

United States Patent

[11] 3,540,700

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 [21] Appl. No. **793,774**
 [22] Filed **Jan. 24, 1969**
 [45] Patented **Nov. 17, 1970**
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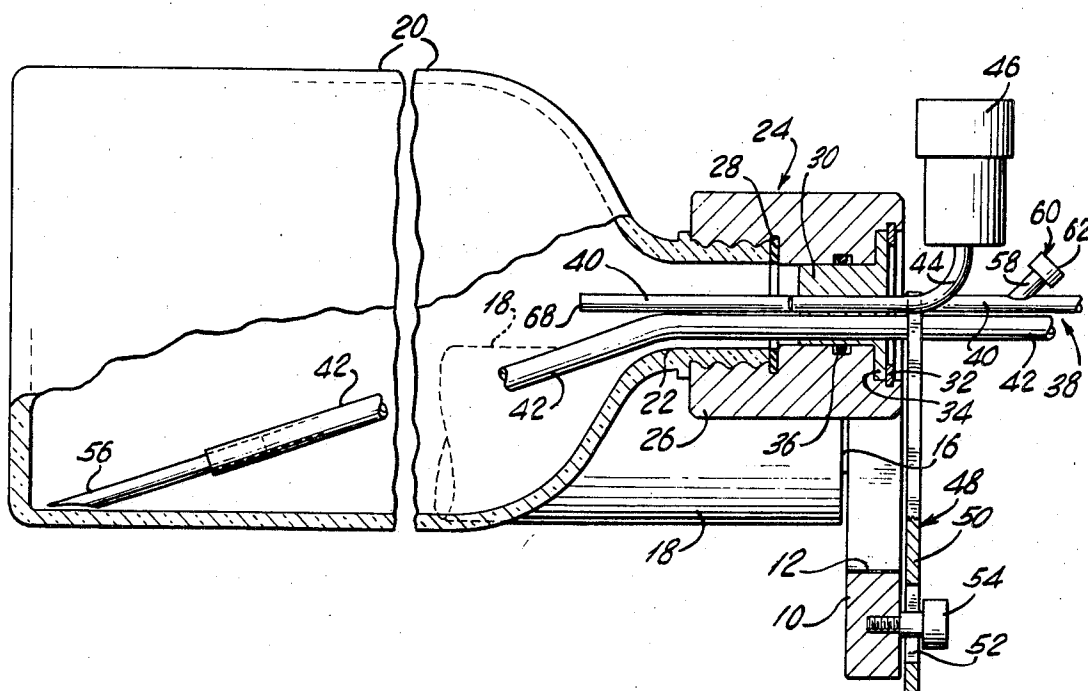
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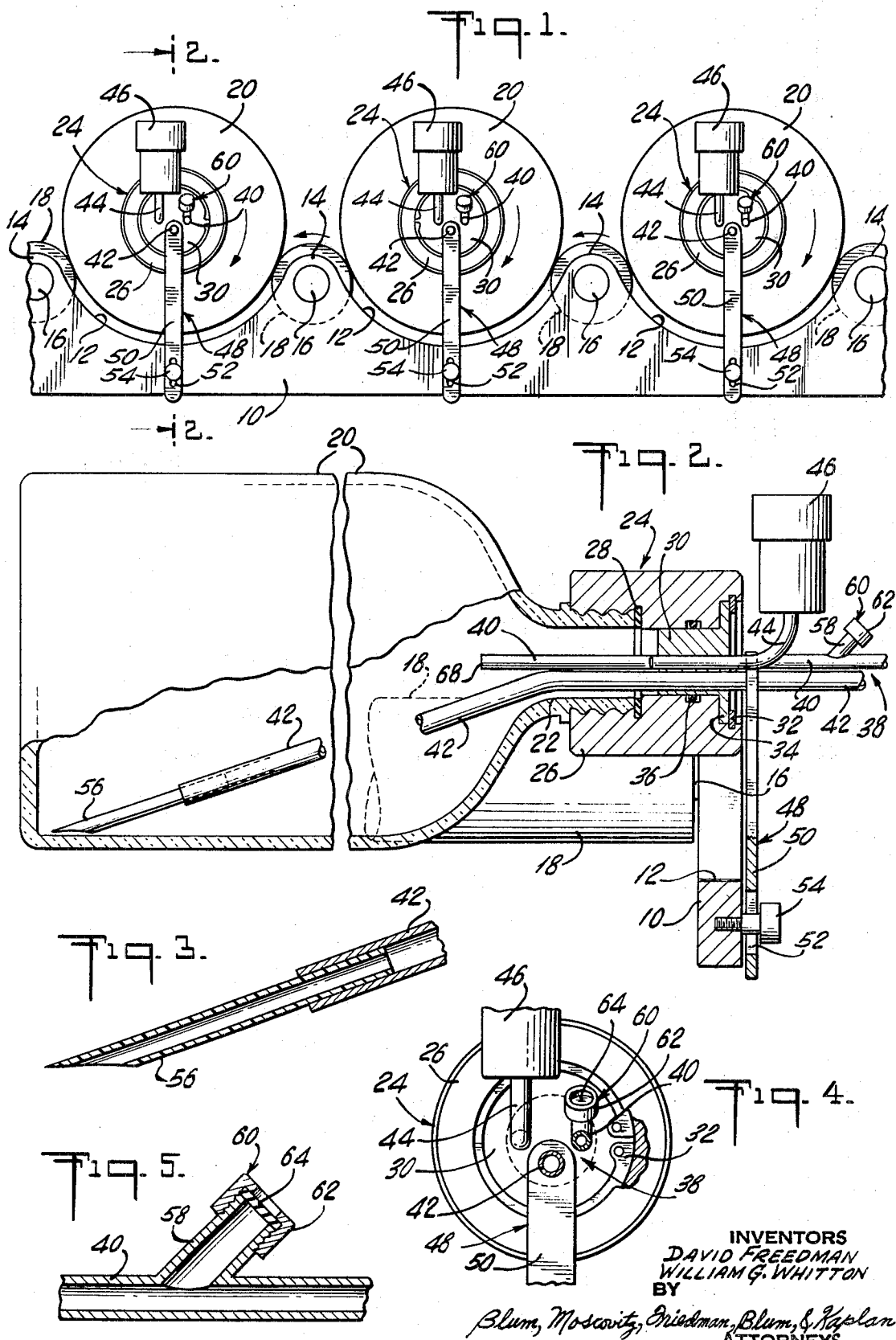
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[54] ROTARY PROCESSING APPARATUS 11 Claims, 5 Drawing Figs.

