United States Patent

Duhring et al.

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[45] **Dec. 5, 1972**

[54] **APPARATUS FOR THE FILLING OF PETRI DISHES**

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[73] Assignee: **H. Struers Chemiske Laboratorium,** Copenhagen, Denmark

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[52] **U.S. Cl.** .....**53/109,** 53/381 A

[51] **Int. Cl.** **B65b 31/02**

[58] **Field of Search** .....53/109, 381 A

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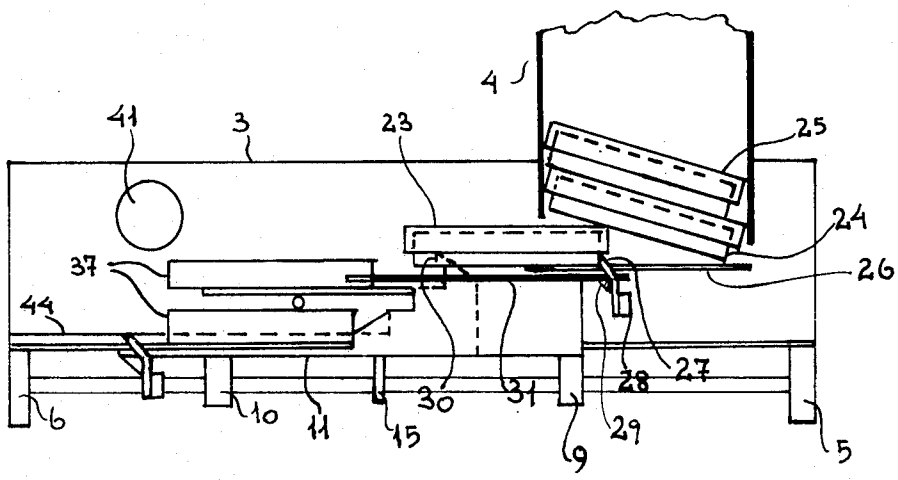
Primary Examiner—Travis S. McGehee

Attorney—Watson, Cole, Grindle & Watson

[57] **ABSTRACT**

An apparatus for filling Petri dishes with cover comprises an alongated sterile chamber in which a dish and lid are fed forward in rectilinear paths in different levels from a stack of closed dishes in a hopper at one end of the sterile chamber, the dish being caused to drop down on the bottom of the chamber between slide rails that catch the edge of the lid. In one position of the travelling path the dish is filled with substrate, and in a subsequent position the lid is caused to drop down on the dish. Preferably the distance between the slide rails is adjustable.

9 Claims, 15 Drawing Figures



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SHEET 1 OF 6

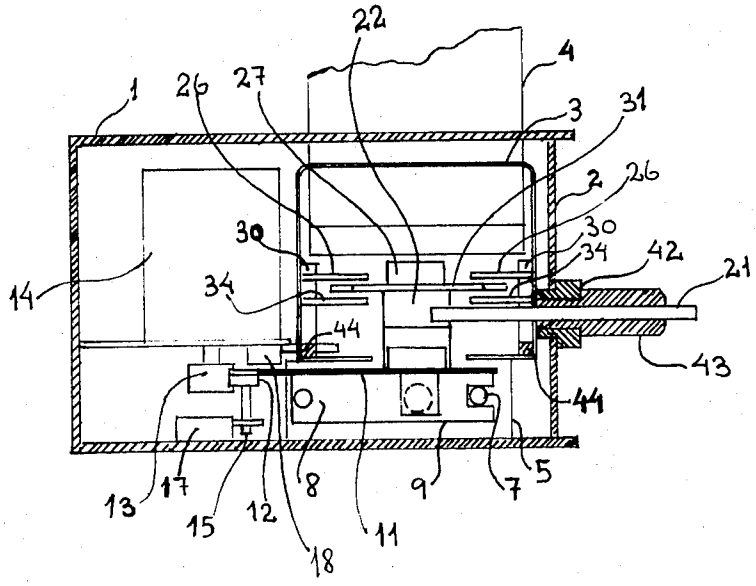


Fig. 1.

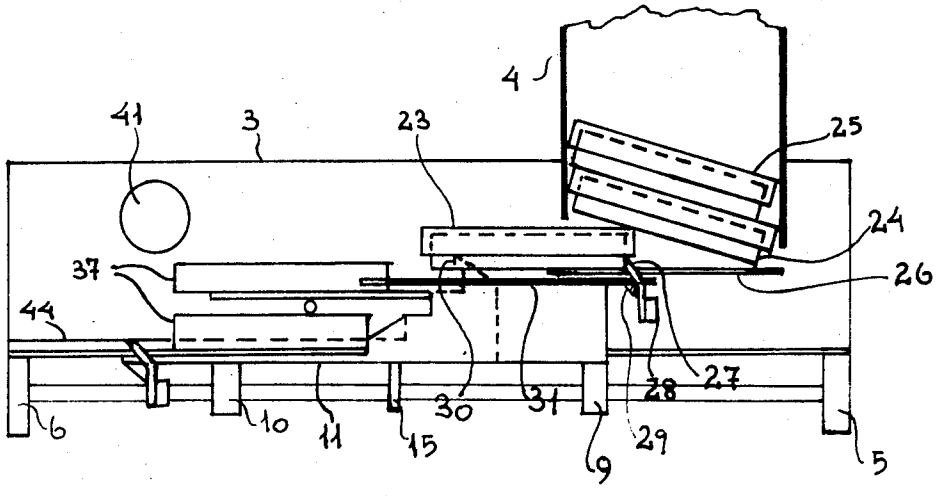


Fig. 2.

