United States Patent [19]

Fry et al.

[11] **3,739,791**

[45] **June 19, 1973**

[54] **DECONTAMINATION APPARATUS**

[75] Inventors: **Jack E. Fry**, Dallas; **Joseph C. Gerard**, Arlington; **Chester C. Hickman**; **John E. Hummel**, both of Dallas, all of Tex.

[73] Assignee: **Arbrook, Inc.**, Arlington, Tex.

[22] Filed: **June 24, 1970**

[21] Appl. No.: **49,407**

[52] **U.S. Cl.**..... **134/157**, 134/169 R, 134/170

[51] **Int. Cl.**..... **B08b 3/06**, B08b 9/00, B08b 11/02

[58] **Field of Search**..... 134/157, 161, 166 R, 134/169 R, 170

[56] **References Cited**

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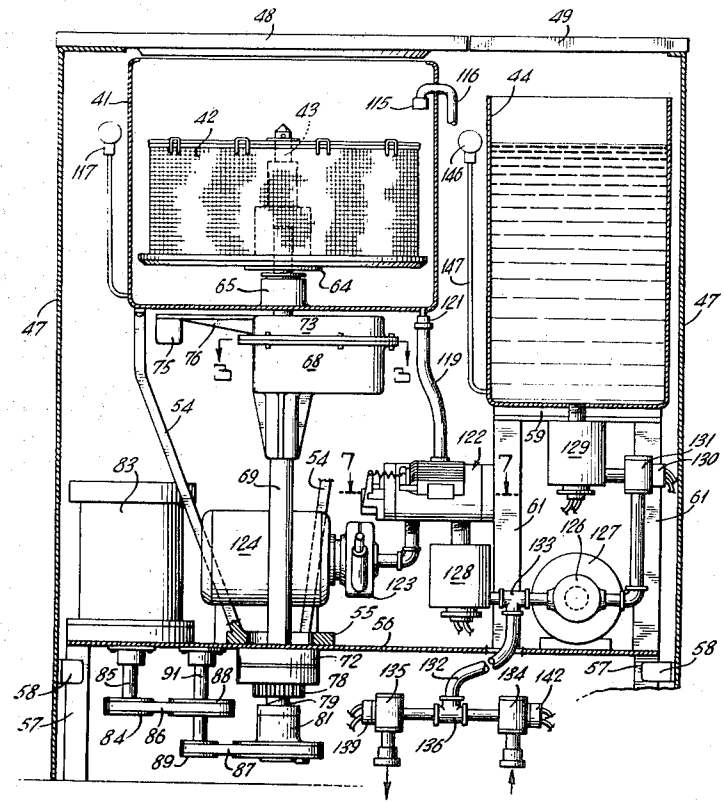
Primary Examiner—Robert L. Bleutge

Attorney—Charles A. Harris and Robert L. Minier

[57] **ABSTRACT**

A closed system, i.e., apparatus for automatically decontaminating various articles, including hollow bags and tubing, by washing and disinfecting them with a liquid chemical disinfectant, using the same tub for both washing and disinfection. The articles are automatically agitated in the washing and disinfecting liquids to loosen dirt and assure complete wetting of their inside and outside surface by the disinfectant. Containers are provided for mounting the hollow articles for agitation and spinning from the same shaft, preferably in baskets provided for this purpose, and for holding them in positions which will assure their thorough washing, disinfecting and emptying. A unique storage and transfer system is employed for the disinfectant supply and this includes a novel diverter or transfer valve for connecting to the tub drainage system. The apparatus preferably uses a disinfectant supply which has a relatively long life and is used over and over again in successive decontaminating cycles and has a use cycle timing device for rendering the apparatus inoperative at the end of a given use cycle for the disinfectant. A device is provided for again rendering the apparatus operative after a new supply of disinfectant is substituted for the old. Various other timing and control features are provided.

6 Claims, 34 Drawing Figures



15 Sheets-Sheet 1

Fig. 1.

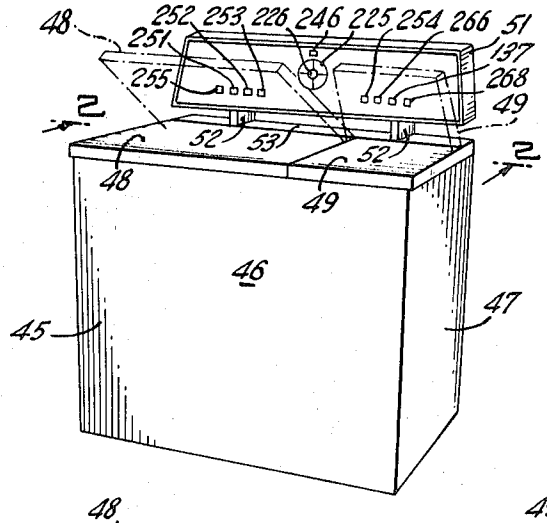
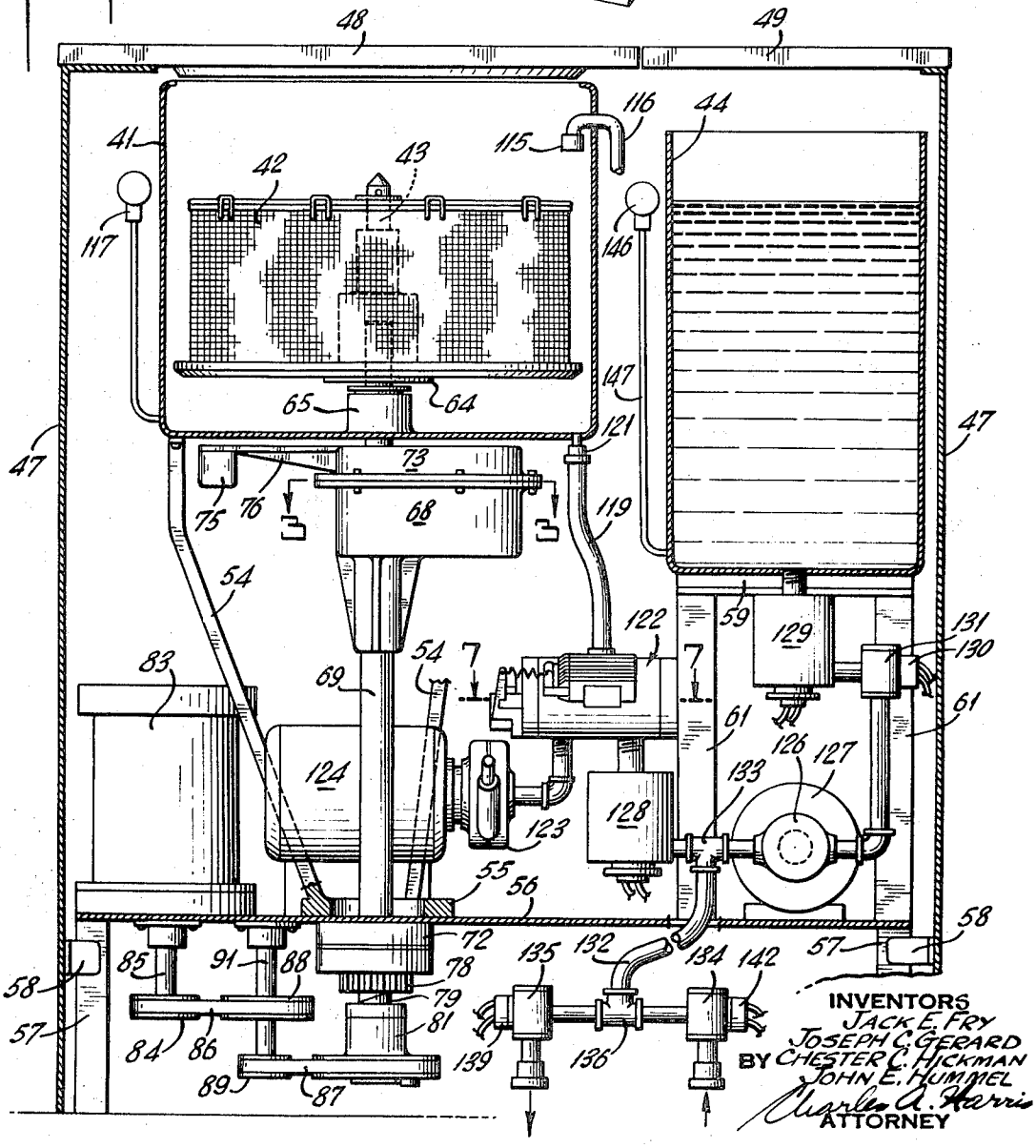


Fig. 2.



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FIG. 4.

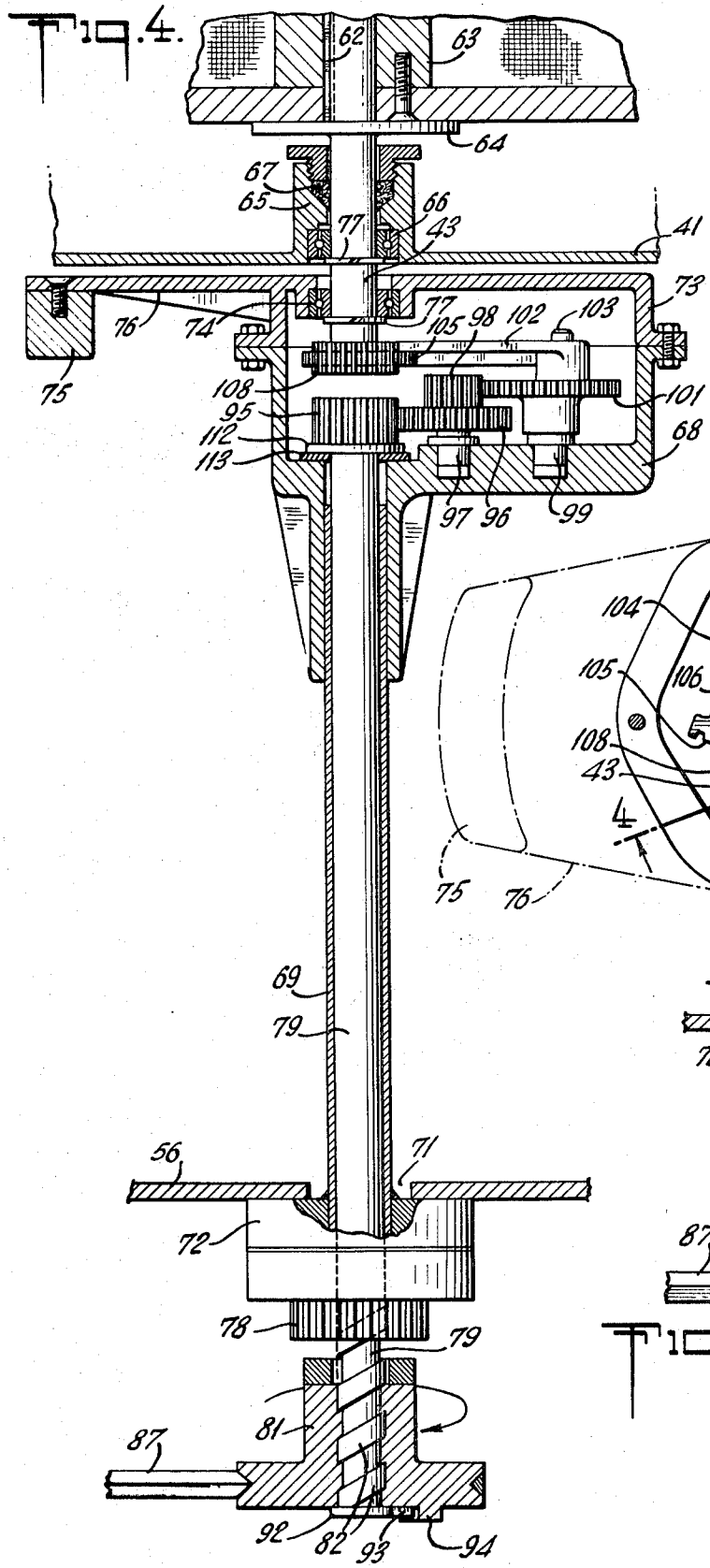


FIG. 3.

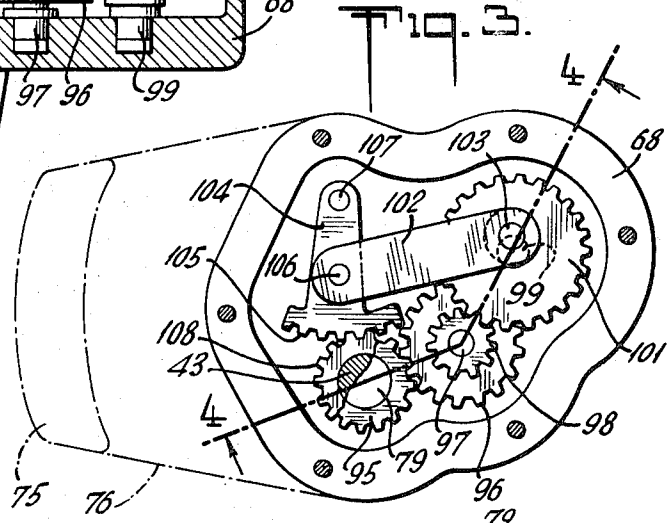
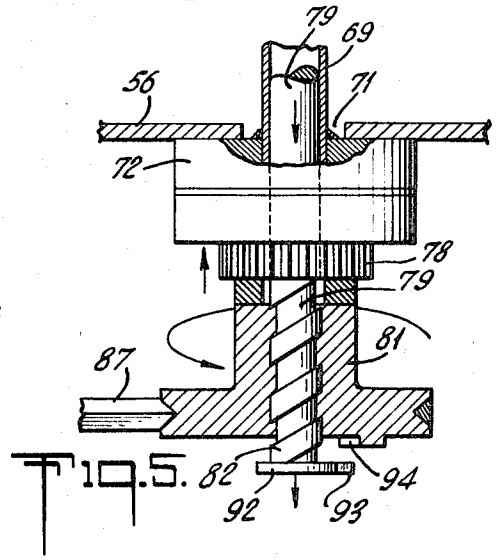


FIG. 5.



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Fig. 6.

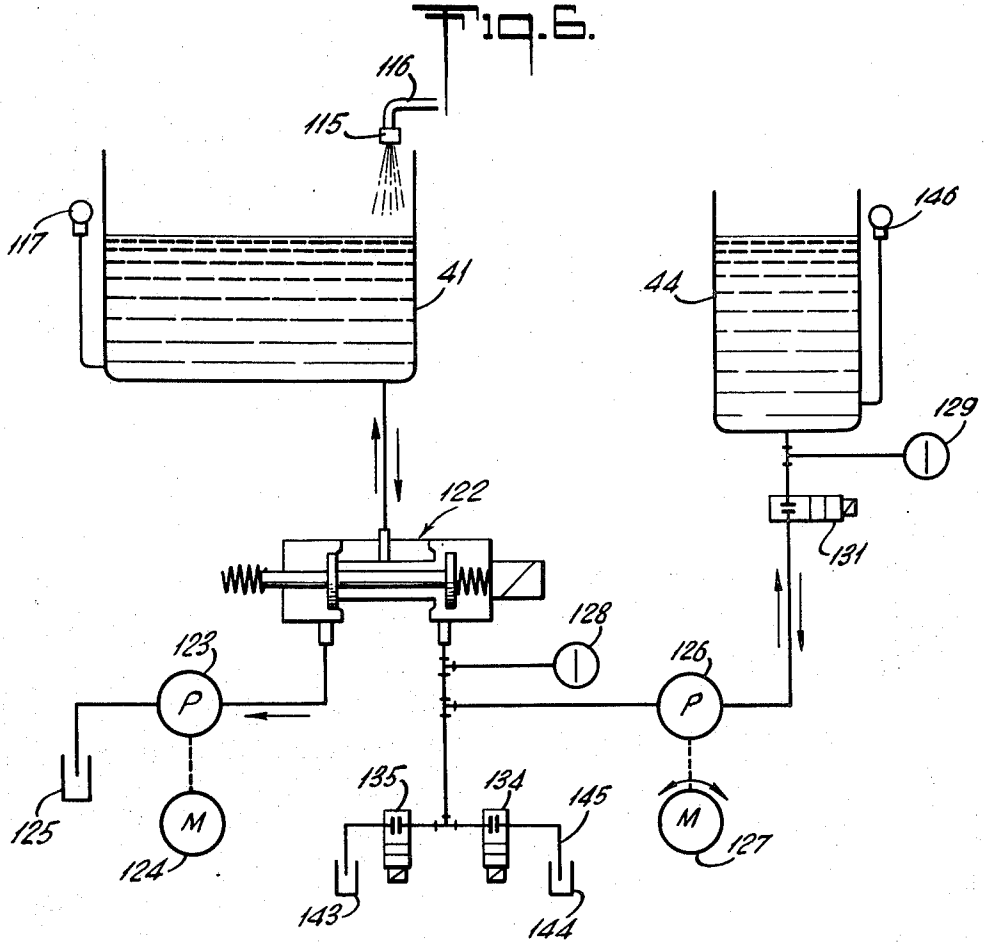


Fig. 7.