[52] U.S. Cl. 259/3,
 259/57
 [51] Int. Cl. B01f 15/02
 [50] Field of Search 259/3, 14,
 15, 16, 30—34, 57, 58, 81, 49, 50, 82, 83, 84, 85,
 86, 87, 88, 89, 90

ABSTRACT: A rotary processing apparatus adapted to carrying out such processing as the production of tissue cultures. The apparatus includes a rotary container having an opening through which materials can be introduced into and removed from the interior of the container. This opening is closed by a closure means which includes an outer ring rotating with the container and an inner plug which is stationary and with respect to which the ring and container rotate. A tubular means extends through the inner stationary plug so that through this tubular means materials can be introduced into and removed from the interior of the container while the latter continues to rotate with respect to the plug and tubular means.





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ROTARY PROCESSING APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to a processing apparatus.

In particular, the present invention relates to that type of processing apparatus which is used in connection with production of tissue cultures. Thus, the present invention is used for the production of cells, viruses, antigens, and the like.

At the present time, methods used for the production of vaccines such as the mumps vaccine and others involves the growth of human cells with a suitable nutrient medium in tissue culture bottles. Such bottles are sealed under sterile conditions with a conventional screw cap. The bottles may be rolled along horizontal axes on rollers, and the entire assembly is situated in controlled-temperature walk-in incubators.

With processing apparatus of this latter type it is periodically necessary to remove the caps from the bottles so that spent medium may be withdrawn and replaced by fresh medium. However, these manipulations are carried out under great risk of bacterial contamination. After a maximum cell growth is achieved, the culture bottles are deliberately infected with virus to induce the production of vaccine, and in connection with these latter operations there is again a great risk of contamination.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide a processing apparatus of the above general type which will avoid the above drawbacks.