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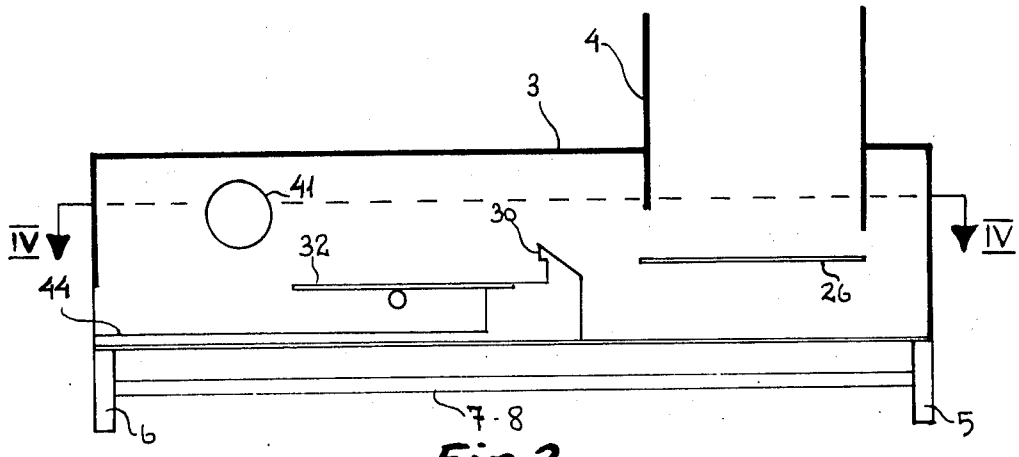


Fig. 3

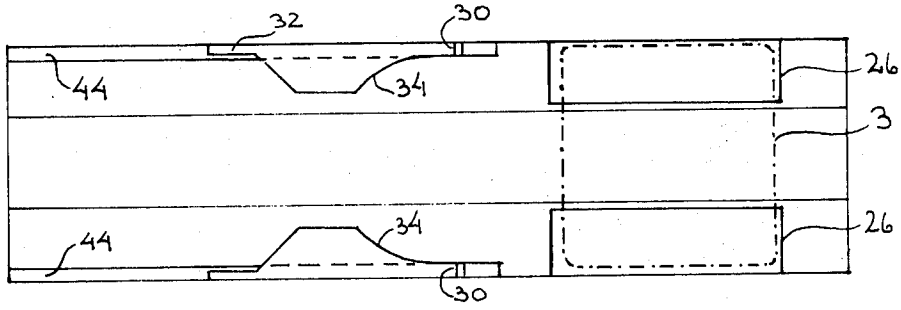


Fig. 4

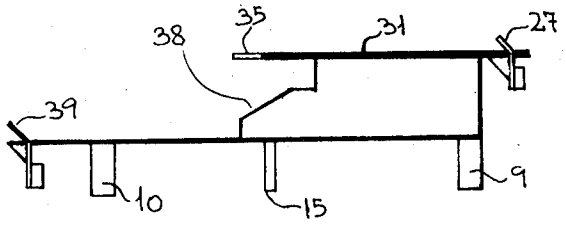


Fig. 5

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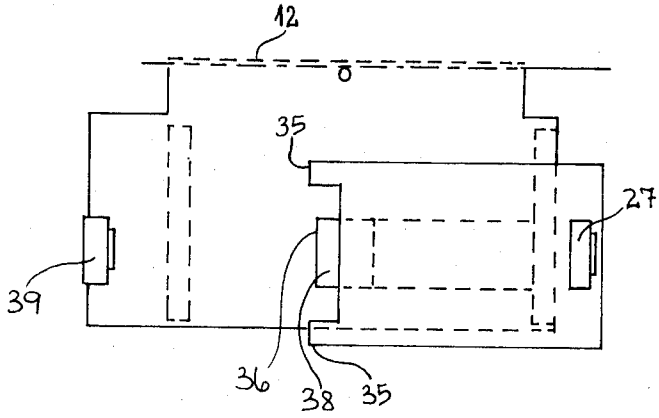