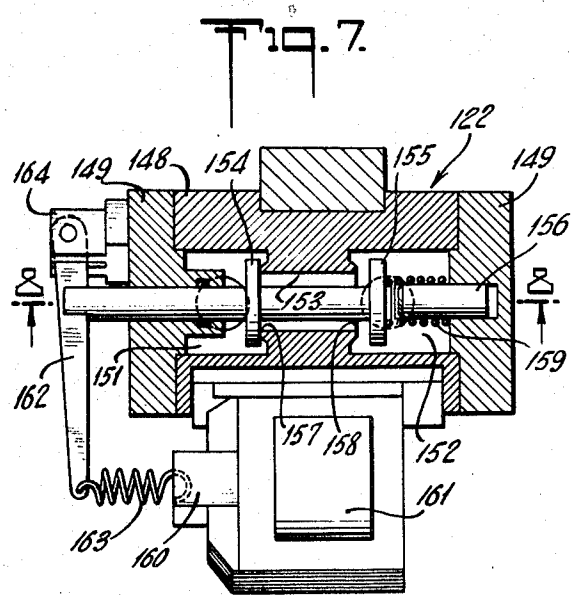
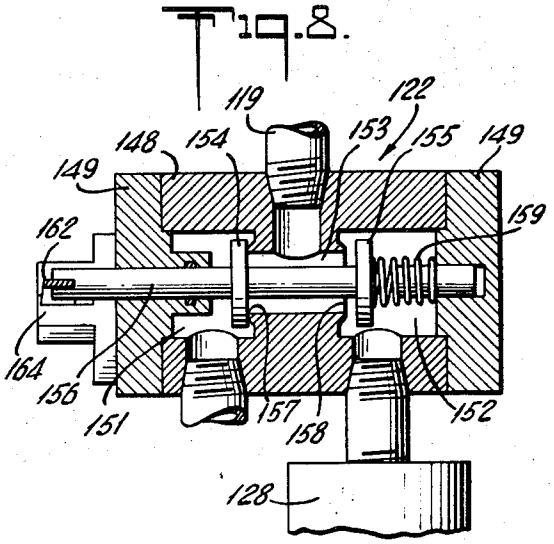
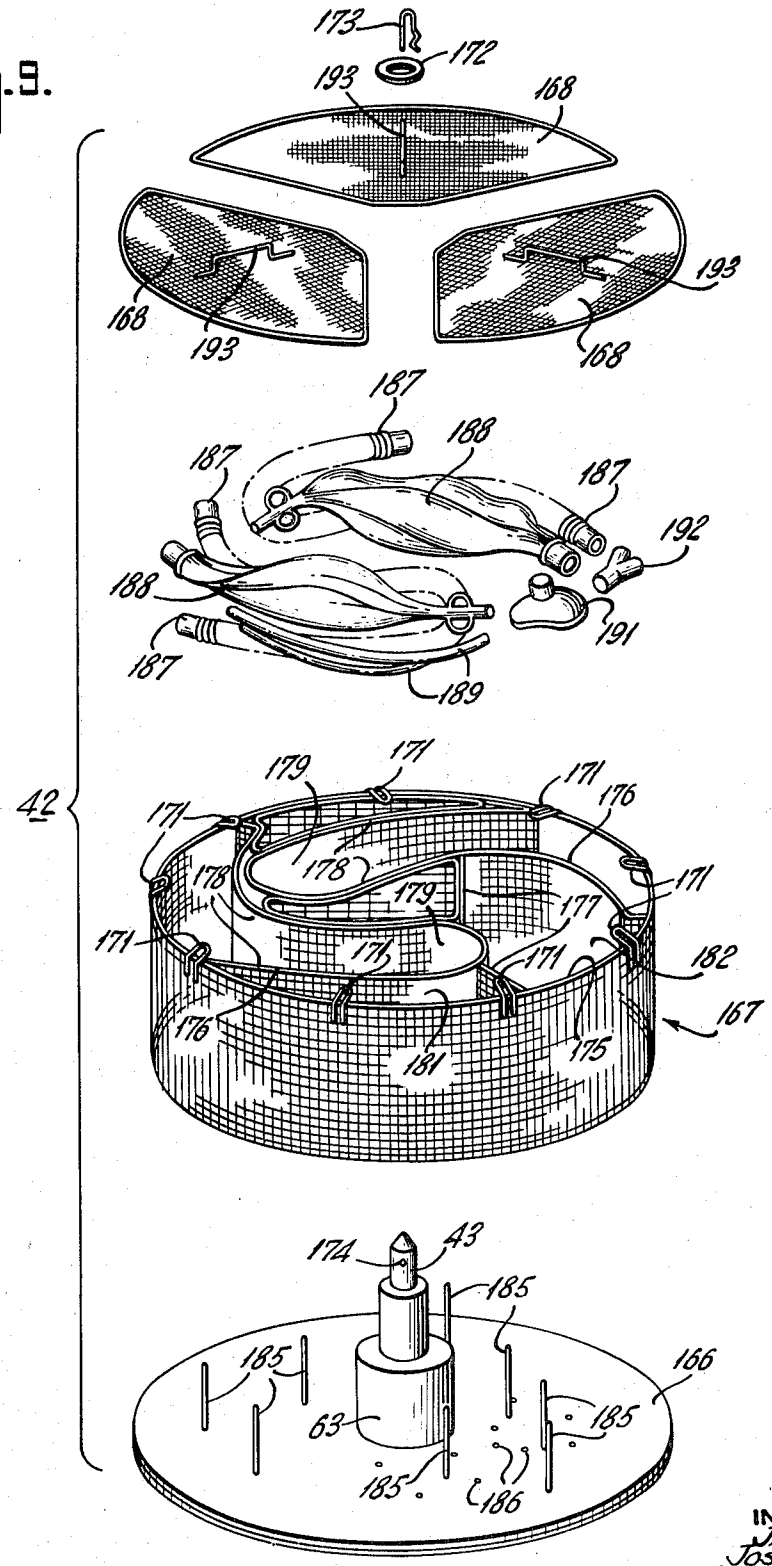


Fig. 8.



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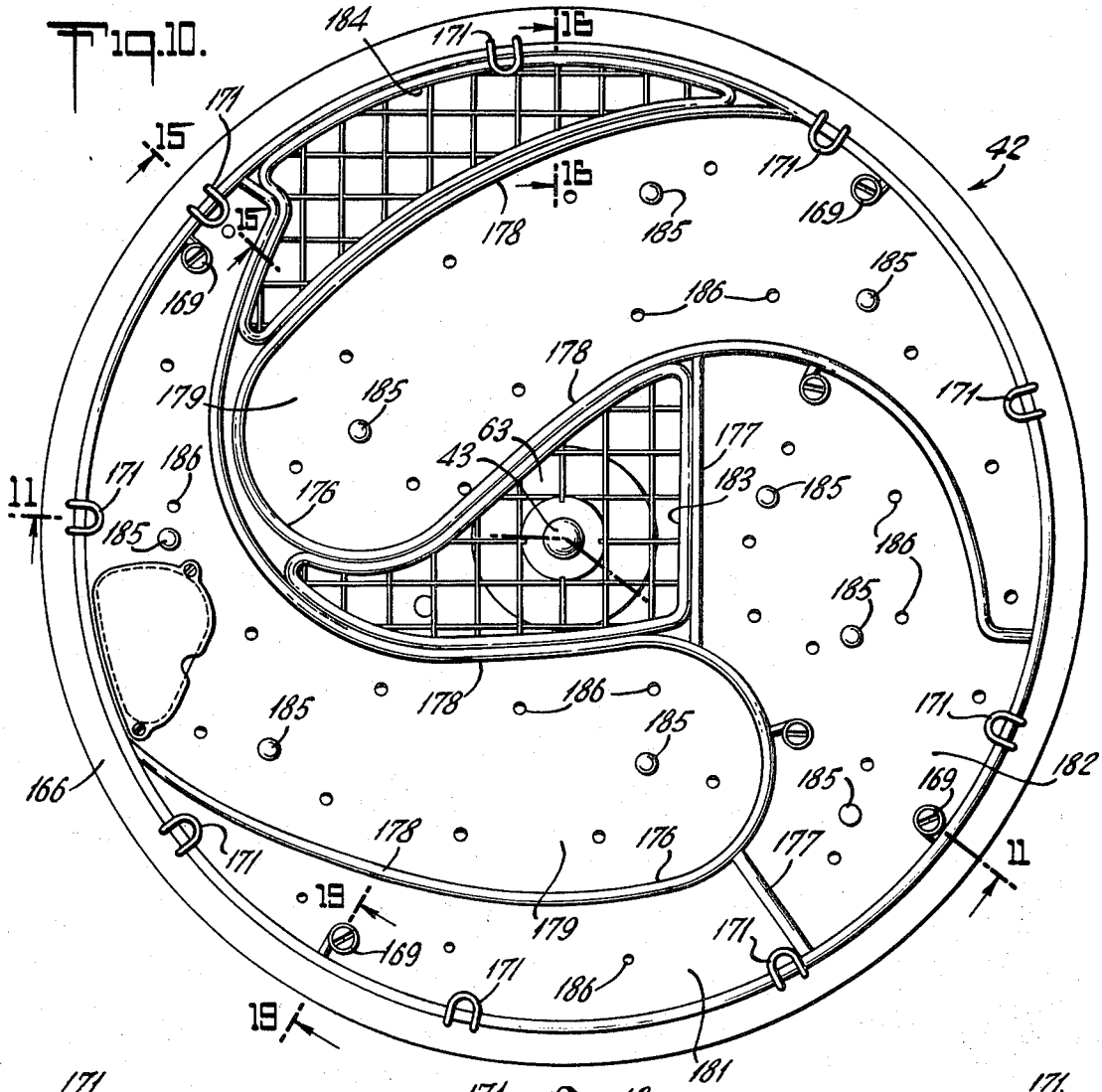
Fig. 9.



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Fig. 10.



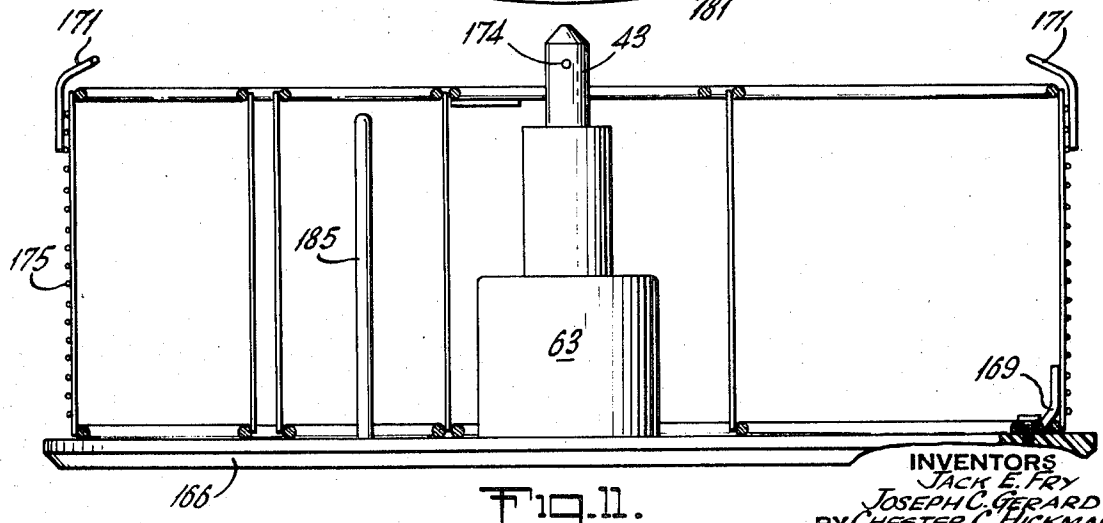


Fig. 11.

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Fig. 12.

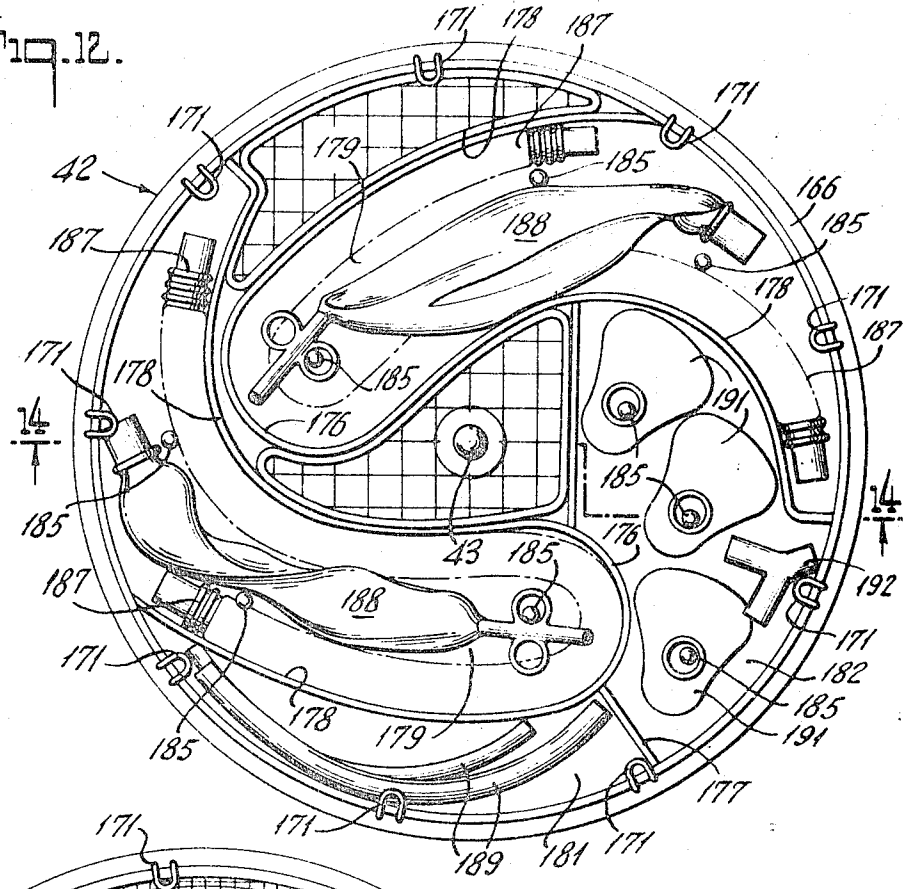
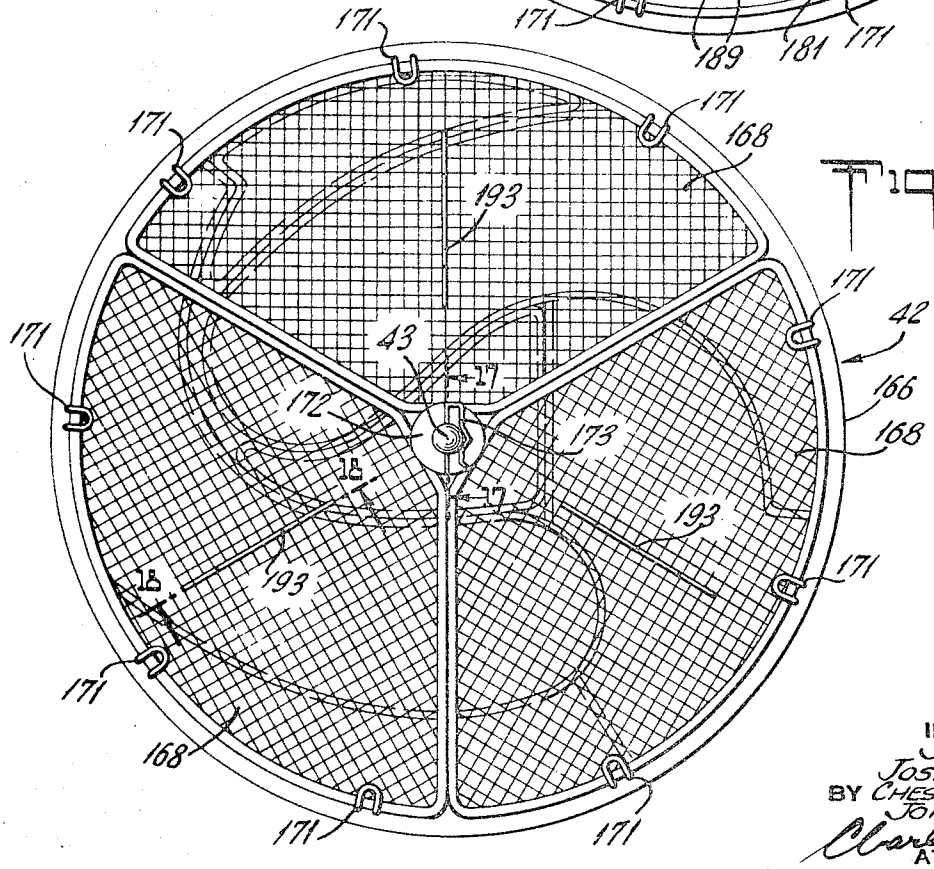


Fig. 13.



