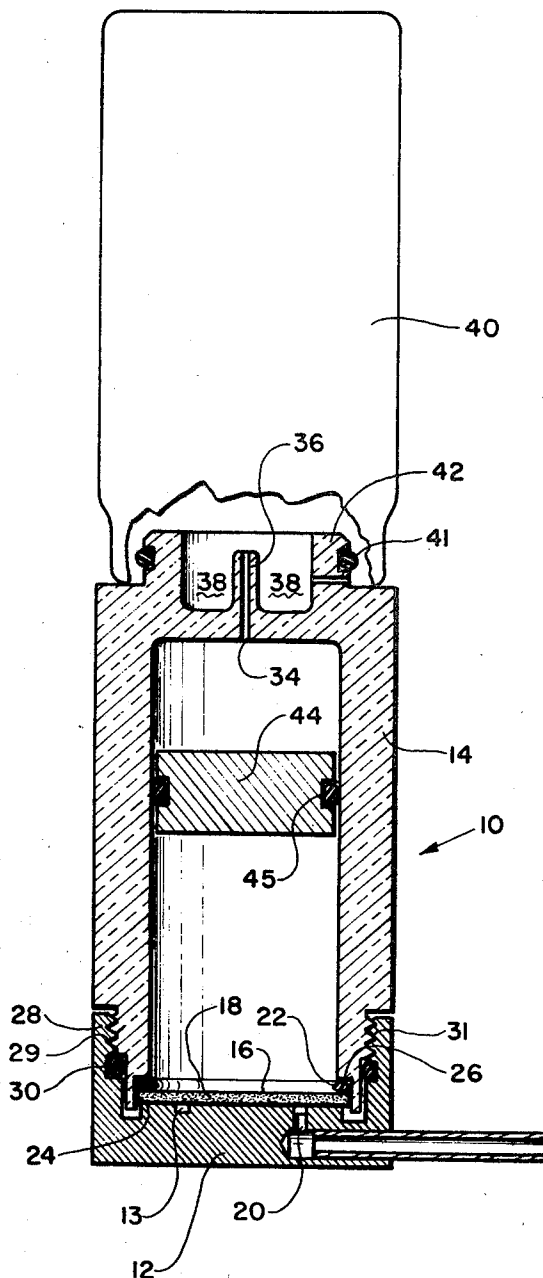
[54] ULTRAFILTRATION CELL

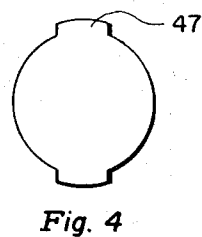
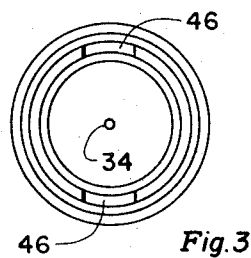
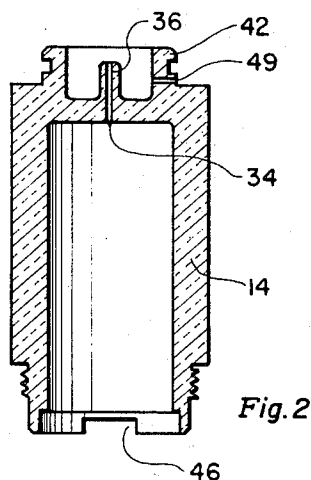
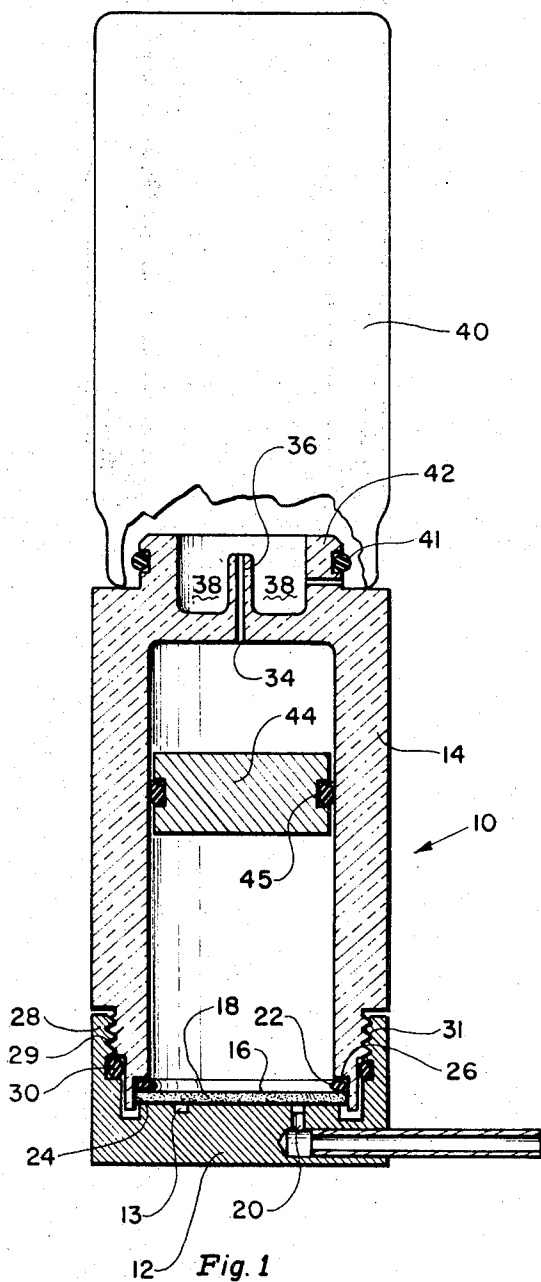
5 Claims, 4 Drawing Figs.