Fig. 6

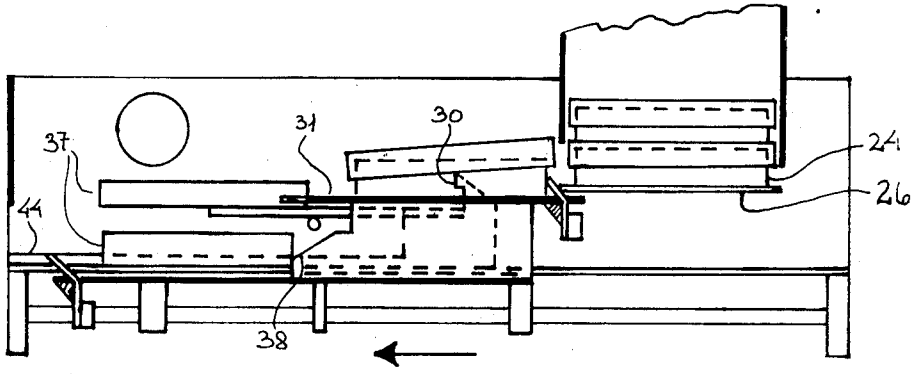


Fig. 7

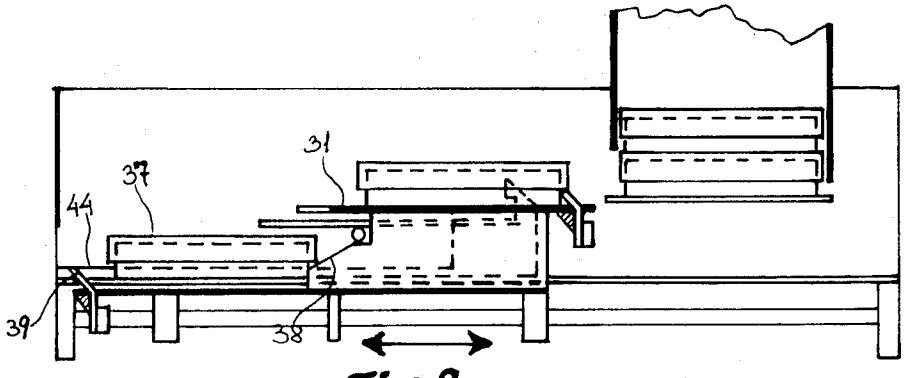


Fig. 8

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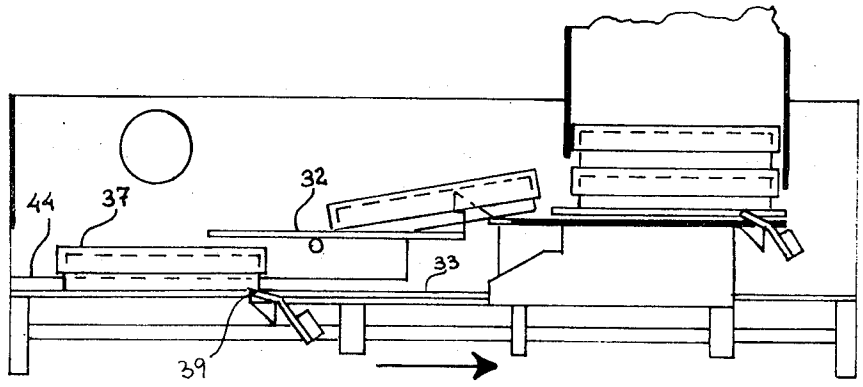


Fig. 9

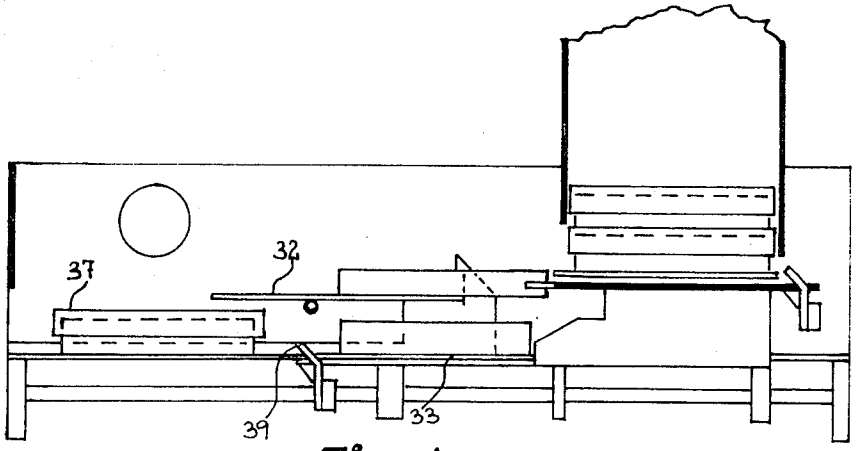


Fig. 10

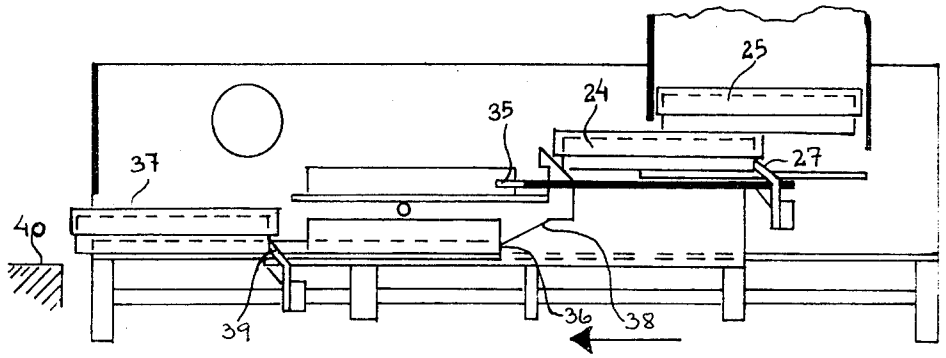


Fig. 11

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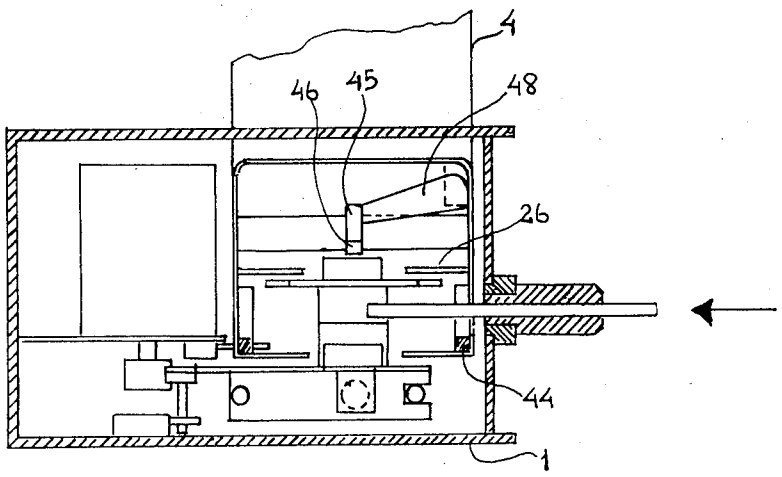