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Fig. 14.

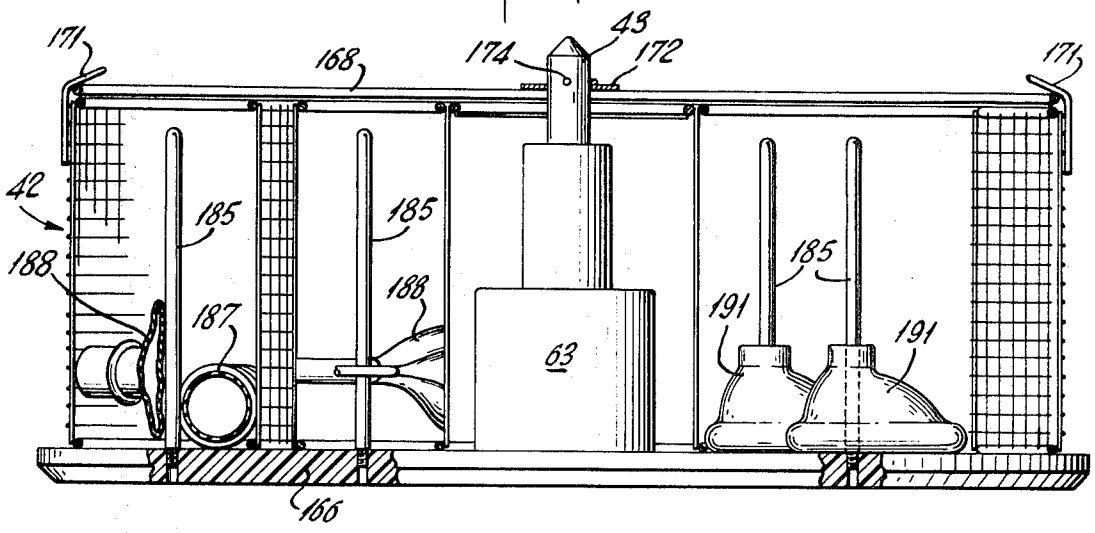


Fig. 15.

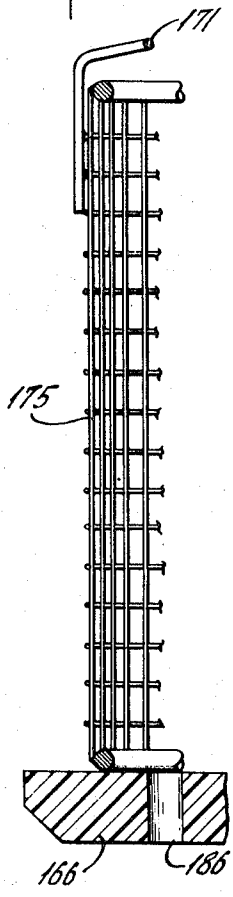


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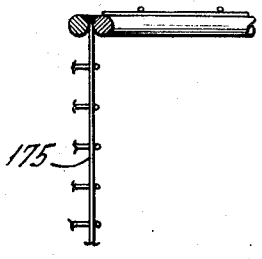
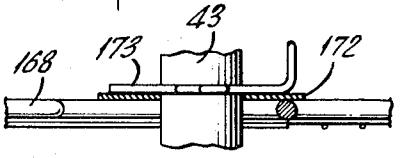


Fig. 17.



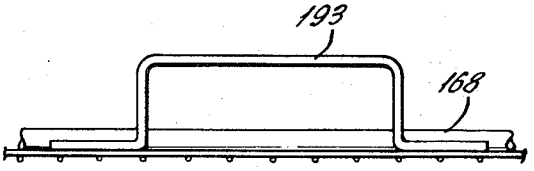
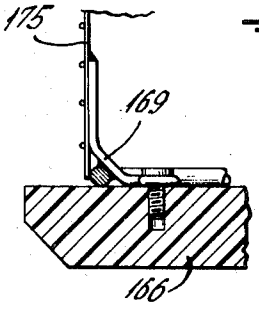


Fig. 18.

Fig. 19.



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Fig. 20.

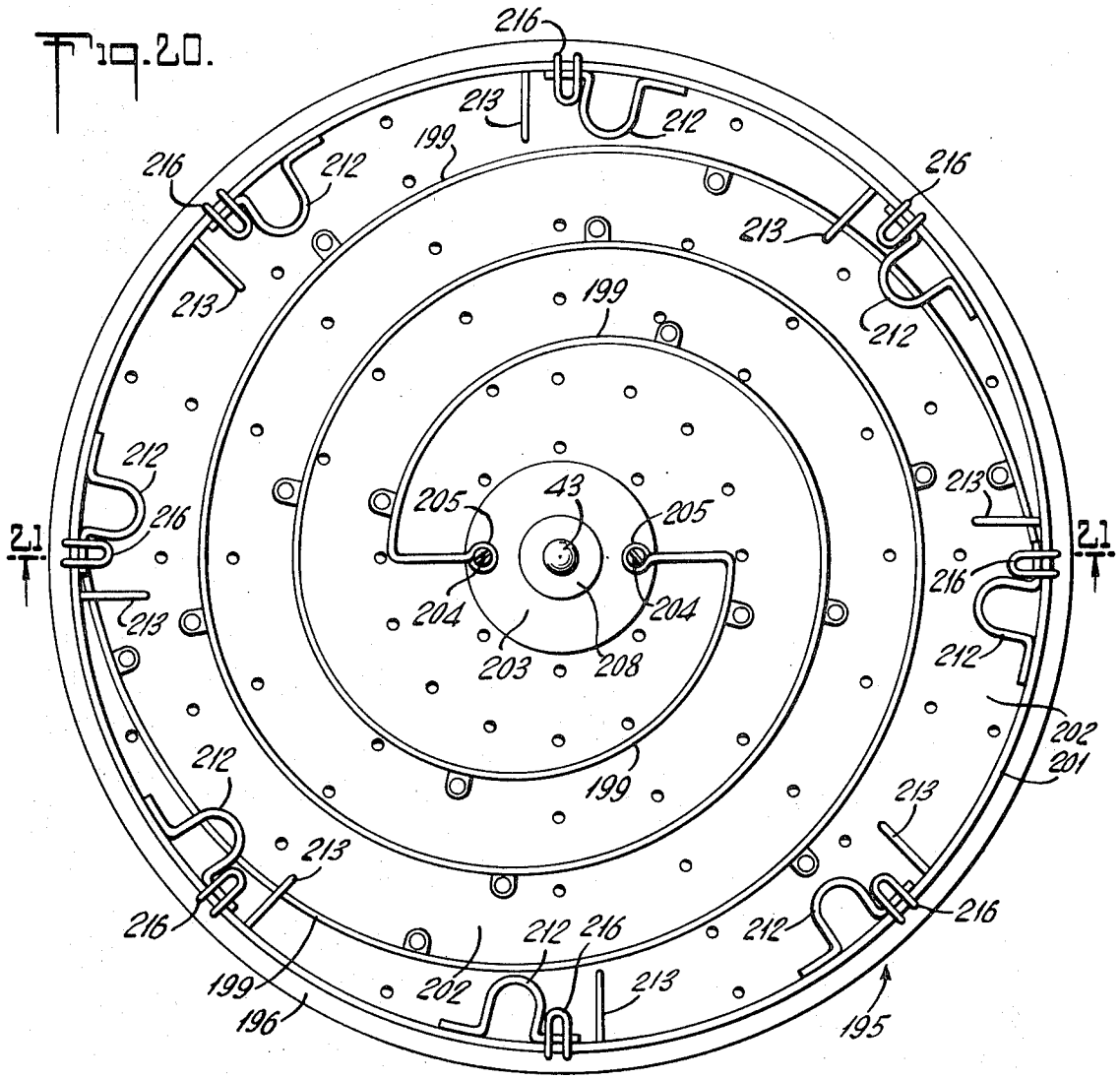
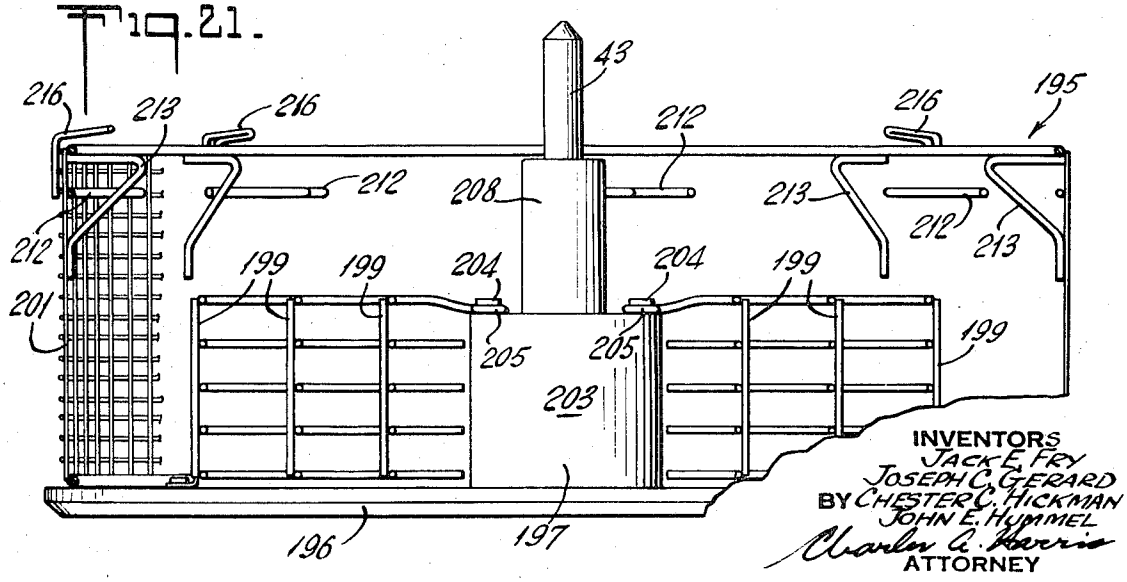


Fig. 21.



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Fig. 22.

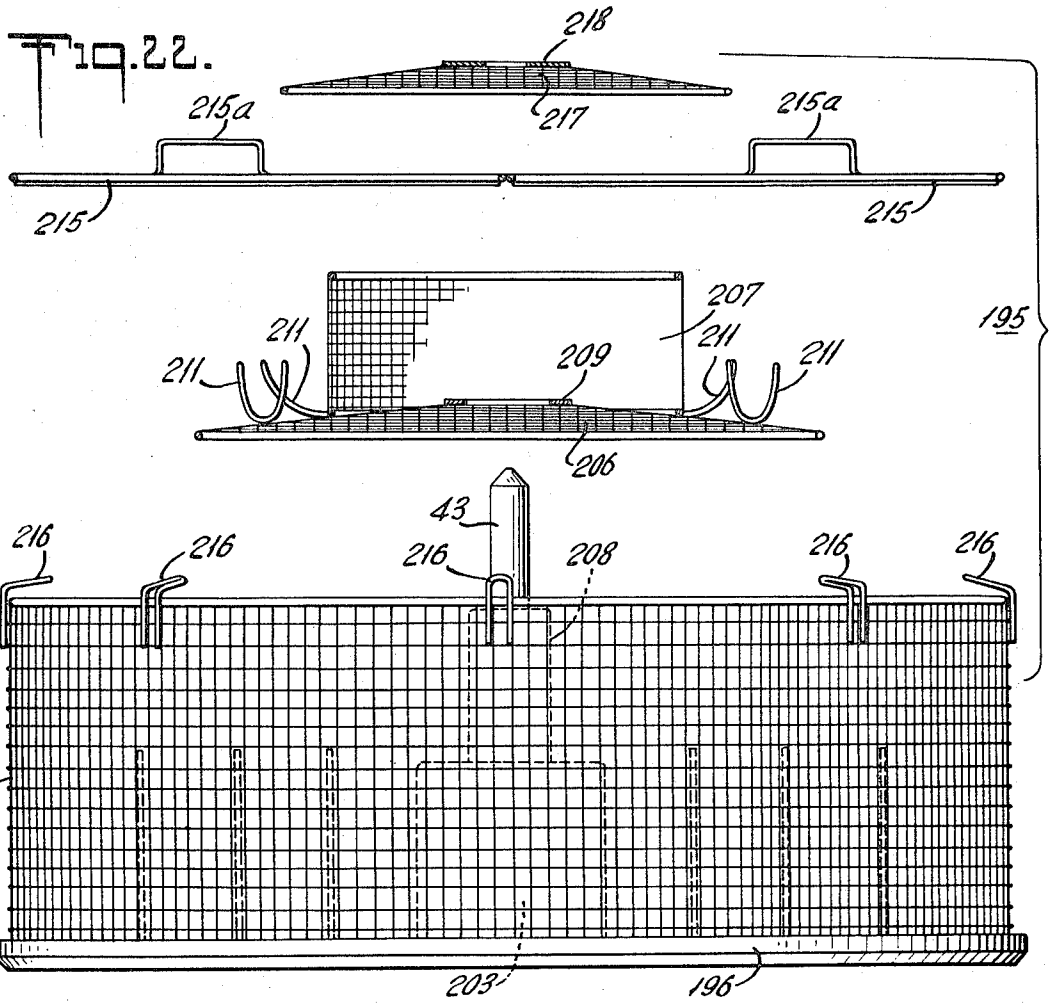
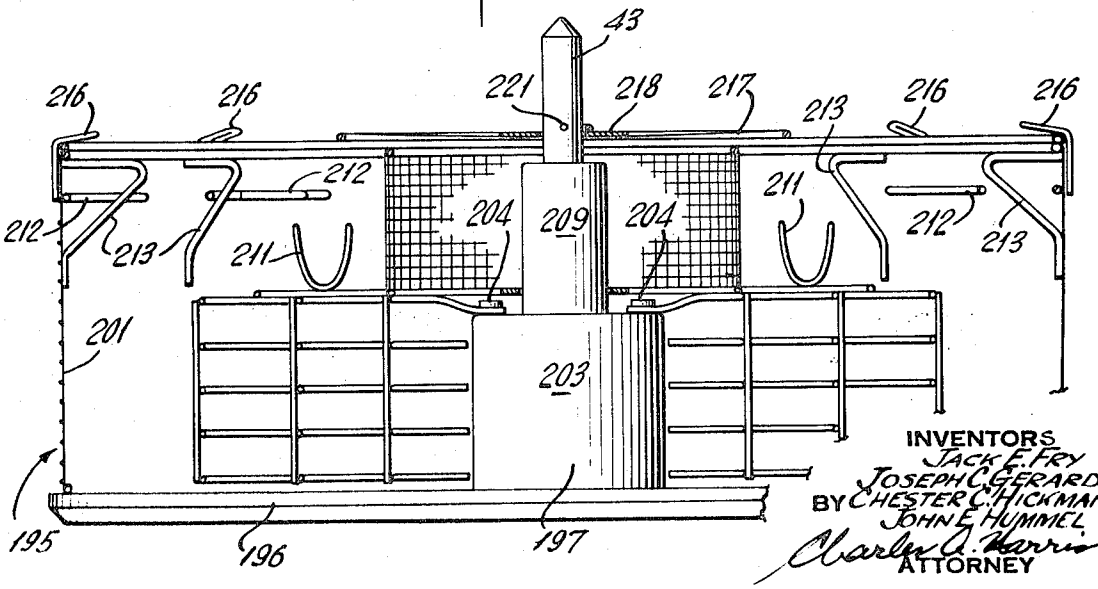


Fig. 25.



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Fig. 23.