In particular, it is an object of the invention to provide a processing apparatus according to which it becomes possible to supply materials to and remove materials from the interior of a rotating processing container without removing the closure from the container.

Thus, it is an object of the invention to provide for a container of the above general type a closure means enabling medium to be passed to and from the interior of the container during rotation thereof so that treatments such as virus inoculation, gas flushing, and trypsinization (removal of cells from the container wall by enzymes) can be carried out without removing the closure from the container and without risking contamination.

Furthermore, it is an object of the invention to provide an assembly of the above type which will enable a relatively large number of containers to be simultaneously operated.

In addition, it is an object of the invention to provide a closure means of the above general type which can be repeatedly sterilized without any deleterious effects thereon.

Also, it is an object of the invention to provide a structure of the above general type which is characterized by a great simplicity, low cost, and complete reliability in operation.

According to the invention a rotary container in which the processing is to be carried out has an opening through which materials are to be introduced into and removed from the interior of the container. A closure means of the invention closes this container at the opening thereof. This closure means includes an outer ring which is fluid-tightly fixed to the container for rotary movement therewith and an inner plug surrounded by the outer ring and with respect to which the ring rotates while having a fluid-tight sealed slidable engagement therewith. A holding means is provided for maintaining this plug stationary so that the ring of the closure means and the container rotate around the stationary plug. A tubular means extends through the plug so that through this tubular means materials may be introduced into and removed from the container without removing the closure means and while the container rotates without interruption.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is a front elevation illustrating part of an assembly for supporting a plurality of containers for rotary movement, with these containers being provided with the closure means of the invention;

FIG. 2 is a longitudinal sectional elevation taken along line 2-2 of FIG. 1 in the direction of the arrows and showing the structure at a scale which is enlarged as compared to FIG. 1;

FIG. 3 is a fragmentary sectional elevation illustrating the details at the lower end of a material extracting tube where the latter tube coacts with the lower interior portion of the container;

FIG. 4 is a partly sectional front elevation fragmentarily illustrating the closure means as it appears in FIG. 1 shown at an enlarged scale in FIG. 4; and

FIG. 5 is a fragmentary longitudinal section illustrating the details of a tube of the tubular means of the invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings, there is shown in FIGS. 1 and 2 the front wall 10 of a suitable stationary frame structure adapted to be supported, for example, on a bench. This front wall 10 extends parallel to an unillustrated rear wall, and these walls are formed along their upper edges with aligned recesses 12 of substantially semicircular configuration. Thus, between these recesses 12, the front and rear walls of the frame will have upper portions 14, and these portions 14 are formed with openings accommodating the suitable bearings to support for rotary movement roller journals 16 of a series of elongated parallel horizontal rollers 18. These rollers may, for example, take the form of suitable rubber sleeves mounted on and gripping elongated shafts which terminate in the journals 16 received in the bearings of the front wall 10 and the unillustrated rear wall of the frame. At this rear wall the roller shafts may respectively carry suitable gears all of which mesh with the teeth of a suitable tooth belt, for example, which is driven from a suitable transmission which in turn is driven by an electric motor, for example, so that in this way all of the rollers are rotated in a counterclockwise direction, as indicated by the arrows in FIG. 1.

Between each pair of successive rollers 18 is a rotary container 20. Each container 20 is in the form of a bottle made of a high quality glass suitable for processing such as the growth of tissue cultures of the type referred to above. Thus, with this arrangement a series of rotary containers 20 which have their central axis horizontally oriented will respectively be rotated about their axis with the several containers rotating in a clockwise direction as viewed in FIG. 1.

Each container 20 is provided with an opening 22 through which materials required for the processing can be introduced into and removed from the interior of each container 20. As is apparent from FIG. 2, this opening 22 in the illustrated example takes the form of the neck of the bottle 20, this neck being provided with an exterior thread as indicated in FIG. 2.