Fig. 12

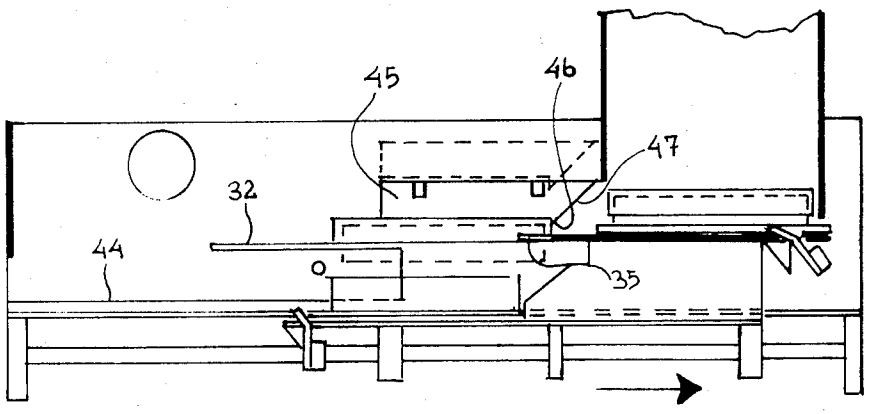


Fig. 13

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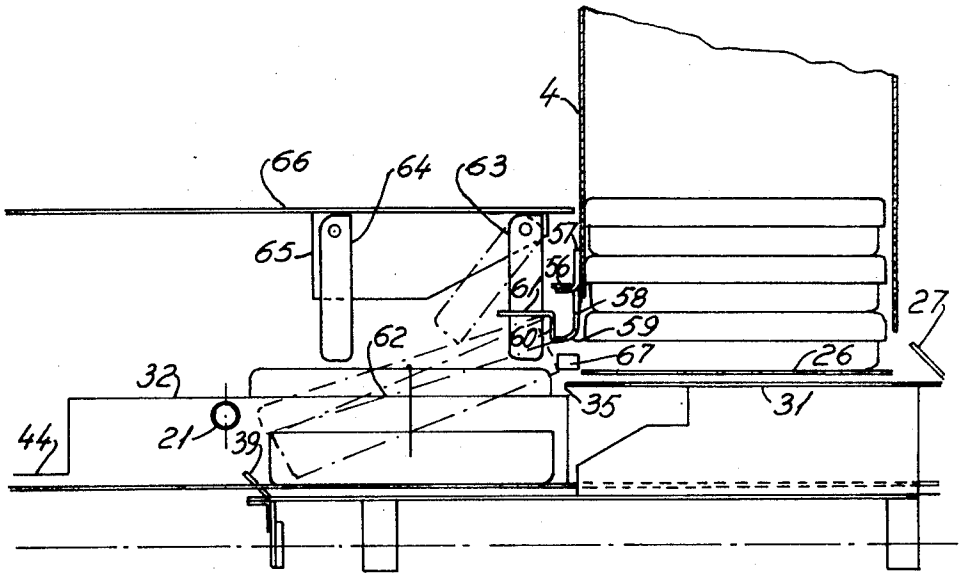


Fig. 14

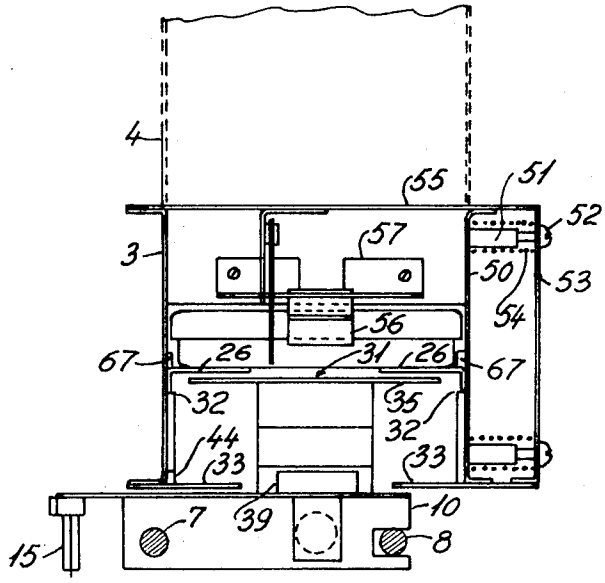


Fig. 15

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APPARATUS FOR THE FILLING OF PETRI DISHES

BACKGROUND OF THE INVENTION.