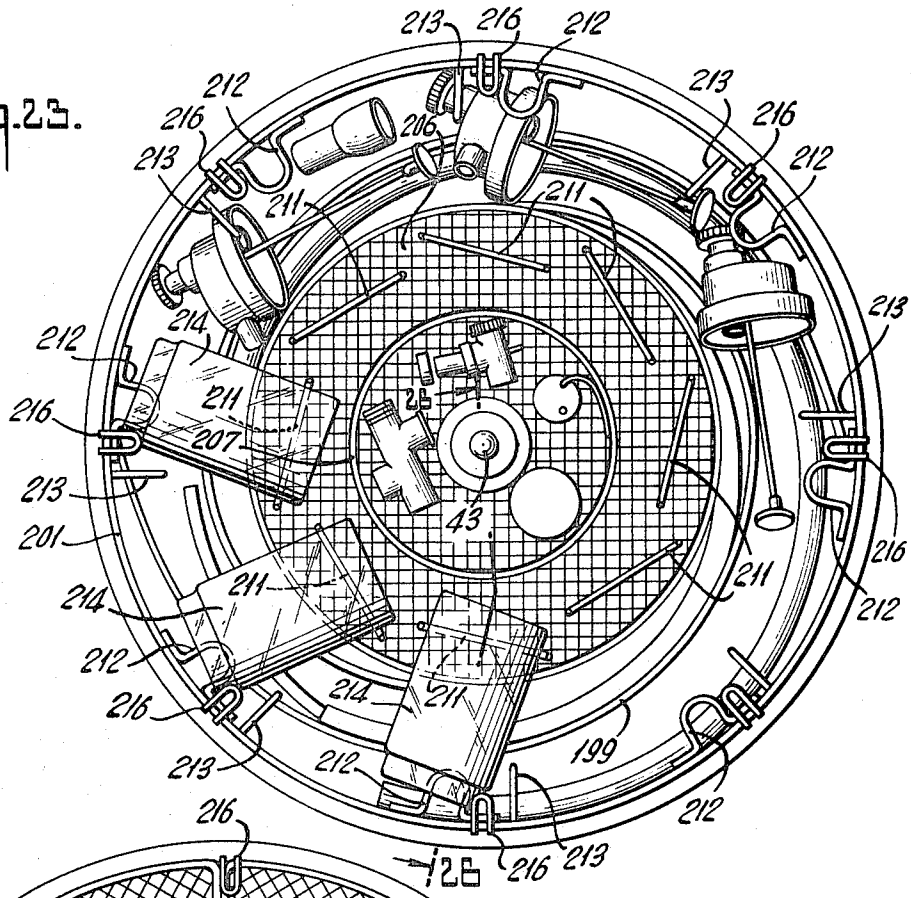
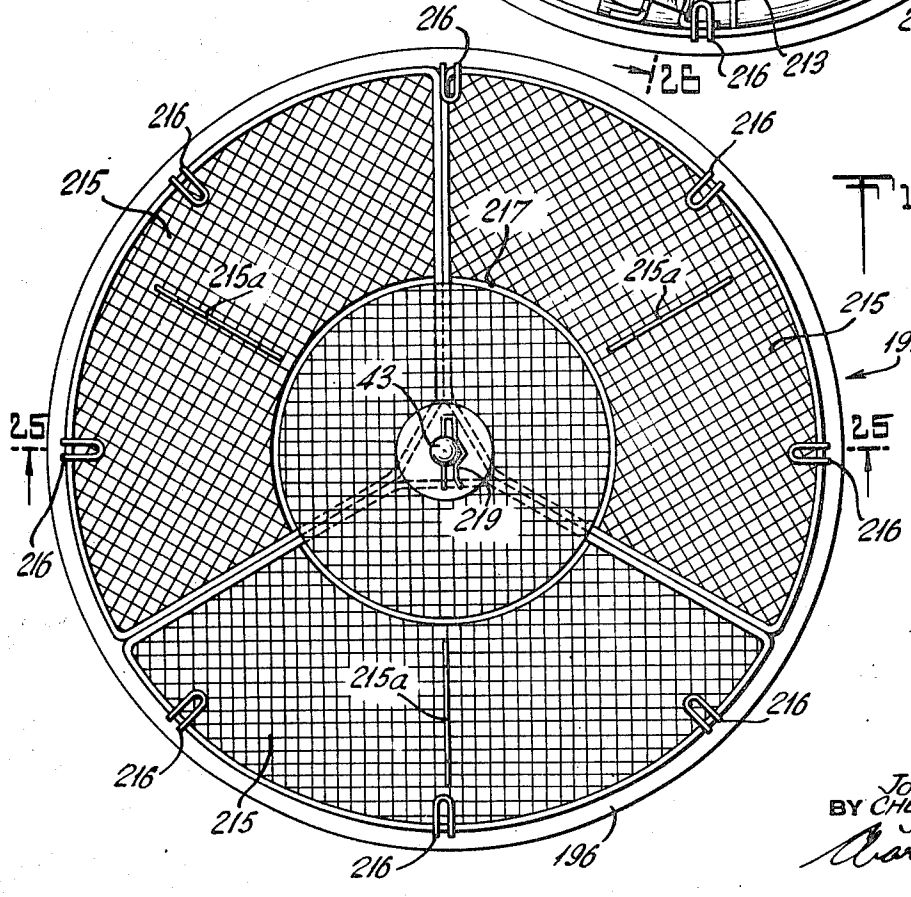


Fig. 24.



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Fig. 26.

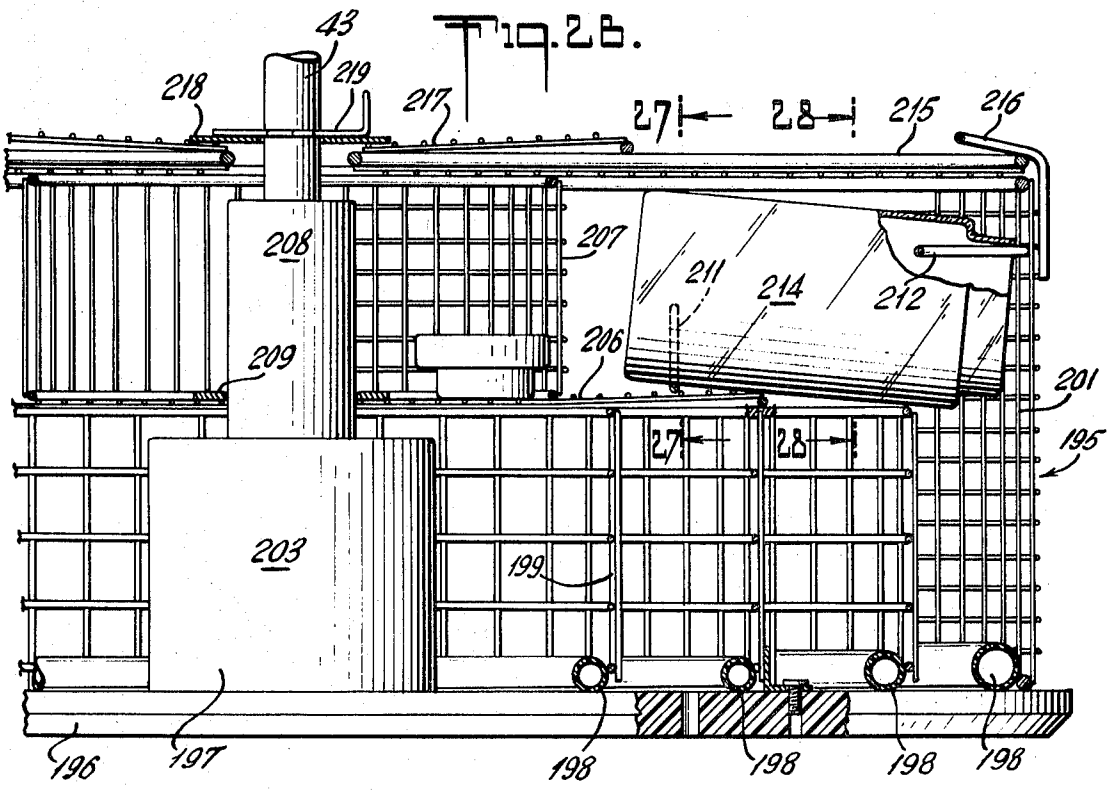


Fig. 27.

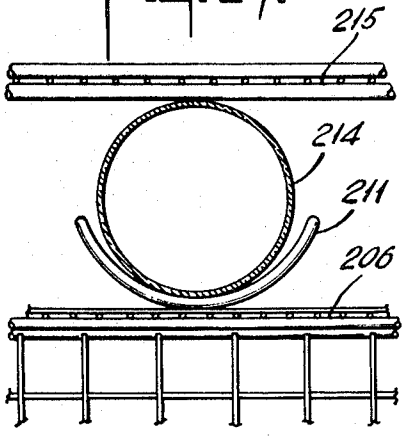
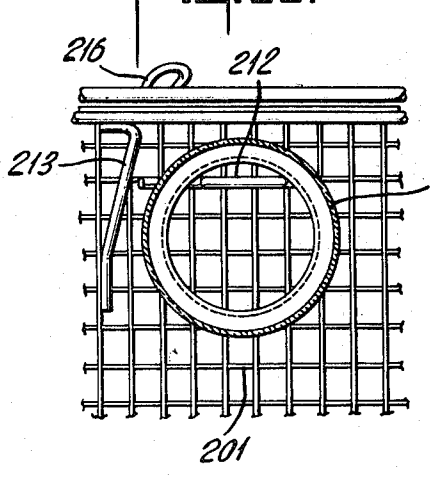


Fig. 28.



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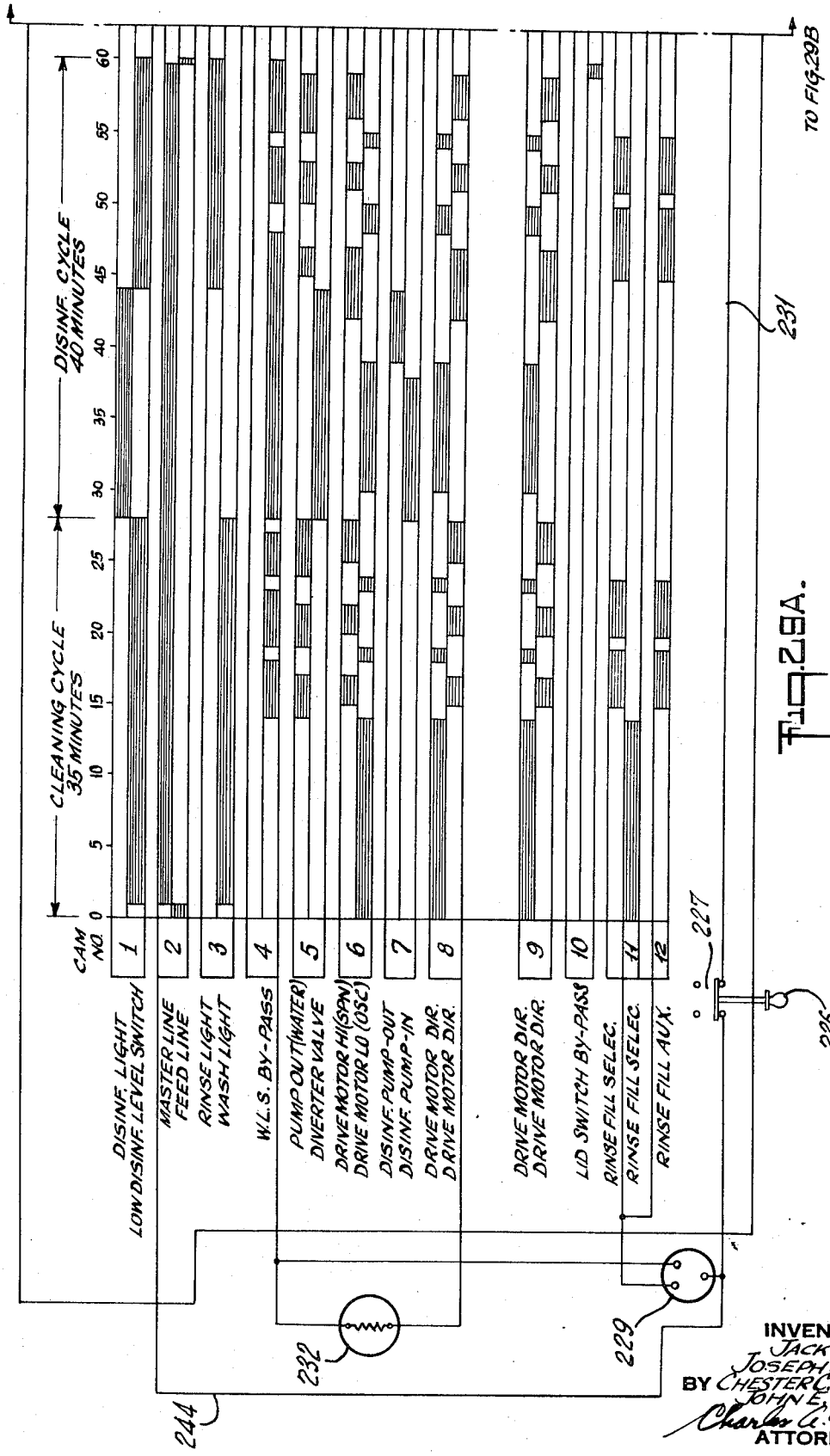


FIG. 29A.

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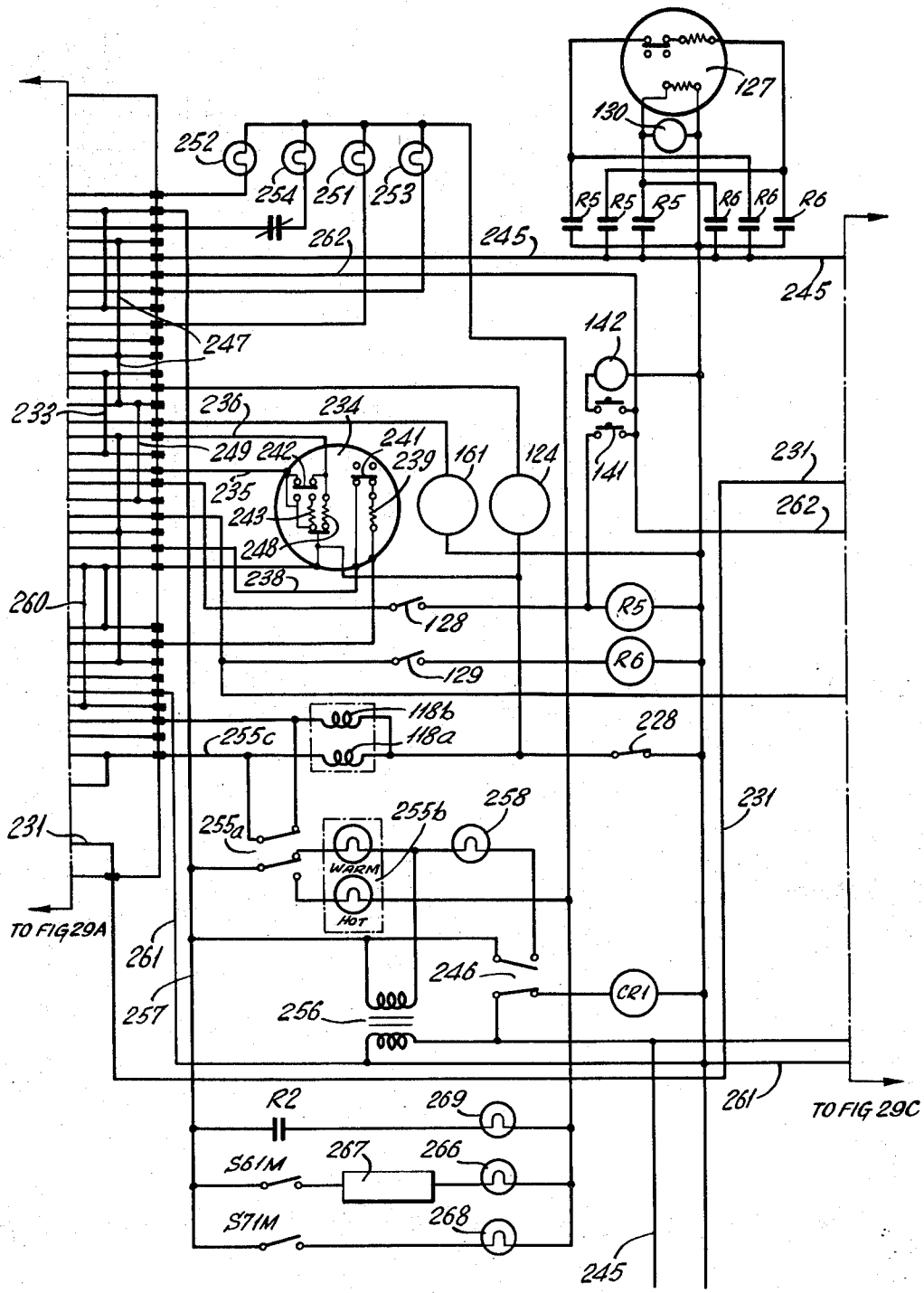


FIG. 29B.