A closure means 24 of the present invention coacts with each container 20 at its opening 22. This closure means 24 includes an outer ring or sleeve 26 which is fixed directly to the bottle 20 for rotary movement therewith. Thus, the ring 26 is in the form of an elongated tubular member having an interior thread which coacts with the thread at the exterior of the neck 22. The direction of the thread is preferably opposite to the direction of rotation of the container so that there will be a tendency to tighten the ring 26 on the container. Just beyond the neck 22 the ring has a shoulder pressing a sealing gasket or ring 28 against the right end face of the opening 22 as viewed in FIG. 2. In this way a fluid-tight fixed connection is provided between the ring 26 of the closure means 24 and the container 20.

The closure means 24 further includes an inner plug 30 which is stationary and around which the ring 26 and container 20 rotate. This inner plug 30 is of a generally cylindrical configuration and has its axis coinciding with the axis of the bottle 20 so that the latter rotates around the axis of the stationary plug 30.

The stationary plug 30 may be made of any suitable metal, for example, and a springy snap ring 32 is provided for retaining the plug 30 within the ring 26. This plug 30 has at its outer end an outwardly directed flange 34 received in an outer recess of the ring 26, and this ring is formed with a groove accommodating the snap ring 32 so that the latter will releasably retain the plug 30 in its position assembled with the ring 26.

At the interface between the plug 30 and the ring 26 a low-friction slidable surface contact can be provided between the ring or sleeve 26 and the plug 30. For example, it is possible to coat the exterior of the plug 30 with a material such as Teflon to achieve this low-friction interface between the plug 30 and the ring 26.

Furthermore, in order to enhance the fluid-tight slidable sealed engagement between the stationary plug 30 and the rotary ring 26, the ring is formed with an interior groove accommodating an O-ring 36 which resiliently presses against the exterior stationary surface of the plug 30.

Materials are introduced into and removed from the exterior of the container 20 through a tubular means 38 which may include a supply tube 40 and a material-extracting tube 42. In addition, the tubular means includes a vent tube 44 extending through the stationary plug 30, having an inner open end communicating with the interior of the container 20 and having an outer open end carrying an air filter assembly 46. The several tubes 40, 42, and 44 are received with a relatively snug, tight fit in axially extending bores which are formed in the plug 30. In addition, the several tubes of the tubular means 38 may be made of metal and may be, for example, welded directly to one or both of the end faces of the plug 30.

A holding means 48 is provided for holding each plug 30 stationary. This holding means includes, for each plug 30, an elongated bar 50 made of a suitable metal and formed with an opening through which the tube 42 extends, this tube 42 being welded, for example, to the upper end of the bar 50 so as to have a fixed connection therewith. At the region of its lower end each bar 50 is formed with a longitudinally extending slot 52 and a screw 54 extends through each slot 52 into a threaded bore of the front frame wall 10, in the manner shown most clearly in FIG. 2. It is emphasized that the screw 54 does not fix the bar 50 to the wall 10. It only prevents rotary movement of the bar 50, and the slot 52 is provided to take care of any variations in the size of the components. Thus, because the screw 54 extends through the slot 52 each bar 50 is prevented from rotating and since each bar 50 is fixed to a tube 42, the plug 30 which is also fixed to the tube 42 is prevented from rotating. With this arrangement it is a simple matter simply to remove the screw 54 so that any container can then be removed from the drive rollers 18.

The outer open end of the tube 42 may be connected to any suitable vacuum pump or the like, so that materials in the interior of the container 20 can be extracted therefrom through the tube 42. In order to situate the tube 42, at its inner lower end, closely adjacent to the lowermost and innermost portion of the container 20 without any substantial frictional contact therewith, each tube 42 is provided at its inner end with a tubular insert 56 made also of a material having a low coefficient of friction such as Teflon, so that with this construction, shown most clearly in FIG. 3, if there should be any frictional contact with the rotary container, no particular damage will be done to the components.