This invention relates to an apparatus for filling a nutrient substrate into Petri dishes with lid, said apparatus being of the kind comprising a sterile chamber, a conveying mechanism for conveying closed dishes one by one from the lower end of a stack in a hopper into and out of the sterile chamber, means for opening the dishes while in the sterile chamber, and means for filling substrate into the dishes while these are open.

In a known apparatus of this kind the conveying mechanism consists of s rotatable star-like dish having openings at its periphery for receiving the Petri dishes, while the means for opening the dishes consist of a cam face engaging the edge of the lid from below at a point of the circular movement of the dishes, whereby the lid is lifted to an inclined position to open the dish sufficiently for permitting the filling-in of substrate through a tube.

A difficulty in the use of such an apparatus is that Petri dishes are supplied in the trade in dimensions which for each individual type vary within rather wide tolerance limits from make to make. Seeing now that the said cam face must be so arranged that the dish cannot be jammed, but on the other hand the edge of the lid must with certainty be engaged by the cam face, it will be understood that there is a considerable risk of failure of the apparatus if it is used for dishes with dimensions outside rather narrow tolerance limits in relation to particular the dishes for which the apparatus was designed. Both jamming of dishes and failure to lift the lid may result in blocking of the apparatus or serious disturbances of the operation, necessitating opening of the sterile chamber, whereby the sterility is jeopar-dized

SUMMARY OF THE INVENTION.

It is an object of the invention to devise an apparatus which is capable of handling dishes with dimensions within wider tolerance limits than in previously known apparatus and in which the danger of blockage and disturbance of the operation necessitating opening of the sterile chamber is reduced.

According to the invention, an apparatus for filling Petri dishes each having a lid comprises an elongated sterile chamber, a hopper at one end of said sterile chamber, said hopper being constructed to receive a supply of Petri dishes with lid stacked upon one another, and being provided at its bottom with a passage opening permitting the passage of the lowermost dish from the hopper into the sterile chamber, a conveyor reciprocatable longitudinally of the sterile chamber and under the hopper, said conveyor having means engageable with a dish and a lid to convey same from the hopper through the sterile chamber, slide rails for supporting the edge of the lid over part of its travelling path in a level lower than that of the edge of the lowermost dish in the stack, a slide track for the dish in a level at a distance below that of said slide rail greater than the height of the dish, a filling outlet in a position below said guide rails and at a distance above said guide track greater than the height of a dish, and means for discharging a predetermined quantity of liquid substrate through said filling outlet while a dish is in a position thereunder.

It has been found that the guiding of dishes and lids in a rectilinear movement is less critical in respect of variations of the dimensions than the guiding in a circular path. Moreover, the elements defining a rectilinear path can be adjusted by a simple parallel displacement and accordingly, in a preferred embodiment of the invention, the distance between said guide rails is adjustable. The opening of the dishes takes place in a simple manner by causing the dish and the lid to drop under the influence of their gravity to different levels with the lid elevated from the dish. Moreover, it is possible to reduce the dimensions of the apparatus to a minimum since the sterile chamber must only have a length corresponding to about three dishes and a width approximately corresponding to one dish.

BRIEF DESCRIPTION OF THE DRAWINGS.

FIG. 1 shows a cross section through an apparatus according to a first embodiment of the invention.

FIG. 2 shows a longitudinal section through same.

FIG. 3 shows a longitudinal section through the stationary parts of the apparatus.

FIG. 4 shows a section along the line IV—IV in FIG. 3.

FIG. 5 is a side view of a conveyor forming part of the apparatus.

FIG. 6 is a top view of same.

FIGS. 7–11 are side views corresponding to FIG. 2, but illustrating the parts in other positions which they successively occupy during a working cycle.

FIG. 12 shows a cross section through an apparatus according to a second embodiment of the invention.

FIG. 13 shows a longitudinal section through the apparatus of FIG. 12.

FIG. 14 shows a longitudinal section through an apparatus according to a third embodiment of the invention.

FIG. 15 is a corresponding cross section.

All figures are to be understood as diagrammatical.

DESCRIPTION OF THE PREFERRED EMBODIMENTS.

In an outer box 1 having a removable front plate 2 there is provided a chamber 3 which is constructed with a hopper 4 extending upwards out of the box 1. The front plate 2 is only removed when the chamber is to be taken out for cleaning and sterilization. The hopper is constructed as a shaft of square cross section and is provided at its front side with an opening through which dishes may be inserted. Corresponding openings are provided in the front plate 2 and in the front wall of the chamber 3.

The chamber 3 is supported on two legs 5 and 6 carrying two slide rods 7 and 8. These serve as guides for two blocks 9 and 10 carrying a conveyor 11, see FIG. 2.

The conveyor 11 is constructed with a laterally extending arm carrying a rack 12 which engages a pinion 13 by means of which the conveyor can be moved back and forth by a motor 14. The motor which is of the multi-pole low-speed type is controlled by automatic switching means well known in the art. The function is as follows: In each of the end positions of the conveyor 11 a pin 15 mounted on the rack 12 operates one of a pair of stationary switches, only one of which, 17, is shown in the drawing. Thereby the motor is reversed

and in this manner the conveyor is caused to move back and forth between the end positions. If, however, a Petri dish passes through the apparatus, the dish will operate a third switch **18** having an arm extending into the chamber **3**. Thereby the motor is stopped. At the same time a hose pump is started to pump substrate from a supply container through a tube **21** opening above the dish. The pump runs for a predetermined number of seconds. When it is stopped the motor is started again. Thus, discharge of substrate takes place only when a dish is present at the proper location.