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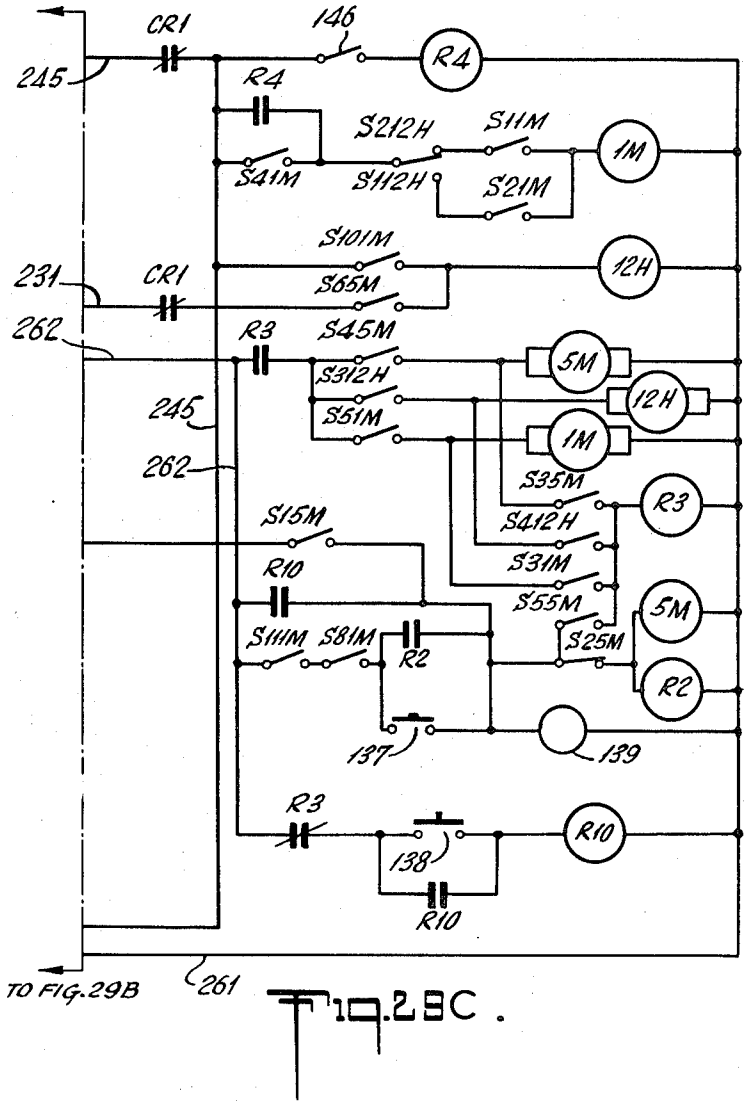


FIG. 29C.

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FIG. 30.
RESET TIMER

FIG. 31.
PERIOD TIMER

FIG. 32.
STEPPING TIMER

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DECONTAMINATION APPARATUS

The present invention relates to the decontamination or the washing and disinfecting of contaminated equipment, and more particularly to the decontamination of generally hollow equipment which may be in the form of tubing, bags, or the like, especially when the equipment is formed of rubber, plastic, metal or some other substantially moisture impermeable material such as is used primarily in hospitals and medical offices for anesthesia, inhalation therapy, etc.

Equipment of this type is subject to direct contamination through contact with each patient and often contains deposits of blood, mucous, vomit, etc. Thus, when this contamination is evident, it has been the custom to attempt to wash by hand the large variety of plain and corrugated tubing, airways, breathing bags, mouth pieces and other hollow articles which are used. Unfortunately, however, these visible deposits are only one type of contamination and merely serve to point to the real problem which is the infection of this equipment with bacteria, bacilli, viruses, spore formers and other pathogenic microorganisms harbored by different patients. Furthermore, a particular item of equipment may appear quite clean, even directly after washing and actually be highly infected with pathogens. It seems clear, therefore that there is a great need for hospital apparatus which will fully decontaminate, or both wash and disinfect this type of equipment.

One of the problems in providing this type of apparatus, however, is that most of the hospital anesthesia and inhalation therapy items to be disinfected, for example, are made, at least in part, of flexible, heat-sensitive materials such as natural or synthetic rubber, plastic, or the like. Thus, they cannot be sterilized or effectively disinfected in the normal heat sterilizing equipment available at hospitals, assuming this type of equipment could be adapted for this purpose. Although gas sterilization could be used to disinfect once the articles re clean, suitable apparatus for both washing and gas sterilizing this type of hollow tubing and other equipment has not been developed.

One attempt at solving this problem is disclosed in British Pat. No. 1,168,035, wherein apparatus is suggested specifically for washing and decontaminating the hollow tubing, breathing bags, etc. forming part of typical hospital anesthesia equipment. This device forces pressurized hot water through the various hollow articles and mentions that the articles finally are disinfected by raising the temperature of the water to 190° F., which, it is said, is sufficient to kill bacteria without injuring the rubber or rubber-like material from which the articles are formed. While there may be some articles which are not adversely affected by a temperature of 190° F., here are many others such as the plastic tubing used in inhalation therapy which definitely would soften at these temperatures. The tubing to be washed must be individually positioned over spaced pipes through which the hot water is projected into the tubing. Then, for those items which do not fit on the piping provided, hot water is sprayed around the interior of the unit by an impeller such as used in a modern dishwasher. There is no mention in this patent of how the decontaminated articles are freed of water and dried or the special problems presented in emptying the different types of tubing used in anesthesia.

We have invented a single decontaminating unit which automatically washes and disinfects hollow articles of the type described using a cold liquid disinfectant. First, the articles are washed free of solid contaminants, such as dried blood and mucous, and rinsed, then they are disinfected by immersing them in a chemical disinfecting solution without the application of heat. Following the disinfection step, the decontaminated items are thoroughly rinsed of the disinfecting liquid and then emptied of the rinsing liquid automatically, again without the need to use heat.

Our decontaminating unit comprises a working tube adapted to hold supplies of washing liquid and liquid disinfectant, respectively, in successive washing and disinfecting steps in the decontaminating cycle for a given set of articles, and a storage tank which holds the disinfectant supply during the washing step. The disinfectant preferably is transferred back and forth between the tank and the tub by a disinfectant piping system which is adapted to be completely sealed off from the tub when not in use for this purpose and includes its own pump.

Our apparatus preferably uses a chemical disinfecting solution which has a relatively long effective life so that a given supply of disinfectant will remain effective for quite some time and during many decontaminating cycles in the apparatus of this invention. For instance, a practical use or life cycle for a given supply of a preferred type of sterilizing solution based upon activated glutaraldehyde is 14 days, as compared with a single decontaminating cycle lasting about 90 minutes. Preferably, both the individual decontaminating cycle and the disinfectant use cycle are automatically timed, the latter by use cycle timing means which renders the apparatus inoperative at the end of a given cycle time following the introduction of a first supply of disinfectant in said apparatus. Then the apparatus includes means for activating the timing means to again render the apparatus operative after the first supply is removed and a new supply of disinfectant is introduced therein. Provision is made for completion of any decontaminating or disinfecting cycle which happens to be in progress at the end of the use cycle time so that the apparatus does not become inoperative until the decontaminating cycle has ended.

When a chemical disinfecting liquid having a relatively long normal effective life (such as 14 or more days) is intended to be used over and over again in successive decontaminating cycles, it is highly important to avoid or minimize dilution or contamination of the disinfectant in each of these cycles since any appreciable dilution or contamination will be cumulative and render the disinfectant ineffective long before the end of its normal effective life. It therefore is important that the tub and the hollow articles to be decontaminated be completely emptied of any washing or rinsing liquid prior to placing the disinfectant in the tub and that the disinfectant be effectively removed from each of the articles and from the tub at the end of the disinfecting cycle, all as described hereinafter. Similarly, it is important that the disinfectant supply be sealed off from the water or other liquid going through the unit during the washing and rinsing cycles and that no washing, rinsing or disinfecting liquid be trapped in the common parts of the system. The method and apparatus of this invention insure that dilution and contamination of the disin-

fectant will be minimized to prevent shortening its normal use or life cycle time, as explained hereinafter.

In the preferred embodiment of this invention, hollow articles to be decontaminated are positioned and held in relatively fixed positions in retaining means drivably mounted from a drive shaft entering the working tub, the tub is filled with a washing fluid such as water and detergent, and then the shaft is rotated back and forth by oscillating means first in one direction and then in the other to reciprocate the articles through the washing liquid so that the liquid and the articles are agitated with respect to one another. When the washing step is completed, the tub is emptied and the drive shaft is spun relatively rapidly in one direction to remove residual washing liquid substantially completely from the hollow articles by centrifugal force. It is an important feature of this embodiment of our invention that the hollow tubing or other articles are so positioned in the retaining means that the washing liquid is forced into the articles during the above-described oscillation or agitation and yet removed therefrom by centrifugal force when the shaft is spun. This occurs when the axes of the end portions of the hollow articles extend in a generally trailing spiral configuration or radially outwardly and obliquely away from the radii of the drive shaft in an angular direction opposite to the direction in which the shaft is spun.

Following removal of the washing liquid, the articles are thoroughly rinsed in a rinsing step which normally includes immersion in the rising fluid and agitation therein as described above in connection with the washing step. As in the washing step, the articles are spun after the rinsing fluid has been removed from the tank, to remove residual liquid substantially completely from the articles. Single or multiple rinsing steps may be used to minimize contamination of the disinfectant with the washing liquid. When the articles are sufficiently rinsed, the disinfectant supply is transferred from the storage tank to the tub so that the articles are completely immersed in the disinfectant liquid. Then the articles are agitated in the disinfectant for a given period of time, say about 10 to 15 minutes, to free any entrapped air and assure that the liquid disinfectant thoroughly wets all internal and external surfaces. At the end of the disinfecting step, the disinfectant supply is transferred back to the storage tank with residual disinfecting liquid being removed from the articles by spinning as described hereinbefore in connection with the washing and rinsing steps. Then, the articles are thoroughly rinsed to remove any residual traces of the disinfectant and finally spun dry by the same centrifugal technique described hereinbefore.

According to the preferred embodiment of this invention, the working tub drains into a diverter valve which connects the tub either to a drainage system or to the disinfectant piping system. The drainage system includes a drainage pump which removes washing and rinsing liquids from the tub when the diverter valve connects the tub to the drainage system, and the disinfectant system includes a reversible disinfectant pump which transfers the disinfectant from the tank to the tub when the diverter valve connects the tub to the disinfectant system and then returns the disinfectant to the tank at the end of the disinfectant step as described above. Preferably, also, the disinfectant pump will not run unless it is immersed in the disinfectant liquid and the operation of the pump is controlled for this purpose by a pair of fluid level responsive switches, one between the tank and the pump and the other between the diverter valve and the pump. The diverter valve positively seals off the drainage system when the tub is connected to the disinfectant system to prevent any possible loss of disinfectant and positively seals off the disinfectant system to prevent contamination of the disinfectant when the tub is connected to the drainage system. It also is important that the diverter valve is designed so that it drains free and does not trap liquid and thereby contaminate or dilute the disinfectant due to passage of the several liquids through the same valve.

In a preferred embodiment of our invention, the use cycle timing means for the disinfectant supply is rendered operative following the end of a given use cycle only when the new supply of liquid introduced reaches a predetermined amount or liquid level in the apparatus.

Preferably, also the apparatus includes means for resetting the use cycle timing means at this point so that it is ready to again time another decontaminating or disinfecting use cycle. This resetting means may be a reset timer operating in a timing circuit with the use cycle timer which may, in turn, comprise a period timer and a stepping timer with the stepping timer counting the periods covered by the period timer. In this way, accurate control of the various cycles may be maintained over a relatively long period of time such as the **14** days corresponding to the normal use cycle of a preferred type of disinfectant liquid.

In order to insure that the disinfectant use cycle is properly timed and also that the disinfectant is not wasted, safety means is provided for preventing removal of the current disinfectant supply from the apparatus prior to the end of its use cycle or at least a given time increment prior thereto. it also is desirable to provide emergency pump out or emptying means to remove the disinfectant from the unit at any time. However, the emergency means should not be too readily activatable and preferably should in some way initiate resetting of the timing means so that the timing means is again ready to operate after the old disinfectant has been replaced with a new supply.

Another advantage of the apparatus of this invention is that the retainers or baskets for holding the articles to be washed may be specifically designed to hold a particular type of equipment such as the various tubings, airways and bags used in anesthesia or the elongated tubing, bottles and the like used in inhalation therapy under ordinary hospital procedures. In fact, the baskets may be designed to mount and hold the various articles so that each article is disposed in such a way that when it is agitated in the tub, the particular washing, rinsing or disinfecting liquid will be forced in and out of the hollows of the article to displace any air pockets and assure that all internal and external surfaces of the article are thoroughly wetted therewith as described hereinbefore, and yet assure that the articles and particularly the end portions thereof are arranged in the proper configuration with respect to the drive shaft so that residual fluid will be removed from the article by centrifugal force when the shaft is spun in one direction at relatively high speed.

Other and further advantages of this invention will appear to one skilled in the art from the following description and claims taken together with the drawings wherein:

FIG. 1 is a view in perspective of a decontaminating unit according to a preferred embodiment of this invention.

FIG. 2 is an enlarged front view, partly in section and partly in elevation, taken along the line 2—2 of FIG. 1, showing the interior of the unit and most of its important working parts, including the retaining basket for holding the articles to be decontaminated in the working tub.

FIG. 3 is a more greatly enlarged top plane view, taken along the line 3—3 of FIG. 2, through the opening in the gear box of the driving mechanism of this unit.

FIG. 4 is a front view, partly in section and partly in elevation, taken along the line 4—4 of FIG. 3, and showing the drive pulley in its lowermost position in which it oscillates the drive shaft supporting the retaining basket for the articles to be decontaminated.

FIG. 5 is a similar view, partly in section and partly in elevation, showing only the lowermost part of the apparatus with the drive pulley in its uppermost position in which it spins the drive shaft and the basket counterclockwise.

FIG. 6 is a schematic piping diagram of the liquid transfer system of the embodiment of the foregoing figures.

FIG. 7 is a more greatly enlarged top view, partly in section and partly in plan, taken along the line 7—7 of FIG. 2 and showing the interior of the diverter valve for controlling the flow of liquid from the working tub.

FIG. 8 is a similar view, partly in section and partly in elevation, taken along the line 8—8 of FIG. 7.

FIG. 9 is an exploded view of a preferred form of retaining basket for decontaminating anesthesia equipment in accordance with this invention.

FIG. 10 is a enlarged top plan view of the basket of FIG. 9 with the cover removed.

FIG. 11 is a view partly in section and partly in elevation taken along the line 11—11 of FIG. 10.

FIG. 12 is a somewhat reduced top plan view of the basket of FIG. 10 showing one set of anesthesia equipment arranged therein in the positions for which the basket is designed.

FIG. 13 is a top plan view of the basket of FIG. 12 with its three cover segments in position thereon but without showing the equipment is contains.

FIG. 14 is a somewhat enlarged view partly in section and partly in elevation taken along the line 14—14 of FIG. 12.

FIG. 15 is a greatly enlarged view partly in section and partly in elevation taken along the line 15—15 of FIG. 10.

FIG. 16 is a similar view partly in section and partly in elevation taken along the line 16—16 of FIG. 10 and showing a portion of the basket structure.

FIG. 17 is a similar view, partly in section and partly in elevation, taken along the line 17—17 of FIG. 13.

FIG. 18 is a view, partly in section and partly in elevation, taken along the line 18—18 through the cover in FIG. 13.

FIG. 19 is a view, partly in section and partly in elevation, taken along the line 19—19 of FIG. 10.

FIG. 20 is a top plan view of a retaining basket for holding inhalation therapy equipment according to another preferred embodiment of this invention, with its cover off.

FIG. 21 is a view, partly in section and partly in elevation, taken along the line 21—21 of FIG. 20.

FIG. 22 is an exploded view of the main parts of the retaining basket of FIG. 20.

FIG. 23 is a somewhat reduced top plan view of the basket of FIGS. 20–22 with its cover removed and with one complete set of inhalation therapy equipment held in position therein.

FIG. 24 is a top plan view of the basket of FIG. 23 with its cover on but without showing the equipment it contains.

FIG. 25 is a view, partly in section and partly in elevation, taken along the line 22—22 of FIG. 24.

FIG. 26 is a more greatly enlarged view, partly in section and partly in elevation, taken along the line 26—26 of a portion of the inhalation therapy basket of this invention showing inhalation therapy equipment in position therein.

FIG. 27 is a similarly enlarged view, partly in section and partly in elevation, taken along the line 27—27 of FIG. 26 and showing one means for retaining the inhalation therapy bottles in their proper positions.

FIG. 28 is a similar view, partly in section and partly in elevation, taken along the line 28—28 and showing another means for holding the inhalation therapy bottles in position.

FIG. 29A shows the cam diagram for the main control timer for the decontamination unit of the foregoing figures along with portions of the wiring diagram connected to the cams involved.

FIG. 29B is another portion of the wiring diagram associated with the main control timer which fits to the right of FIG. 29A as illustrated by the arrows in both of these figures.

FIG. 29C is the wiring diagram for the disinfectant use cycle timing system which also is associated with the main control timer and fits to the right of FIG. 29B as indicated by the arrows in both of these figures.

FIG. 30 shows the cam diagram for the reset (5 minute) timer for the disinfectant use cycle timing system.

FIG. 31 shows the cam diagram for the period (12 hour) timer for the disinfectant use cycle timing system.

FIG. 32 shows the cam diagram for the stepping (14 day) timer of the disinfectant use cycle timing system.

INTRODUCTION

Referring to the drawings, and FIG. 2, in particular, there is shown a preferred decontaminating unit of this invention which comprises a working tub 41 in which the articles to be decontaminated are first washed and then disinfected by immersion in a liquid chemical disinfectant, a retaining basket 42 in which the articles are mounted and held during washing and disinfection, a drive shaft 43 on which the basket is mounted for oscillation and for spinning, and a storage tank 44 for holding the liquid disinfectant when it is not needed in the tub 41.