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[51] Int. Cl. B01d 31/00
[50] Field of Search 210/22, 23,
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ABSTRACT: An ultrafiltration apparatus comprising a reser-
voir for receiving materials to be ultrafiltered, a self-contained
auto-controlling, gas-pressurizing means to pressurize said
reservoir, a removable base member to allow easy filling and
cleaning of the apparatus, and a free piston mounted in the
reservoir forming a barrier between the pressurizing gas and
material being processed and also forming a valve effective
against leakage when the reservoir is being filled from the bot-
tom.





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ULTRAFILTRATION CELL

BACKGROUND OF THE INVENTION

Ultrafiltration is being rapidly accepted as an important method for concentrating, purifying, and fractionating various biological macromolecular materials and other macromolecular materials. Ultrafiltration normally requires moderate operating pressures, usually in the range of 10 to 100 p.s.i.g. Apparatus which has been available to the laboratory technician or field investigator has heretofore required an independent pressurized gas source and regulator therefore, (e.g. gas conduits and cylinders of gas) or required manual operation (e.g. hand-operated syringe-type ultrafilters). The commonly-used gas sources are usually inconvenient to handle and excessively space-consuming for convenient use in the average laboratory. Moreover, they require careful control of pressure regulating valves and their use is, therefore, subject to operator error. The syringe-type ultrafilters, although having the advantages of being portable, have no pressure controlling mechanism, and the pressure at which the ultrafiltration is carried out is largely dependent on the strength and/or care exercised by the operator.

SUMMARY OF THE INVENTION

Therefore, it is an object of the invention to provide an improved portable ultrafiltration apparatus which is capable of providing constant operating characteristics which are not dependent on operator judgement nor easily changed by operator error.

Another object of the invention is to provide an ultrafiltration apparatus which is quickly and easily filled and assembled.

Another object of the invention is to provide compact and portable ultrafiltration apparatus which comprises a handle means for facilitating dispensing of the ultrafiltrate.

Other objects of the invention will be obvious to those skilled in the art on reading the instant specification.

The above object have been substantially achieved by construction of an ultrafiltration apparatus comprising a reservoir for receiving material to be ultrafiltered, a self-contained and auto-controlling gas pressurizing means mounted on said reservoir, a removable base member to facilitate filling and cleaning of the apparatus, and a free piston mounted in the reservoir forming (1) a barrier between the gas and material being processed and (2) a leak-proof barrier against leakage when the reservoir is being filled from the bottom.

By an auto-controlling gas pressurizing means is meant one wherein the gas maintains constant pressure at constant operating temperatures. In practice a fluid is utilized wherein a gas phase is maintained in pressure equilibrium with its compressed liquid phase during operation at an ambient temperature above the gas's boiling point.

ILLUSTRATIVE EMBODIMENT OF THE INVENTION

In this application and accompanying drawings we have shown and described a preferred embodiment of our invention and have suggested various alternatives and modifications thereof, but it is to be understood that these are not intended to be exhaustive and that other changes and modifications can be made within the scope of the invention. The suggestions herein are selected and included for purposes of illustration in order that others skilled in the art will more fully understand the invention and the principles thereof and will be able to modify it and embody it in a variety of forms, each as may be best suited in the condition of a particular case.

IN THE DRAWINGS

FIG. 1 is an elevational view, partially in section, of the apparatus of the invention.

FIG. 2 is a section of the reservoir body of the apparatus of the invention.

FIG. 3 is a bottom view of the reservoir body shown in FIG. 2.

FIG. 4 is a plan view of the membrane support plate.

Referring to FIG. 1, it is seen that an ultrafiltration cell 10 is comprised of a bottom member 12 and a cylindrical reservoir member 14. A membrane 16 and a porous support plate 18 are sealed between members 12 and 14. Base member 12 comprises collector grooves 13 on the top surface thereof to facilitate the transport of ultrafiltrate to conduit 20 cut into base member 12. An O-ring seal 22 is placed in a cylindrical groove 24 formed at the membrane perimeter by shoulder 26 of reservoir member 14 and the membrane itself.