The conveyor **11** carries a frame **22** extending into the chamber **3** and having a platform **31** in an elevated position above the bottom of the chamber. The cooperation of the several parts of the said frame with the stationary parts in the chamber will best be understood from a study of FIGS. **7–11**, illustrating the various phases of the function of the apparatus, in conjunction with figures **3** and **4** separately showing the chamber and the parts mounted therein, as well as FIGS. **5** and **6** showing the conveyor with the parts mounted thereon.

The arrangement will be explained by following the travel of a dish through the apparatus. The dishes, of which the lowermost three ones are denoted by **23**, **24** and **25**, are stacked in closed state and supported on two plates **26** forming the bottom of the hopper. The frame of the conveyor carries a pawl **27** which has two end positions, viz. an erected position in which it is engageable with the dish without reaching the lid, and a lowered position in which it can slide under the bottom of the dish. When the conveyor is moved from its right-hand end position to the left, the pawl **27** pushes the lowermost dish **23** out of the stack of dishes, FIG. **2**. The pawl is kept in its upright position by a counter weight **28** which, however, is so light that the pawl cannot lift a dish. In its upright position the pawl is supported by a bracket **29**. When the dish is pushed out of the hopper, as in FIG. **2**, the lid passes above two stationary hooks **30**, one of each side of the dish while the dish itself passes between the hooks. In FIG. **7**, the dish has slid off the plates **26** and is now supported on the platform **31** while the lid is supported partly on the front edge of the dish, partly at both sides on the hooks **30**. In FIG. **8**, which shows the conveyor in its left-hand end position, the lid has slid off the hooks **30** and is again in position on the dish. The sides of the lid are now located in front of the hooks, and when the conveyor is again moved to the right, the lid and thereby also the dish are detained by the hooks **30** which engage the lid at both sides so that the platform **31** is withdrawn from under the dish, as shown in FIG. **9**. Thereby the dish with the lid in position thereon is caused to drop. The lid is caught by two slide rails **32**, while the dish drops down between these and lands on two lower rails **33** constituting the bottom of the chamber and forming a slide track for the dish. If, at the location where the slide rails **32** are struck by the lid, the slide rails had only a sufficient width for just catching the edges of a lid of minimum diameter, unreliability of the function were to be feared because the lid, which would then only be supported in two diametrically opposite zones, would have a tendency to oscillate about an axis through these supporting zones. This is unfortunate since the lid should immediately thereafter be engaged by the front edge of the platform **31** when the conveyor again moves to the left. To avoid such oscillations of the lid, the guide rails **32** are provided with two arcuate lugs **34**, FIG. **4**, which support the lid along a substantial part of its circumference when it is in the position shown in FIG. **10**. It will be seen that when the conveyor goes from the position shown in FIG. **9** to that shown in FIG. **10**, the lid is moved towards the hooks **30** between which it cannot pass and thereby the lid is centered in the middle plane of the chamber because the hooks engage the lid from behind in two points in symmetrical positions with respect to the middle axis between the guide rails **32**. When the conveyor has been reversed and is again moved to the left this centering is maintained because the lid is pushed forwards by two projections **35** of the platform **31** which engage the lid in two points is symmetrical positions with respect to the middle plane. In FIG. **11** the dish,which is moved forward by a vertical surface **36** of the frame of the conveyor, has reached the point where it operates the switch **18**, whereby the movement of the conveyor is stopped while the dish is being filled.

The continued movement of the dish will best be understood by considering the preceding dish **37**, see FIG. **2**, where this dish has just been filled and is pushed further forwards to the left. When the lid slides beyond the ends of the guide rails **32**, FIG. **7**, it drops onto the dish, cf. FIG. **8**. It has been found that the lid, in order to be properly received on the dish, should preferably drop down from the rail **32** slightly behind the position of the dish and then be guided into position by an inclined surface **38** on the frame **22**. The conveyor is provided at its extreme left hand end with a pawl **39** of the same character as the pawl **27** at the other end. When in its lowered position the pawl **39** slides under the bottom of the dish during the next movement of the conveyor to the right, FIG. **9**, and during the next following movement of the conveyor to the left, FIG. **11**, the pawl in its erected position conveys the filled and closed dish out of the chamber and onto a receiving table **40**.

An ultraviolet lamp, which is mounted in the box and extends into the chamber through a hole **41**, keeps the air in the chamber sterile during operation. The tube **21** is sterilized together with the hose. In order to permit insertion of the tube into its socket **42**, FIG. **1**, in the front plate, which is not sterilized, without destroying the sterility, the tube is provided with a sleeve **43** which is sterilized together with the tube, while the end of the tube, which is to extend into the chamber, is withdrawn into the sleeve. The sleeve is mounted in position in the socket **42** and the tube **21** is thereafter pushed into the chamber.

If a dish has accidentally been placed in the hopper in inverted position it will not block the movement, but will follow the normal path of the lid through the mechanism and will be pushed out without substrate having been discharged.

In the embodiment of FIGS. **12** and **13** the arcuate lugs **34** have been omitted so that a dish that may not become separated from the lid, but remains suspended therefrom, may pass between the guide rails **32** which are arranged at a so high level that the suspended dish can pass above the tube **21**. Consequently, the

mechanism will not be blocked even if the dish fails to be opened. This may — though extremely rarely — occur owing to manufacturing faults or because a particle of the material has become jammed between the lid and the dish, or because both the lid and the dish happen to be so accurately plane that the air penetrates too slowly. Another advantage of the embodiment of FIGS. **12** and **13** is that greater variations of the height of the combined dish and lid are permissible.