The working tub 41 and the disinfectant tank 44 each are disposed inside a cabinet 45 having a front wall 46, a back wall not shown and opposed side walls 47. A pair of hinged covers, i.e., a tub cover 48 and a tank cover 49, are provided to enclose the unit while at the same time offering easy access to the tub 41 and the tank 44, respectively. A control console 51 for operating the unit is mounted on legs 52 supported by a cross member 53 from which the covers 48 and 49 are

hinged along the back wall of the unit. The tub **41** is supported on a tripod consisting of three metal legs **54** bolted to the bottom of the tub. The legs **54** are inclined inwardly towards their lower extremities where they join a foundation ring **55** which, in turn, is secured to a horizontal foundation plate **56** which is elevated somewhat above the bottom edges of the cabinet. The foundation plate **56** is supported by six legs **57,** one at each of its corners, each of which in turn is secured to an angle bar **58** extending inwardly from one of the side walls of the cabinet. The disinfectant tank **44** is mounted on a pair of horizontal angle irons **59,** only one of which is shown in FIG. **2,** and each angle iron is supported at each of its ends by a vertical leg **61.** The resulting four vertical legs **61** extend downwardly to the horizontal foundation plate **56** and are secured thereto.

The apparatus of this embodiment is adapted to operate automatically, as will be explained more fully hereinafter in conjunction with the diagrams of FIGS. **29A, 29B, 29C, 30, 31** and **32,** to successfully wash, rinse, disinfect, rinse again and then empty (of liquid) a set of initially contaminated equipment placed therein for treatment during an automatically timed decontamination cycle.

During the decontamination cycle, the drive shaft **43** and the basket **42** containing the equipment are rotatively oscillated in the tub **41** during washing, deep rinsing and disinfecting, and are spun relatively rapidly in one direction at several points during the cycle to empty the equipment of liquid. As will be explained more fully hereinafter in conjunction with the description of FIGS. **9–28,** the retaining basket **42** is especially designed to receive particular types or sets of hollow articles of equipment, such as anesthesia and inhalation therapy equipment, and hold them in specific positions which will cause the liquid to circulate through them during the aforesaid agitation and to empty from them when the basket is spun.

Basket Drive

The retaining basket **42** is drivably mounted for rotation with and on the drive shaft **43** by a keyway **62** which rotatably connects the shaft with the spindle **63** of the basket and rests on a horizontal annular ring **64** welded to the drive shaft. The drive shaft **43,** in turn, is mounted for rotation in a vertical stuffing box bearing **65** at the bottom of the tub. The bearing **65** includes a single ball bearing race **66** and a packing gland **67** for assuring that no leaks occur where the shaft **43** passes through the tub **41.** The lower end of the drive shaft **43** extends into a gear box **68** welded to, and therefore adapted to rotate with, a vertical outer shaft **69** which extends downwardly from the bottom of the gear box and thence through a hole **71** in the foundation plate **56.** The lower end of the outer shaft **69** is rotatably mounted in a cylindrical brake **72** which is fixed to the underside of the foundation plate **56.** The upper end of the outer shaft **69** is rotatably mounted from the drive shaft **43** through the gear box **68** which has a bolted cover plate **73** rotatably mounted on the lower end of the drive shaft through another ball bearing race **74** fitted between the drive shaft **43** and the cover plate **73.** Rotation of the gear box **68** is counterbalanced by a counterweight **75** bolted to a horizontal extension **76** of the gear box cover plate. The drive shaft **43** is positioned vertically by a pair of spaced thrust rings **77** fixed to the drive shaft under each of the bearing races.

The cylindrical brake **72** operates in a conventional manner to normally brake or prevent the outer shaft **69,** and therefore the gear box **68,** from rotating,as shown in FIG. **4.** The brake is adapted to be released to allow the outer shaft **69** to rotate when a brake release cylinder **78** at the bottom of the brake is thrust upwardly as shown in FIG. **5.**

An inner intermediate shaft **79** extends upwardly through the brake **72** and the outer shaft **69** into the gear box **68** and is mounted for rotation therein. A drive pulley **81** is mounted at the lower end of the intermediate shaft through mating square helical male threads **82** on the intermediate shaft and female threads in the drive pulley. Thus, when the pulley **81** is rotated it will tend to move helically along the threads and if it is restrained from moving axially it will rotate the intermediate shaft **79.**

Referring to FIG. **2,** it will be seen that a drive motor **83** mounted on the foundation plate **56** drives a power pulley **84** mounted at the end of a short power shaft **85** extending from the drive motor through the foundation plate, and that the power pulley **84** turns the drive pulley **81** through a transfer belt **86** and a drive belt **87** and a pair of transfer pulleys **88** and **89** mounted on an intermediate stub shaft **91** extending downwardly from the foundation plate **56.** The purpose of the transfer belts and pulleys is to obtain the desired speed ration between the drive motor **83** and the drive pulley **81.** The drive motor has two speeds, i.e., one relatively low speed in the clockwise direction and a second relatively high speed in a counterclockwise direction (both viewed from the top). When the motor rotates at its relatively low speed in the clockwise direction it also turns the drive pulley **81** at its lowest speed in a clockwise direction, as illustrated in FIG. **4.** As shown in this figure, when the drive pulley **81** is turned by the drive belt **87,** in a clockwise direction it tends to move downwardly on the helical threads **82** until it reaches the detent plate **92** secured to the bottom of the intermediate shaft **79.** This plate presents a detent **93** which contacts a corresponding axial shoulder **94** depending from the drive pulley, when the drive pulley is in its lowermost position shown in FIG. **4.** In this position, the drive pulley **81** is mechanically engaged with the intermediate shaft **79** through the detent **93,** as well as through the helical gear teeth **82** and therefore drives the intermediate shaft clockwise. As indicated hereinbefore, in this position of the drive pulley **81** the cylindrical brake **72** prevents the outer shaft **69** and the gear box **68** attached thereto from rotating. However, the intermediate shaft **79** rotated freely inside the outer shaft so that an intermediate pinion **95,** fixed to the upper end of the intermediate shaft **79,** rotates therewith inside the gear box **68.** This pinion **95** is in direct engagement with a first transfer gear **96** which, in turn, is mounted on and turns a stub shaft **97** rotatably mounted in the gear case. Rotation of the stub shaft **97** also turns a transfer pinion **98** keyed thereon, and the transfer pinion **98** drives an oscillating gear shaft **99** through a somewhat larger oscillating gear **101** fixed thereto. The oscillating gear shaft **99** also is mounted for rotation in the gear case and is connected to one end of an oscillating link **102** through a pin **103** mounted eccentrically on the oscillating gear **101.** The other end of the link **102** is connected to the pivoted arm **104** of an arcuate oscillating gear rack **105** by a similar pin **106** attached to the arm. The arm **104** is pivotally mounted at one end on a shaft

107 fixed to the gear case and presents the gear rack 105 at its other end. The rack 105, in turn, drivably engages the teeth of a drive pinion 108 keyed to the lower end of the drive shaft 43 on which the basket 42 is mounted. Thus, when the drive pulley 81 is turned clockwise at relatively low speed, it also rotates the intermediate pinion 95 clockwise and the intermediate pinion 95 turns the oscillating gear 101 clockwise through the transfer gear 96 and transfer pinion 98 which are in respective engagement therewith. Rotation of the oscillating gear 101 causes the link 102 to oscillate back and forth from left to right and pivotally drive the oscillating rack 105 back and forth in the same manner. This oscillating motion of the rack 105, in turn, rotates the drive pinion 108 and the drive shaft 43 first in one direction and then in the other to impart a corresponding rotative oscillating motion to the retaining basket 42 mounted at the top of the drive shaft. During this time, the outer shaft 69 and the gear box 68 are held in a fixed position by the cylindrical brake 72 at the lower end of the outer shaft.

When the drive motor 83 is rotated at relatively high speed in the opposite direction, i.e., counterclockwise, it also will rotate the drive pulley 81 at a correspondingly higher speed counterclockwise and, as shown in FIG. 5, will first cause the pulley 81 to move upwardly along the helical gear teeth 82 until a thrust collar 111 attached to the top of the pulley is driven into contact with the lower surface of the brake release cylinder 78 and thereby moves the brake release cylinder axially upwardly to release the cylindrical brake 72 and allow the outer shaft 69 and the gear box 68 to rotate. The upward motion of the drive pulley 81 in this direction is limited by the brake structure so that when the pulley reaches the point shown in FIG. 5 its continued rotation tends to thrust the intermediate shaft 79 axially downwardly, as shown by the arrows. This continued downward axial thrust of the intermediate shaft 79 presses a thin brake collar 112, keyed to the intermediate shaft 79 under the intermediate pinion 108, into driving engagement with an annular braking disk 113 secured to the gear box 68. As a result, continued counterclockwise rotation of the drive pulley 81 now rotates the shaft 69 and the gear box 68, with all of its gearing, counterclockwise at the same angular speed as the drive pulley. Since the oscillating rack 105 now is rotated counterclockwise with the gear box 68 and all of the other gears to which it is connected, and since the rack 105 remains in engagement with the drive pinion 108 during this time, it also rotates the drive pinion 108 and the drive shaft 43 counterclockwise at relatively high speed. This, in turn, rotates the retaining basket 42, or spins it, counterclockwise at a relatively high speed. As indicated hereinbefore, the counterweight at one end of the gear box cover plate counterbalances the relatively heavy gear box 68 during this high speed rotation.

Liquid Transfer Systems

As indicated hereinbefore and as will be explained hereinafter, equipment positioned in the retaining basket 42 will be successively washed, rinsed, disinfected, rinsed again and then emptied during the decontamination cycle. As a result, the working tube 41 will successively receive supplies of washing liquid, rinsing liquid, disinfectant and rinsing liquid again. In fact, the preferred cycle for the equipment of this embodiment involves several supplies of rinsing water in various spray rinsing and deep rinsing steps. The successive use of different liquids accentuates the need for a system which will transfer each type of liquid without contaminating the disinfectant since, as explained hereinbefore, the disinfectant supply is intended to be used over and over again during a relatively long disinfectant use cycle.

The washing liquid is water used with a conventional protein dissolving detergent which is placed into the tub 41 through its top opening. A filling and spray nozzle 115 is provided at the end of a water supply line 116 which passes through the side of the tub 41 near its top both for filling the tub for washing purposes and for spray and deep rinsing. The water supply to the spray nozzle is controlled by a mixing valve, not shown, which, in turn, is controlled by a water level switch 117 and a mixing valve controller 118 which allow the water to be supplied either hot or warm.

A drain hose 119 is connected to a drain fitting 121 at the bottom of the tub 41 in such a way that the tube can be completely drained by gravity through the fitting. The drain hose 119, in turn, is connected to the top of a diverter valve 122 which is adapted to connect the hose either to a drainage system for removing any liquid directly from the tube to any suitable drain, or to a disinfectant transfer system which transfers the supply of liquid disinfectant back and forth between the tub 41 and the disinfectant supply tank 44. The drainage system simply consists of a centrifugal drain pump 123 driven by an electric motor 124 mounted on the foundation plate 56 and connected to the diverter valve 122 and to a drain 125, shown schematically in FIG. 6, by a suitable drain piping.

The disinfectant transfer system comprises a reversible disinfectant pump 126, preferably of the positive displacement type, which is driven by a reversible electric motor 127 and is connected to the diverter valve 122 and the disinfectant tank 44 through a diverter valve float switch 128 just under the diverter valve 122 and a disinfectant tank float switch 129 just under the disinfectant tank 44. Thus, the diverter valve 122, when it is connected to the disinfectant transfer system, drains directly into the diverter valve float switch 128, and the disinfectant tank 44 drains directly into the disinfectant tank float switch 129. These float switches each are of the type which will open electrically when the liquid passing through them falls below a certain level, and they are connected in the electrical control system so that the diverter valve float switch 128 is operable when the disinfectant is being pumped from the tub 41 to the tank 44 and the disinfectant tank float switch 129 is operable when the disinfectant is being pumped from the tank to the tub, as will be explained hereinafter in connection with the decontamination cycle. In either case, as soon as the disinfectant falls below a certain level in the controlling float switch, it will shut off the disinfectant pump motor 127 and the pump 126. This assures that the disinfectant pump 126 only will operate when immersed in disinfectant, i.e., it will not pump air or pump air into the disinfectant supply which might have a deleterious effect upon the chemical formulation of the disinfectant. A solenoid controlled disinfectant transfer valve 131 also is located between the disinfectant tank float switch 129 and the disinfectant pump 126. This valve 131 seals off the disinfectant supply when it is in the tank 44 and re-

moves pressure from the disinfectant pump **126** when the pump is not in action. The transfer valve **131** is automatically operable through a disinfectant transfer solenoid **130** as will be explained hereinafter. A disinfectant filling and drain line **132** is connected to the transfer system through a T fitting **133** located between the disinfectant pump **126** and the diverter valve float switch **128.** This line, in turn, is connected both to a disinfectant fill valve **134** and a disinfectant drain valve **135** through another T fitting **136.** The drain valve **135** is operable from a drain control button **137** on the front of the control console **51** and through an emergency pump-out button **138,** shown only in FIG. **29C,** at the rear of the cabinet. The drain valve **135** is operated through a disinfectant drain solenoid **139** in a manner which will be explained more fully hereinafter. Similarly, the fill valve **134** is operated by a push button switch **141,** shown only in FIG. **29B,** and at the rear of the cabinet, which operates a similar filling solenoid **142** on the fill valve **134.** Thus, when it is desired to remove the disinfectant supply from the unit at the end of its effective use cycle, both the disinfectant transfer valve **131** and the disinfectant drain valve **135** are opened by activating their respective solenoids and the disinfectant pump **126** is operated to pump all of the disinfectant into a suitable drain **143.** Then, when it is desired to refill the tank **44** with a new supply, the disinfectant fill valve **134** and disinfectant transfer valve **131** are activated and the pump **126** is run in the other direction to pump the new supply from its container **144** through a filling hose **145** connected to the disinfectant fill valve **134** and thence into the tank **44.** A disinfectant level switch **146** open to the disinfectant supply in the tank **44** and connected thereto through a pressure line **147** which enters the bottom of the tank is provided to control the resetting of the automatic timers for the disinfectant use life cycle all as will be explained more fully hereinafter.

The diverter valve **122** comprises a housing **148** and a pair of opposed end plates **149** which together define a drainage chamber **151** at one end of the valve and a disinfectant chamber **152** at the other end of the valve. The drainage chamber **151** and the disinfectant chamber **152** are connected by a level central passageway **153** which is raised above the bottom surfaces of the two chambers **151** and **152** so that it normally drains into one or the other of the chambers. The relationship of the tub drain **119,** the drainage system and the disinfectant transfer system to the diverter valve **122** is shown most clearly in FIG. **8.** The tub drain **119** is connected to the top of the central passageway **153** intermediate its ends, the drainage system piping is connected to the bottom of the drainage chamber **151** and the disinfectant transfer system piping is connected to the bottom of the disinfectant chamber **152.**

As indicated hereinbefore, the diverter valve **122** is designed to positively seal off the drainage system when the tub **41** is connected to the disinfectant system and positively seal off the disinfectant system when the tub is connected to the drainage system. This is accomplished by sealing disks **154** and **155** fixed to a horizontal valve rod **156** which is adapted to be moved horizontally to place one or the other of the disks into sealing relation with one or the other of a pair of vertical valve seats **157** and **158,** one at each end of the horizontal central passageway **153.** The valve rod **156** normally is urged to the left in FIGS. **7** and **8** by a compression spring **159** fitted around the rod **156** and pressing against the adjacent sealing disk **155** so that this disk, in turn, is pressed against and in sealing contact with the valve seat **158** at that end of the central passageway, thereby sealing off the disinfectant chamber **152** and connecting the tub drain **119** to the drainage piping. However, in FIGS. **7** and **8** the valve rod **156** is shown in its other extreme position wherein the sealing ring **154** at the opposite end of the rod is pressed into contact with the valve seat **157** at the other end of the central passageway **153,** thereby sealing off the drainage chamber **151** and connecting the tub drain **119** to the disinfectant transfer system. This is accomplished by energizing a diverter valve solenoid **161** which presses the valve rod **156** to the right against the compression spring **159.** The core **160** of the solenoid **161** is connected to the end of a valve lever **162** by a tension spring **163** and the lever is pivotally connected to a bracket **164** at the left end of the diverter valve in such a way that when the solenoid core **160** is moved to the right it swings the lever **162** in the same direction. The lever **162,** in turn, is fitted into a slot at the left end of the valve rod **156** and thereby presses the valve rod to the right. The seating of the sealing disks **154** and **155** in their respective valve seats **157** and **158** at the ends of the central passageway **153** therefore is positively controlled in one direction by the compression spring **159** and in the other direction by the lever controlled solenoid **161.** As shown more clearly in FIG. **8,** the central passageway **153** completely drains into the particular chamber to which it is connected and each of the chambers **151** and **152** is designed to completely drain by gravity into its respective piping system so that the diverter valve **122** drains free and does not trap any liquid. As a result, contamination or dilution of the disinfectant due to the passage of different liquids through the same valve is minimized.