An upwardly projecting shoulder 28 of base member 12 forms means for bearing against reservoir member 14 and thereby controlling the maximum strain that can be placed on O-ring seal 22 during assembly of the apparatus. The inner wall of shoulder 28 and adjacent external wall 29 of reservoir member 14 are provided with fastening means such as threads 31 so that the two members are easily assembled by a simple screwing step. An auxiliary O-ring seal 30 helps avoid any leakage which may essentially occur due to wear of, or damage to, the threads.

The top of reservoir member 14 comprises an orifice 34 molded into a nozzlelike projection 36. Projection 36 is centered in a recess 38 and is adapted to engage the valve of a pressurized gas source such as can 40. Can 40 is received in recess 38 as projection 36 simultaneously activates the dispensing nozzle of can 40. An O-ring 41 is placed in the neck 42 of reservoir member 14 and forms biasing means for holding can 40 on neck 42 during the operation of the cell. However, O-ring 41 is sufficiently resilient to allow can 40 to be easily removed from neck 42 when it is desirable to stop the ultrafiltration action.

A vent conduit 49 has been drilled through neck 42 into recess 38 to provide a release for any errant propellant gas pressure.

Mounted in reservoir member 14 is a free-acting piston 44 which together with an O-ring seal 45 forms means to isolate gas on the upper side thereof from any sensitive biological fluids being subjected to ultrafiltration on the bottom side thereof. This piston 44 also acts as a seal means to prevent leakage through orifice 34 when bottom member 12 is unscrewed and the apparatus is inverted for filling with liquid to be ultrafiltered.

Referring to FIG. 2, it will be seen that there are slots 46 cut into the base member 12. Slots 46 are means for receiving earlike projections 47 of membrane support plate 18 and thereby holding the membrane support plate from turning while base member 14 is being screwed onto reservoir member 12. Such turning of the support plate has been found to exert undesirable stress on membrane 16.

The operating gas should be carefully selected to provide a suitable pressure for ultrafiltration processing solutions of biological-type macromolecular materials. Such solutions are those having molecular or cell-like constituents in the range of from 1.0 millimicron up to about 500 millimicrons. Thus the membranes which are preferred for use, and indeed necessary for the optimum operation of the apparatus of the invention, are the anisotropic membranes of the type having very thin (0.1 to 5 microns) barrier skins. These skins have effective pore sizes of from 1.0 to 500 millimicrons, depending on the particular ultrafiltration which one wishes to carry out, and are typified by the membranes sold under the trade designation DIAFLO XM and DIAFLO PM by Amicon Corporation of Lexington, Mass.

Suitable operating conditions are usually from about 5 to 150 p.s.i.g. and 10 to 40° C. Therefore, a particularly suitable gas dichlorodifluoromethane sold under the trade designation Freon 12 and other halohydrocarbon gases sold under various trade designations are especially useful. This gas will allow an operating pressure of about 70 p.s.i.g. at typical liquid-gas equilibrium conditions of about 70° F. A most suitable gas container is a standard "1 3/8-inch by 2 1/2-inch" tube (2 ounce-type) equipped with a so-called Newman-Green valve. This type of valve may be used to supply pressurizing fluid in either the upright or inverted position. Thus the can itself

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forms a useful handle which conveniently fits into the human hand and facilitates dispensing ultrafiltrate onto test tubes, onto glass slides, etc. Such a small container is useful over from about 40 to 60 ultrafiltration batch cycles and is therefore economical as well as convenient in the manipulative sense.

Various other advantages and modifications will be apparent to those skilled in the art and fall within the scope of the appended claims.

I claim:

1. Ultrafiltration apparatus comprising a reservoir having a pressurized gas inlet adjacent one end and a base member for closing said other end of said reservoir including means for supporting and sealing an ultrafiltration membrane to said other end and an outlet for material passing through said membrane, a free-acting piston mounted within said reservoir between said inlet and said base member for sliding movement to and from said inlet and base member, said piston including means forming a slidable seal against the wall of said reservoir, and means for releasably connecting said base member to said reservoir independently of the gas inlet end of said reservoir to

permit material to be filtered to be placed in the reservoir between the piston and the base member, said piston being arranged to seal said material against contact with pressurized gas.

2. Apparatus as claimed in claim 1 in which the means for supporting the membrane comprises a porous plate, and the releasable connecting means comprises mating screw threads on said base member and said reservoir, said apparatus including means for preventing turning of the porous plate with respect to the reservoir while said base member is being screwed onto said reservoir.

3. Apparatus as claimed in claim 2 comprising a self-contained auto-controlling gas pressurizing means connected to said gas inlet.

4. Apparatus as claimed in claim 3 comprising an ultrafiltration membrane mounted on said porous plate opposing said piston.

5. Apparatus as claimed in claim 4 in which said means for sealing said membrane to said reservoir includes an O-ring disposed around the margin of the membrane.

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