However, if no special precautions are adopted the situation previously mentioned may occur, viz. the situation where the lid, being supported only in two diametrically opposite points, begins to oscillate and will therefore not be engaged by the projections **35** when it is to be pushed further forwards. To avoid this, a vertically movable bar **45** is provided which constitutes a guide member engageable with the upper face of the lid to restore this to horizontal position at a minimum of delay. To detain the dish when the platform **31** is moved away from under it, the bar **45** is provided with a small hook **46**. In FIG. **13** the bar **45** is shown in full lines in its lowermost position and in dotted lines in its uppermost position which it reaches when the dish is to be moved from the hopper in under the bar. The hook **46** thereafter engages the lid from behind. Thus, the two hooks **30** have been omitted.

When there is no dish under the bar, this must not drop so far down that the dish being moved out of the hopper does not strike the inclined end face **47**. The bar may be mounted on two arms **48**, FIG. **12**, which are so constructed that the bar is stopped in a level corresponding to that which it assumes when resting on a lid after the dish has dropped down.

As compared with the first embodiment, that of FIGS. **12** and **13** has the disadvantage that the centering of the lid obtained by means of the hooks already before the platform **31** has been withdrawn does not occur so that the vertical side walls of the chamber, which in the first embodiment did not touch the dish, must take over the centering until the lid is centered by the projections **35** when the conveyor is advanced. This results in a reduction of the permissible tolerance with respect to the diameter of the lid. This drawback can be remedied by using two bars, each having a hook **46**, the two hooks **46** being arranged symmetrically with respect of the middle plane of the apparatus (not shown in the drawing).

A centering at the beginning of the movement of the dish could of course also be obtained by providing the pawl **27** with two projections engaging the dish already during its travel out of the hopper, but this would reduce the stability of operation because these projections might not be in contact with the dish at the moment when the platform **31** is withdrawn from under it so there would be a danger of irregular movement.

In the embodiment shown in FIGS. **14** and **15**, one side wall of the sterile chamber can be adjusted, as illustrated in FIG. **15**, by means of three long nuts **51** (only two of which are shown) mounted on the side wall **50**. The nuts **51** receive two adjustment screws **52** which are urged against two metal straps **53**, only one of which is shown in the drawing, one strap being provided at each end of the side wall. The counter force is exerted by the springs **54**. The straps **53** are connected with the other side wall by means of ties **55**. Two adjustment screws are provided in one strap and one in the other.

By the adjustment of the distance between the guide rails it has become possible to employ guide means for the lid which are less critical in respect of variations of the dimensions and the configuration of the dish than in the two embodiments first described. A pawl **56** is pivotally mounted and depends in front of the opening through which the dishes pass out of the hopper **4**. The pawl **56** is pivotable about a horizontal axis by being suspended in a slot of a bracket **57** attached to the front wall of the hopper. The pawl has a vertical portion **58** facing the hopper and continues at its lower end in the form of a rounded portion **59**. At the side facing away from the hopper the pawl has a vertical surface **60** which terminates at its lower end in a sharp bend, and also a horizontal arm **61**. As will be seen, the pawl can rotate upwards and away from the hopper to a horizontal position but is prevented by the front wall of the hopper from rotating in a direction towards the hopper where it is stopped in vertical position as shown in FIG. **14**.

The function of the pawl **56** is as follows: When a dish is moved out of the hopper by means of the conveyor pawl **27**, the pawl **56** is urged upwards to permit the dish to pass, the rounded portion **59** sliding on the top face of the lid. When the dish has reached a certain position the pawl **56** again drops down to vertical position. Now the conveyor **31** moves back towards the hopper. The dish follows this movement until it strikes the vertical portion **60** of the pawl, acting as a stop face, and then remains stationary. The vertical portion **60** determines the position of the dish in which this is to be opened. This position is so selected that the lid does not come too close to the bottom plates of the hopper or the front end **35** of the conveyor, where it might be caught, and the position determined by the pawl is also so selected as to secure a suitable distance from the passage opening of the hopper. When the dish is opened it sucks in air, and if it is too close to the hopper it might suck in bacteriae from the non-sterile air in the hopper. When the conveyor continues its backward movement in under the hopper, the dish with lid drops to an inclined position as shown in dot-dash line in FIG. **14** and the opening of the dish begins when the edge of the lid strikes the slide rails in the point **62**. Hereby the lid is tilted upwards and strikes the horizontal portion **61** of the pawl which acts as a stop serving to prevent continuation of the movement of the lid. The pawl may make a little jump, but still by its inertia and the friction will absorb a substantial proportion of the momentum of the lid, thereby tending to steady the very light and very elastic lid which is supported in a line not far from its center of gravity and therefore has a natural tendency to oscillate.

As an additional safeguard against such oscillations, two arms **63** and **64** are provided which are pivotably mounted and capable of rotating away from the hopper. The arms **63** and **64** depend freely from a bracket **65** which is carried by a locked cover **66**. This arrangement has been chosen to make the chamber more readily accessible for cleaning purposes.