Retaining Baskets

As indicated hereinbefore, when the drive pulley **81** is turned clockwise, the drive shaft **43** and the retaining basket **42** mounted thereon are oscillated back and forth rotatively in the tub **41** with the clockwise rotation of the drive pulley and the intermediate shaft **79** being converted in the gear box **68** to oscillating rotative movement. The angular stroke, or arc of oscillation, may be varied somewhat depending upon the type of equipment to be decontaminated, but in the embodiment shown it is approximately 180°. The length or angular extent of the oscillating stroke can be varied by changing the gearing in the gear box. When the drive pulley **41** is turned counterclockwise, the drive shaft **43** and the retaining basket **42** turn with the pulley in the same direction, and when the pulley **41** is turned relatively rapidly the basket **42** is spun relatively rapidly in that direction.

FIGS. **9–19** show one embodiment of a retaining basket **42** according to this invention which is specifically designed and adapted to hold a number of mostly hollow items of equipment used in anesthesiology. This basket, which may be referred to some times hereinafter as the anesthesia basket, comprises a circular base plate **166,** the spindle **63** which fits over the drive shaft **43,** a cylindrical foraminous side wall structure, and a **3** piece foraminous cover **168** which closes the top of the basket. The circular base plate **166** may be formed of any suitable corrosion resistant material and may be

a molded laminate of a methacrylate resin. In fact, the base plate may be of the same generally foraminous construction as the side wall structure **167** which, in turn, is shown as a relatively open metal wire screening covered with a vinyl plastisol. This is the same type of plastic coated wire which conventionally is used in the construction of dishwasher baskets. The wire side wall structure **167** is welded together and then bolted or screwed onto the base plate through fastening clips **169** also welded to the wire structure. The cover comprises three pie shaped segments **168** which also are of vinyl covered wire screening and these segments are fitted under wire fingers **171** mounted around the perimeter of the wall structure and then held in position centrally by a large washer **172** which slides over the drive shaft **43** and is held down axially by a cotter pin **173** inserted through a hole **174** in the shaft.

The foraminous side wall structure of the basket **42** comprises a cylindrical outer wall **175,** two generally spiral positioning walls **176** and a pair of transverse end walls **177,** which between them define four compartments for positioning the anesthesia equipment to be decontaminated. Each of the spiral positioning walls is curved in the form of a lobe having a pair of spiral legs **178** and each of the lobes define with the cylindrical outer wall **175** an inclined positioning compartment **179** for the hollow corrugated anesthesia tubing and breathing bags. A side compartment **181** for endotracheal tubes is formed between one of the inclined compartments **179** and the cylindrical outer wall **175** and a general compartment **182** is formed on one side of the basket where the transverse end walls **177** intersect the spiral walls **176** and the cylindrical outer wall **175.** The center section of the basket surrounding the spindle **63** is covered by a screening section **183** secured to the spiral walls **176** and the remaining peripheral space opposite to the side chamber **181** is covered by a similar wire section **184.**

FIGS. **9, 12** and **14,** in particular, illustrate how the anesthesia equipment is positioned in the basket **42** and thereby mounted on the drive shaft **43** for rotation therewith. In this connection, it should be noted that three vertical pins **185** secured to the base plate are provided in each of the main compartments and the general compartment for positioning of the equipment therein. A series of drain holes **186** also are provided in the base plate **166** for assuring that the washing, disinfecting and rinsing liquids do not accumulate on the surface of the plate The anesthesia basket of this embodiment is adapted to accomodate six full sets of the type of equipment which normally is used in anesthesiology. The six sets are placed one on top of the other in the same arrangement shown for the sake of clarity with respect to only one set resting on the base plate. A typical arrangement of one set consists of a relatively long corrugated tube **187** and a hollow breathing bag **188** in each of the inclined compartments **179,** a pair of endotracheal tubes **189** in the side compartment **181** and three face masks **191** and a Y-piece **192** in the general compartment **182.** Of course, any given set of equipment may include a somewhat differently shaped item or one more or less of a particular type of equipment.

As indicated hereinbefore, one of the major objectives of this invention is to provide means which will assure that all of the interior and exterior surfaces of the equipment are thoroughly wetted by the washing, rinsing and disinfecting liquids and then emptied of each of the liquids so as to avoid dilution and contamination of one liquid by the other. The retaining basket **42** is so designed that when it is oscillated rotatively back and forth with the shaft **43,** as described hereinbefore, the washing, rinsing or disinfecting liquid (as the case may be) will be caused to move back and forth over the articles and inside their hollow interiors. This is accomplished by shaping the compartments **179** and **181** and arranging the positioning pins **185** in such a way that the hollow articles are generally disposed with their axes inclined to the radii of the drive shaft **43.** Also as explained hereinbefore, it is quite important to empty the hollow articles as completely as possible of each of the liquids with which they are successively treated. For instance, after washing the articles must be emptied of the washing liquid; after rinsing the articles must be emptied of the rinsing liquid; and after disinfecting the articles must be emptied of the disinfecting liquid, etc. This is accomplished in the unit of this invention by positioning the hollow articles in the basket **42** in such a way that the liquids are removed therefrom by centrifugal force when the drive shaft **43** is spun, i.e., rotated relatively rapidly, counterclockwise. This result is attained when the hollow articles are so held in the basket **42** that the axes of their end portions individually extend in a generally trailing spiral configuration which normally means that they extend radially outwardly and obliquely away from the radii of the drive shaft in an angular direction, i.e., clockwise, opposite to the direction, i.e., counterclockwise, in which the retaining basket and the drive shaft are spun. The legs **178** of the spiral walls **176** of the inclined compartments **179** extend in this same generally trailing spiral configuration with respect to the direction in which the basket **42** is spun and the pins **185** in the inclined compartment are arranged therein in such a way that the long corrugated tubing **187** can be disposed directly against its respective spiral wall **176,** as shown most clearly in FIG. **12,** between the wall and the outermost pins **185** in the compartment. Then one of the breathing bags **188** is secured at the leading end of the compartment **179** by placing one of the rings **193** at the closed end of the bag over the pin **185** at that end of the compartment and placing the remainder of the bag **188** between the two halves of the corrugated tubing **187** which already has been positioned in the compartment, as shown in FIG. **12.** The endotracheal tubes **189** are positioned in the side compartment **181** in such a way that their curved axes also are in a generally trailing spiral configuration with respect to the direction of spinning of the basket as described hereinbefore. The face masks **191** are placed in position in the general compartment **182** merely by dropping them over the three pins **185** provided for this purpose which extend through the air hole in the masks and the Y-piece **192** may be positioned anywhere in the general compartment.

When the anesthesia basket is completely loaded, the three pie shaped cover sections **168** are placed in position under the fingers **171,** as shown in FIGS. **13** and **14,** and the washer **172** is placed over the drive shaft **43** and held in position thereon by the cotter pin **173.** Then the basket **42** and its contents are ready to be treated in accordance with the process of this invention. The fact that the cover is in the form of three pie shaped segments **168,** not only facilitates positioning of

the segments under the fingers **171** extending from the cylindrical outer wall of the basket **42**, but allows access to the contents of the basket without entirely removing the cover. To facilitate this, an individual handle **193** is welded to each of the segments **168** for lifting the segments from the basket and placing them in position.

FIGS. **20–28** show a retaining basket **195** according to a somewhat different embodiment of the invention which is adapted to hold several sets, i.e., eight, of inhalation therapy equipment to be decontaminated in the same general manner as described hereinbefore in connection with the anesthesia equipment. The inhalation therapy basket **195**, like the anesthesia basket **42** comprises a circular base plate **196** and a spindle **197** which fits over the drive shaft **43**. However, the foraminous side wall and cover structure of this basket **195** is somewhat more complicated. This equipment includes inhalation therapy tubing **198** in the form of various diameters of small gauge, flexible hose which must be arranged carefully in order to be assured that it will be properly exposed to the washing and disinfecting liquids when the basket **195** is oscillated and properly emptied when the basket is spun. For this purpose the basket **195** includes a pair of corresponding spiral foraminous wire walls **199** beginning on opposite sides of the drive shaft **43** near the center of the basket and spiraling outwardly until they reach a cylindrical outer foraminous wire wall **201** similar to the cylindrical outer wall **175** of the anesthesia basket. As a result, two spiral compartments **202** are formed, one inside the other. The spiral walls **199** in this inhalation therapy basket are mounted on the circular base plate **196** and extend upwardly only slightly more than half way through the depth of the basket. These walls **199** are secured at their inner ends to the larger cylindrical bottom section **203** of the spindle **197** by screws **204** passing through corresponding eyes **205** at each end of the wire structure. After the tubing **198** has been wound inside the spiral compartments **202**, as shown for one set in FIGS. **23** and **26**, an intermediate structure consisting of an upwardly dished circular wire shelf **206** and a cylindrical foraminous wire central compartment wall **207** is pressed over the upper smaller half **208** of the spindle, as shown most clearly in FIGS. **22** and **25**. The circular shelf **206** has a central opening defined by an annular collar **209** which fits around the top half of the spindle **208** and holds the intermediate structure in position radially with respect thereto. As shown most clearly in FIGS. **22** and **23**, this circular shelf **206** presents a set of eight curved wire brackets **211**, each of which extends at an angle of slightly less than 90° to the radii of the drive shaft **43**. Again, as shown most clearly in FIG. **23**, these brackets are adapted to cooperate with a corresponding set of eight wire hangers **212** welded to the cylindrical outer wall **201** and extending inwardly therefrom and with a set of eight spacing brackets or spacers **213** also extending inwardly from the outer wall **201** adjacent the leading side of the hangers **212**. The brackets **211**, the hangers **212** and the spacers **213** are adapted to hold the glass jars **214** used in inhalation therapy in such a way that when the mouth of one of these jars is placed over one of the hangers **212** with its base in the adjacent bracket **211**, the axis of the mouth of the jar will extend radially outwardly and obliquely away from the radii of the drive shaft **43** and the basket **195** in an angular direction opposite to that in which the shaft and the basket are spun, thereby assuring that the jars **214** will be emptied of liquid by centrifugal force.

As shown most clearly in FIG. **23**, the central compartment formed by the wall **207** may be used to hold various valves and other solid items used in inhalation therapy so that they might be decontaminated. Also, there is enough room in the unit to position various other items such as mouth pieces, jar tops, etc. in the upper portion of the basket above the tubing. To assure that all of these articles and the various parts of the inhalation therapy basket **195** are held firmly in position during the decontamination cycle of the process, a segmented cover is provided. This cover consists of three pie shaped segments **215**, similar to those of the anesthesia basket, which are adapted to fit under fingers **216** extending inwardly from the cylindrical outer wall **201** of the basket, as described hereinbefore, and an upwardly dished circular retaining screen **217** which has an integral washer **218** defining a central opening adapted to fit over the uppermost portion of the drive shaft **43**. Thus, after the tubing **198** and other inhalation therapy items are placed in the lower portion of the retaining basket **195**, the wire shelf **206** and central wall **207** are placed over the upper end **208** of the spindle **197** and the various jars **214** and other pieces of inhalation therapy equipment are placed in position, as shown in part in FIG. **23**. Then, the three pie shaped segments **215**, each having a handle **215***a*, are positioned under the fingers **216** and around the drive shaft **43** and the dished retaining screen **217** is placed over the uppermost portion of the drive shaft **43** and pressed downwardly until a cotter pin **219** can be placed in the retaining hole **221** provided in the drive shaft. When this point is reached, all of the parts of the basket **195** are held firmly in position by virtue of the fact that the dished configurations of the circular wire shelf **206** and the circular retaining screen **217** have been at least partially removed by the pressure under which they are held. In other words, the tendency of the circular wire shelf **206** and the retaining screen **217** to return to their normal dished configurations causes continuing pressure between adjacent parts of the basket which holds the parts firmly in position.

Decontamination Cycle

As indicated hereinbefore, the apparatus of the embodiment of this invention shown in the drawings operates automatically in successive decontamination cycles within a relatively lengthy disinfectant use cycle, i.e., 14 days. The disinfectant use cycle is timed and controlled by means which will be described more fully hereinafter in such a way that the unit is rendered inoperative to begin a new decontamination cycle at the end of the disinfectant use cycle, until the current supply of disinfectant is removed from the machine and replaced with a new supply. Various other use cycle controls are provided all of which will be described more fully hereinafter.

The contaminated equipment is decontaminated as the unit is operated through its decontamination cycle which, in turn, consists of two sub-cycles, i.e., a cleaning cycle and a disinfecting cycle. The cleaning cycle involves a number of steps centered around washing. In fact, a preferred cleaning cycle for this embodiment of the invention using an anesthesia basket for decontaminating anesthesia equipment, as described in connec-

tion with FIGS. 9–19, is set forth below in twelve steps which essentially involve washing, rinsing and emptying the equipment preparatory to the disinfecting cycle. The time taken in each step is indicated.

CLEANING CYCLE

Step	Time Min.	Sec.
1. Fill	3:	40
2. Wash	17:	30
3. Drain	1:	15
4. Spin Dry and Spray Rinse	2:	30
5. Fill	3:	40
6. Deep Rinse	1:	15
7. Drain	1:	15
8. Spin Dry and Spray Rinse	2:	30
9. Fill	3:	40
10. Deep Rinse	1:	15
11. Drain	1:	15
12. Spin Dry	3:	45

NOTE: All filling times given in this application are based upon the assumption that the filling water pressure is 65 p.s.i.

The disinfecting cycle also involves a number of steps based upon soaking the washed equipment in a liquid disinfectant while agitating same. The various steps in a typical disinfecting cycle according to a preferred embodiment of the invention are as follows:

DISINFECTING CYCLE

Step	Time Min.	Sec.
1. Disinfectant Fill and Agitate	13:	45
2. Drain Disinfectant	3:	45
3. Spin Dry	3:	45
4. Spray Water Rinse and Spin Dry	2:	30
5. Water Fill	3:	40
6. Deep Rinse	2:	30
7. Drain	1:	15
8. Spin Dry and Spray Rinse	2:	30
9. Water Fill	3:	40
10. Deep Rinse	1:	15
11. Drain	1:	15
12. Spin Dry	3:	45
13. Lid Switch Bypass	1:	15

The decontamination cycle according to this embodiment of the invention will be described with particular reference to FIGS. 29A and 29B which essentially are the cam diagrams and the associated wiring diagram for a decontamination cycle timer, not shown. The decontamination cycle timer and the other timers used in the disinfectant use cycle all are drum type clock timers which conventionally are used for timing automatic washing cycles and the like, each of which comprises a number of circumferential cams with associated cam switches. Thus, it will be seen that the decontamination cycle timer of FIG. 29A comprises 12 cams all but one of which is adapted to connect a central switch terminal with either a top or a bottom cam switch terminal. Thus, each cam may be said to have two switches in that it either connects to the top or the bottom terminal. Only one-half of the cam may be used as for Cams No. 4 and No. 10, and Cam No. 12 is illustrated as operating only in one direction, i.e., down. The shaded portions indicate that current is passing through the particular cam switch during the horizontal increment which is shaded. The cam diagram of FIG. 29A is divided into 60 timing increments, each of which represents 1 minute, 15 seconds. Thus, it will be seen that the cleaning cycle is represented by 35 minutes on the cam and the disinfecting cycle is represented by 40 minutes, as indicated at the top of the diagram. However, the cleaning cycle and the disinfecting cycle each are somewhat longer than 35 minutes and 40 minutes, respectively, because there are steps during these cycles when the timer drum is not rotated, as will be explained more fully hereinafter.

The various timers and allied circuitry are located in the control console 51 and a control dial 225. Various lights and control buttons to be described are presented on the face of the console. A starting knob 226, connected to a push-pull switch 227, is provided in the center of the control dial 225 for initiating the decontamination cycle. Thus, to start the machine in its decontamination cycle, the tub cover 48 is closed to close a lid switch 228 which is provided for safety purposes (and is adapted to open the circuit and stop the machine when the tub cover is open) and the starting knob 226 is pulled out to close the push-pull switch and provide power to a water level switch 229 by connecting it with an auxiliary power line 231. The water level switch 229, in turn, powers the bottom switch of Cam No. 11 which opens the mixing valve, not shown, by operating the mixing valve controller 118 as described hereinbefore, thereby initiating Step 1, i.e., the filling of the tub with water, in the cleaning cycle. Normally a suitable amount of a protein dissolving detergent would have been shaken into the working tub 41 over the equipment to be decontaminated prior to starting the unit. Of course, the anesthesia equipment would have been previously arranged in the retaining basket 42 as described hereinbefore in referring to FIGS. 9–19.