Materials are supplied to the interior of the container through the supply tube 40. As is most clearly apparent from FIG. 5, each supply tube 40 is provided with a branch 58, and this branch is closed by a diaphragm closure 60. Thus, the diaphragm closure includes a threaded ring 62 threaded onto and fluid-tightly engaging the upper end of the branch 58, and this ring 62 carries a flexible closure diaphragm 64 made of a suitable elastomer, for example. The materials which are to be introduced are supplied to the interior of the tube 40 so as to flow therealong into the interior of the container, discharging from the inner end 68 of the supply tube 40. Thus, through this closure 60 it is possible to provide virus inoculation through the rubber diaphragm 64, so that a high standard of

sterility will be achieved with this rubber diaphragm. The nutrient is admitted along the other branch of the supply tube 40, so that in this way any residue virus which may be present in the supply tube is washed down by the subsequently added nutrient.

It is apparent, therefore, that with the structure described above it is possible to carry out processes such as the growth of tissue culture in a completely safe and reliable manner. The quality of the glass of each bottle 20 is such that it has sufficient clarity to permit the growth to be observed. With a series of bottles it is possible to have sequential feeding either manually or automatically in any selected sequence. Also, it is possible to adjust the rate of the nutrient feed as desired. The entire assembly can be modular in design so that several tiers can be placed one upon the other with each tier having a series of horizontally arranged rotary bottles. In this way processes at various stages can be carried out simultaneously. With the apparatus of the invention it is possible to easily carry out such operations as nutrient addition, withdrawal of spent medium through the extracting tube 42, filtered air exhaust through the vent tube 44, CO₂ gassing, virus inoculation, and trypticinization.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above constructions without departing from the spirit and scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

We claim:

1. In a processing apparatus, a rotary container in which a given processing is to be carried out, said container being formed with an opening through which materials are to be introduced into and removed from the interior of the container, closure means coacting with said container at said opening thereof for closing the container, said closure means including an outer ring carried by the container at the opening thereof for rotary movement therewith and an inner plug around which said ring rotates together with said container, holding means coacting with said plug for holding the latter stationary while said ring and container rotate around said plug, and tubular means extending through said plug and through which materials can be introduced into and removed from said container.

2. The combination of claim 1 and wherein said plug of said closure means and said ring of said closure means define between themselves an interface of low friction.

3. The combination of claim 1 and wherein a rotating means coacts with said container for rotating the latter.

4. The combination of claim 3 and wherein said rotating means includes a pair of parallel mutually spaced rollers respectively having horizontal axes, said container having a diameter greater than the distance between said rollers and resting thereon to be rotated thereby about a horizontal axis, said ring of said closure means having its center situated in the axis of rotation of said container and said plug being of a generally cylindrical configuration and having an axis coinciding with the axis of rotation of said container.

5. The combination of claim 4 and wherein said tubular means includes at least one tube extending through and fixed to said plug, a frame supporting said rollers, and said holding means including a bar extending from and fixed to said one tube and releasably connected with said frame.

6. The combination of claim 4 and wherein a series of said rollers are located one after the other in parallel relation with one of said containers situated between and carried by each pair of successive rollers rotated thereby so that a number of

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processes can be independently carried out in several containers.

7. The combination of claim 1 and wherein said tubular means includes at least one venting tube communicating with the outer atmosphere and with the interior of the container through said plug and an air-filter carried by said venting tube at the exterior of the container.

8. The combination of claim 1 and wherein said tubular means includes a supply tube through which materials are supplied into the interior of the container and an extraction tube through which materials can be extracted from the interior of the container.

9. The combination of claim 1 and wherein said tubular means includes an elongated supply tube extending through said plug for supplying materials to the interior of the container, and said supply tube having a branch extending therefrom at the exterior of the container, a diaphragm clo-

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sure extending across said branch and closing the latter so that through said branch materials can be introduced into said supply tube to be washed along the interior of the latter and into the container by other materials.

10. The combination of claim 1 and wherein said container is in the form of a bottle having a neck forming said opening thereof, said ring being threaded onto said neck and having a fluid-tight engagement therewith, and said plug which is held stationary also having a fluid-tight engagement with the ring which rotates around said plug with said container.

11. The combination of claim 1 and wherein said tubular means includes a tube extending to a low portion of the container for extracting materials therefrom, and a low-friction insert carried by the latter tube at the low portion of the container for reducing the friction resulting from any engagement between the latter tube and the container.

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