When a dish passes from the hopper into the sterile chamber, the two arms **63** and **64** are urged upwards and away from the hopper to permit the dish to pass,

the arms resting on the top face of the lid. When the lid has dropped down on the slide rails, the arms **63** and **64** return to vertical position and thereby restrain vertical movement of the lid to the small clearance between the lid and the ends of the arms. The said clearance is not critical because all that is required is that the front edge **35** of the conveyor cannot miss the wall of the lid when the conveyor moves forward again. A considerable variation of the height of the lid is therefore permissible and no adjustment in this direction is required. It will be seen that the two arms **63** and **64** could also solve this problem even if the lid were so high that the arms could not swing back to vertical position but would both rest on the lid on opposite sides of the line of support. In practical operation the function of the arms is such that the lid does not perform perceptible oscillations.

To prevent disturbances arising from dishes having rounded edges, or the lid of which is very conical, it is desirable that dishes in inverted position should not be permitted to move into the sterile chamber. Such dishes in inverted position would travel unsteadily on the slide rails and might drop partly down between them, whereby the lid might strike the filling tube **21** and block the apparatus, which must then be opened. It is therefore preferable that the motor should be blocked already before dishes in inverted position leave the hopper. This is obtained, in the embodiment shown, by providing two small stop blocks **67** on the side walls immediately outside the hopper. The height of the blocks should be smaller than the minimum height of the dish up to the edge of the lid, but greater than the maximum rounding of the bottom of the lid, and the distance between the blocks should be so great that the dishes can pass between them but the lids cannot. Since there is always a great difference between the diameters of the lid and the dish, and since the distance between the blocks follows the adjustment of the side wall **50**, a thickness per block corresponding to the width of the slide rails with take care of all situations. If the apparatus is blocked owing to the occurrence of a dish in inverted position in the hopper, the motor is stopped whereafter the dishes in the hopper are lifted and the inverted dish is moved back into the hopper.

Some dishes have marked edges on the lid and on the bottom. On the lid these serve to facilitate the stacking, and on the bottom they serve to prevent scratching of the bottom when the dish is placed on a table. This is the reason why the pawl **56** should have a rounded portion **59**. If the pawl had a sharp bend instead, the pawl **56** would catch the edge of the bottom when the dish is moved back into the hopper.

I claim:

1. An apparatus for filling Petri dishes each having a lid, said apparatus comprising an elongated sterile chamber, a hopper at one end of said sterile chamber, said hopper being constructed to receive a supply of Petri dishes with lid stacked upon one another, and being provided at its bottom with a passage opening permitting the passage of the lowermost dish from the hopper into the sterile chamber, a conveyor reciprocatable longitudinally of the sterile chamber and under the hopper, said conveyor having means engageable with a dish and a lid to convey same from the hopper through the sterile chamber, slide rails for supporting the edge of the lid over part of its travelling path in a level lower than that of the edge of the lid of the lowermost dish in the stack, a slide track for the dish in a level at a distance below that of said slide rails greater than the height of the dish, a filling outlet in a position below said slide rails and at a distance above said slide track greater than the height of a dish, and means for discharging a predetermined quantity of liquid substrate through said filling outlet while a dish is in a position thereunder.

2. An apparatus as in claim **1** in which said conveyor is constructed with an elevated platform for receiving dishes from said hopper, detaining means being provided for detaining a dish and lid against backward movement from a predetermined position at a distance from said hopper.

3. An apparatus as in claim **1**, in which the distance between said slide rails is adjustable.

4. An apparatus as in claim **1**, in which said slide rails are mounted on the side walls of said sterile chamber, means being provided for adjusting the distance between said side walls.

5. An apparatus as in claim **1** in which means are provided for yieldably engaging the upper face of a lid when received on said slide rails.

6. An apparatus as in claim **5**, in which said yieldably engaging means comprise at least one pivotably mounted arm depending freely above the level of said slide rails.

7. An apparatus as in claim **1**, in which said detaining means comprises a pawl mounted at the front side of said hopper, a stop engaging said pawl from the rear to define a position of rest of said pawl in which it depends in front of said passage opening, said pawl being rotatable upwards and away from said hopper when engaged by a dish with lid travelling through said passage opening, said pawl being constructed with a substantially vertical stop face for detaining a dish with lid against rearward movement and with a substantially horizontal stop face to engage the rearmost portion of a lid upon upward tilting of same.

8. An apparatus as in claim **7**, in which said substantially vertical stop face is located at a distance in front of said passage opening and is connected through a rearwardly rounded portion with a portion of the pawl depending directly in front of said passage opening.

9. An apparatus as in claim **1** and further comprising a pair of stop blocks provided at the sides of the apparatus adjacent to said passage opening, and extending upwards from the level of the bottom of the hopper, the distance between said stop blocks being greater than the maximum diameter of a dish, but smaller than the minimum diameter of a lid, the height of said stop block above the bottom of the hopper being smaller than the minimum height of a dish as measured up to the edge of a lid in position thereon.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,704,568

DATED : December 5, 1972

INVENTOR(S) : Ornolf Duhring and Lavritz Gudmund Damgaard

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the Title Page of the patent, the following information should be added:

-- Foreign Application Priority Data

October 16, 1970 Denmark.....5276/70
March 29, 1971 Denmark.....1497/71 --.

Signed and Sealed this

Thirty-first Day of *October 1978*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

DONALD W. BANNER
Commissioner of Patents and Trademarks