During this initial filling step, the decontaminating cycle timer is not yet operated and filling is controlled completely by the water level switch 229. When the water reaches the desired level in the tube 41, the water level switch operates to shut off the mixing valve and power a timer motor 232 which begins to turn the decontamination timer drum, and at the same time powers the bottom terminal of Cam No. 4 which, in turn, powers the bottom switch of Cam No. 6 through a jumper 233 shown at the right end of the diagram. As indicated by the shading, Cam No. 6 is in the bottom position at this point so that its bottom switch energizes a drive motor 234 for the retaining basket 42 containing the equipment to initiate oscillation of the basket. As shown in FIG. 29B, this powers lead 235 of the drive motor which initially powers lead 236 and, through a jumper 237 and the top switch of Cam No. 8, powers the lead 238 which is connected to the starting coil 239 which starts the motor. Rotation of the motor 234 then opens two centrifugal switches 241 and 242, one of which 241 disconnects the starting coil 239 and the other 242 connects lead 235 to a low speed coil 243 which turns the motor clockwise. As explained hereinbefore under the heading "Basket Drive," this serves to rotatively oscillate the retaining basket 42 in the working tub 41 and causes the washing fluid to move in and out and back and forth through and over the hollow articles to be decontaminated. This washing operation continues for 17½ minutes as indicated in the cleaning cycle table, above, and as can be seen from FIG. 29A. It is important to note that at the end of 1 minute and 15 seconds from the beginning of the decontamination cycle the water level switch 229 is connected to a master power line 244 through Cam No. 2 which connects the master line 244 to a main power line 245 which is

the direct or indirect source of all current supplied to the unit. Of course, this means that while the decontaminating cycle could be stopped prior to the end of the initial 1 minute, 15 second period by pushing in the starting knob **226** it only can be stopped after the end of this period by opening the tub cover **48** which, in turn, opens the lid switch **228** or, as will be explained more fully hereinafter, by an emergency stop switch **246** on the front of the console **51.**

At the end of the washing step, the tub drain pump motor **124** is energized through the top switch of Cam No. **5** which, in turn, is now powered through a pair of jumpers **247** connected to the master power line **244,** as shown at the right of the cam diagram in FIG. **29A.** Following another single interval, i.e., 1 minute, 15 seconds, on the cam diagram, Cam No. **6** connects to its top terminal and reverses the drive motor **234** by powering lead **236** which is directly connected to a high speed coil **248** of the drive motor which now turns the motor counterclockwise. As explained hereinbefore under the heading "Basket Drive," this spins the basket **42** and its contents at a relatively high speed in the counterclockwise direction. The centrifugal force generated in this spinning action of the basket **42** causes any washing liquid remaining in the tubing, bags and other hollow anesthesia articles to leave the equipment through their inclined hollow end portions as explained under the heading "Retaining Baskets." It will be seen from the diagram of FIG. **29A** that the drive motor **234** continues to spin while the drain pump **123** is driven through its motor **124** for another 2 minutes and 30 seconds to remove residual washing liquid from the articles.

At the end of the washing step and simultaneously with the energization of the drain pump motor **124,** Cam No. **4** is activated to bypass the water level switch **229** and thereby prevent the water level switch from opening the mixing valve to attempt to fill the tub **41** which is being emptied by the drain pump **123.** As shown in the diagram, this bypass will remain activated for 5 minutes, or one cam increment longer than the drain pump. At the end of this period, the water level switch **229** is again powered by the master line **244.** This immediately disconnects the timer motor **232** and connects the rinse-fill selector Cams No. **11** and No. **12** since the water level switch will move to its filling position in response to the fact that the working tub is empty. The top switch of Cam No. **11** and the single switch of Cam No. **12** both are closed at this point to energize both the cold and hot water valve solenoids in the mixing valve controller **118** and thereby open both valves to obtain a mixed supply of warm rinse water. Again as explained hereinbefore, it will take approximately 3 minutes and 40 seconds for the tub **41** to fill and when it does the water level switch **229** then will shut off the mixing valve controller **118** and power the timer motor **232** which turns the timer drum. This again connects the switches of Cams No. **6** and No. **8** to oscillate the retaining basket **42** for a period of 1 minute and 15 seconds. This is Step 6, i.e., deep rinse, of the cleaning cycle. Steps 7, 8, 9, 10, 11 and 12 then are repetitions of steps 3–6 of the cleaning cycle with the single exception that in Step 12 the basket **42** is spun for 3 minutes and 45 seconds to remove residual rinsing water from the hollow articles prior to the beginning of the disinfecting cycle, 43 minutes and 30 seconds after the beginning of the decontamination cycle.

The diverter valve solenoid **161** is energized by the closing of the bottom switch of Cam No. **5** at the very beginning of the disinfecting cycle to seal off the drain piping and connect the working tub **41** to the disinfectant piping system as shown in FIGS. **7** and **8.** The diverter valve **122** remains energized for 20 minutes which is the length of time that the tub is connected to the disinfectant piping system. The reversible disinfectant pump motor **127** also is energized to operate the disinfectant pump **126** and pump disinfectant from the tank **44** to the tub **41** at the beginning of the disinfecting cycle and remains energized to turn in this direction through the bottom switch of Cam No. **7** which is powered through a supplementary jumper **249** connected to the jumpers **247** which are tied to the master power line **244.** At this point, Cam No. **7** powers relay **R6** which, in turn, causes contacts **R6,** shown at the top of FIG. **29B,** and powers the disinfectant pump motor **127** in one direction to pump toward the working tub **41.** When the contacts **R6** are closed the disinfectant transfer valve solenoid **130** also is energized to open the disinfectant transfer valve **131** and thereby connect the transfer pump **126** with the disinfectant supply in the disinfectant tank **44.** It should be noted that the disinfectant tank float switch **129** is in series with the relay **R6** between the relay and its power source. Thus, as explained hereinbefore, when the disinfectant level falls below a designated point in the float switch **129,** the switch **129** opens and de-energizes the relay **R6** thereby shutting off the disinfectant pump **126** to assure that it remains immersed in disinfectant and does not run dry. Also, as indicated hereinbefore, as soon as this disinfectant tank float switch **129** receives enough additional disinfectant from the tank, the float switch again is closed to energize the disinfectant pump motor **127** through the relay **R6** and its associated contacts. As shown in FIG. **29A** at two intervals, i.e., 2 minutes and 30 seconds after the beginning of the disinfectant cycle, Cams No. **6** and No. **8** energize the drive motor **234** at low speed in the clockwise direction to oscillate the retaining basket and contents. This time the basket **42** is immersed in the disinfectant supply and the disinfectant is caused to thoroughly wet the inside and outside surfaces of the articles of equipment by virtue of the agitation which results from the rotative oscillation of the basket. The disinfectant pump motor **127** is de-energized by Cam No. **7** prior to the end of the first oscillation step in the disinfectant cycle and at the end of this step Cam No. **7** reverses the disinfectant pump motor **127** by energizing relay **R5** which causes contacts **R5** to close and run the pump **126** in the opposite direction to transfer the disinfectant supply from the tub **41** back to the tank **44.** Now it should be noted that power reaches the relay **R5** only through the diverter valve float switch **128** which is located between the relay and its power source. Thus, the disinfectant pump motor **127** now is controlled by the liquid level in the diverter valve float switch **128.** This is Step 2 in the disinfecting cycle. At the end of 4 minutes and 15 seconds, the drive motor **234** is energized in the spin direction through Cams No. **6** and No. **9,** as described hereinbefore in connection with the cleaning cycle, and the retaining basket **42** is spun at relatively high speed to empty the hollow articles of the disinfectant by centrifugal force. This is step 3 in the disinfectant cycle and

lasts for 3 minutes and 45 seconds, during which time the disinfectant pump **126** normally would stop and start again several times due to the fact that the disinfectant being spun from the hollow articles will first be pumped below the control level in the diverter valve float switch **128** to stop the pump and then will fill the float switch again to start the pump **126** successively.

As described hereinbefore, at **20** minutes past the beginning of the disinfectant cycle the diverter valve solenoid **161** will be de-energized by Cam No. **5** to seal off the disinfectant supply from the drainage system which now is connected to the working tub **41** through the tub drain **119** and the diverter valve **122** itself.

As the diverter valve is de-energized to connect the tub to the drainage system the retaining basket **42** remains spinning as indicated by the shaded bar connecting the top switch terminal of Cam No. **6.** Then Cams No. **5,** No. **10** and No. **11** become energized simultaneously to begin Step 4, "Spray Water Rinse and Spin Dry" in the disinfecting cycle. Thereafter successive filling, deep rinsing, draining and spin drying and spray rinsing cycles complete the disinfectant cycle in the same manner as described in connection with the completion of the cleaning cycle. Then, as for the cleaning cycle, the operating part of the disinfecting cycle is ended with Step **12** which is a spin drying operation without spray rinsing. Thus, the driving motor **234** finally is de-energized at one interval prior to the very end of the disinfecting cycle. At this point, Cam No. **10** closes its bottom switch to bypass the lid switch **228** through a jumper **260** and a bypass line **261,** thereby assuring that the timer motor **232** will continue to receive power until the cycle is ended even if the lid **48** is opened to remove the decontaminated equipment when the unit stops operating. Then, at approximately 30 seconds before the end of the cycle, Cam No. **2** de-energizes the master power line **244** by disconnecting it from the main power line **245** and energizes a feed line **262** used to power the disinfectant pump-out and reset timer circuitry as will be explained more fully hereinafter. However, the decontamination cycle does not end yet because the timer motor **232** remains energized through the auxiliary power line **231** due to the fact that the water level switch **229** is bypassed by Cam No. **4** until the end of the last increment on the diagram at 44 minutes and 50 seconds past the beginning of the disinfectant cycle.

During the decontamination cycle it is important for the operator or other hospital personnel, for instance, to know what part of the cycle the unit is in and it is particularly important to know whether or not the working tub **41** is exposed to the disinfectant supply, i.e., with the diverter valve **122** energized. The reason for this is that the disinfectant is a chemical which might give off annoying gases or vapors particularly when agitated. Thus, signal lights **251, 252** and **253** are provided to indicate successively that the unit is in its cleaning or washing cycle, the disinfectant portion of the disinfecting cycle, and the rinsing portion of the disinfecting cycle. A wash light **251** is energized by the lower switch terminal of Cam No. **3,** a disinfectant light **252** is energized by the upper terminal of Cam No. **1** and a rinse light **253** is energized by the upper terminal of Cam No. **3,** as indicated in FIGS. **29A** and **29B.** There is also a low disinfectant level light **254** which is connected to the disinfectant level switch **146** and lights up when the disinfectant supply is below the desired switch level in the tank **44.** However, the light **254** only is energized through the bottom terminal of Cam No. **1** when the disinfectant supply is in the disinfectant tank **44,** i.e., when the diverter valve solenoid **161** is de-energized. The purpose of this is to indicate if disinfectant is lost through evaporation or for any other cause and allow the operator to bring the supply back to its proper level by placing more disinfectant in the tank. These and the other lights and signals described herein all are powered from the main power line **245** through a transformer **256** which converts the 110 volt supply to 24 volts in a signal line **257** which, in turn, supplies power to all the signal circuitry.

A hot-warm signal light and switch **255** is provided at one end of the console **51** to control the temperature of the wash water and to indicate whether this water is hot or warm. This unit **255** comprises a push button switch **255*a*** and hot-warm signal lights **255*b*.** As explained hereinbefore, the water level switch **229** initially energizes the mixing valve controller **118** through Cam No. **11.** As indicated in the timing of FIG. **29A,** the lower switch of Cam No. **11** is closed at the beginning of the decontamination cycle thereby powering line **255*c*** in FIG. **29B.** Then, depending upon the position of the hot-warm switch, either the hot and cold water valves of the mixing valve controller both will be opened through their respective solenoids **118*a*** and **118*b*** (as shown in FIG. **29B**) or only the hot water valve will be opened. As indicated, with the hot-warm switch in the position shown in FIG. **29B,** the line **255*c*** will be connected both to the hot water solenoid **118*a*** and to the cold water solenoid **118*b*** of the mixing valve controller **118,** thereby mixing hot and cold water to obtain a warm water wash. For this reason, the warm water light of the signal **255*b*** is energized as shown. When the hot-warm switch is moved to its hot position it energizes the hot indicating light of the signal **255*b*** and de-energizes the cold water valve solenoid **118*b*** of the mixing valve controller **118** and only hot water is supplied. The hot-warm switch **255*a*** is a push button switch of the type that will change from the hot to the warm position successively as it is pushed and released. The push button is transparent or translucent and divided with a line with the hot water light on one side and the warm water light on the other side of the line, thereby providing a simple indicator-control for water temperature.

As indicated hereinbefore, an emergency stop switch **246** is provided on the front of the console **51** to allow the operating parts of the unit, including the decontamination cycle timer, to be deactivated in case an emergency stop is necessary. This switch activates a relay CR **1** which opens normally closed contacts CR **1** respectively in the auxiliary power line **231** to the starting switch **227** and in the main power line **245** between the disinfectant use cycle circuitry of FIG. **29C** and the operating circuitry of FIGS. **29A** and **29B,** thereby completely deactivating the operating parts of the unit. However, as explained more fully hereinafter, this will not deactivate the disinfectant use cycle timers since they are still connected to the activated side of the main power line **245** and are designed to time the life of the disinfectant solution regardless of whether or not the unit is in operation. An emergency signal light **258** also is provided on the face of the console **51** to indicate when the emergency stop switch **246** is activated, as shown in FIG. **29B.**

Disinfectant Use Cycle

The 14 day disinfectant use cycle is controlled by three timers, i.e., a period timer **12H**, a stepping timer **1M** and a reset timer **5M** which are located in the control console **51** but are not otherwise physically shown, and by circuitry associated therewith and shown in FIG. **29C**. The circuitry of FIG. **29C** is connected with the circuitry associated with the decontamination cycle timer shown in FIG. **29B** as indicated by the arrows to the left of FIG. **29C**. These three use cycle timers also are drum type clock timers similar to the decontamination cycle timer. Thus, each timer comprises a number of cams each of which has the capability of controlling two switches or switch terminals, although in some cases only one switch position is used. FIG. **29C** identifies each of the cam switches used.

The disinfectant use cycle is timed by the stepping timer **1M** and the period timer **12H** working in cooperation with one another. The period timer **12H** times 12 hour periods in 6 hour increments as shown in the timing diagram of FIG. **31**, and the stepping timer **1M** counts the number of 6 hour increments during the overall use cycle time of 14 days as shown in the timing diagram of FIG. **32**. The reset timer **5M** controls the replacement of the disinfectant supply and resets these three timers and their associated circuitry for timing the use cycle for a new supply of disinfectant. The timing for the reset timer is shown in FIG. **30**.

Assuming the timers and the circuitry to be reset and ready to time a new disinfectant use cycle, they will remain inoperative until the new disinfectant supply is placed in the disinfectant tank and reaches the level in the tank which will activate the disinfectant level switch **146** and thereby connect the relay **R4** with the main power line. When this is done, the contacts **R4** are closed, supplying power through switches **S112H** and **S21M** to the stepping timer **1M**. This starts the stepping timer and thereby closes the switch **S101M** to supply power to the period timer **12H** and initiate the disinfectant use cycle for the new disinfectant supply.

It should be noted at this point that the period timer will generally be referred to as the timer **12H** which stands for 12 hour timer, since this timer times 12 hour periods in two 6 increments. Similarly, the stepping timer will be referred to as the timer **1M** since it turns in one minute increments as will be explained more fully hereinafter and therefore also may be called the 1 minute timer. The reset timer happens to operate on a 5 minute cycle and therefore is designated **5M** for 5 minute timer. This code also is used in identifying the switches for these timers. For instance, switch **S1** on the 1 minute timer is designated **S11M**, meaning switch **1** for the 1 minute timer. **S112H**, then is switch **1** for the 12 hour timer, etc. Referring to FIGS. **30, 31** and **32** it will be seen that at the beginning of the disinfectant use cycle switches **2, 3, 4, 5** and **10** of the stepping timer **1M** are closed, switch **1** of the period timer **12H** is closed and switches **2** and **6** of the reset timer **5M** are closed. Since the reset timer **5M** is not normally operated during the disinfectant use cycle, switches **S25M** and **S65M** remain closed throughout the disinfectant use cycle. **S65M** powers the auxiliary power line by connecting it to the main power line through **S101M** and thereby allows the decontamination cycle to be started by pulling out the starting knob **226** as described hereinbefore. The closing of **S41M** at the beginning of the disinfectant use cycle bypasses the disinfectant level switch **146** and continues to provide power for timing the disinfectant use cycle regardless of the level of the disinfectant in the disinfectant tank **44**. The stepping timer **1M** operates for one minute at a time to successively open and close the switches **S11M** and **S21M** through Cams No. **6** and No. **8** of the stepping timer as shown in FIG. **32**. At the beginning of the use cycle, **S112H** and **S21M** are closed. **S112H** remains closed for approximately 170 minutes on the cam diagram but **S21M** only remains closed during the first 1 minute period of operation of the stepping timer **1M**. At the end of 1 minute **S21M** opens to stop the stepping timer and **S11M** closes in readiness for the next one minute step of the stepping timer **1M**. When Cam No. **2** of the period timer **12H** operates at the end of 350 minutes to close **S212H**, the 1 minute timer again is operated, this time through **S11M**, and this stepping sequence repeats itself a total of 56 times throughout the 14 day disinfectant use cycle.

Since it is quite important to insure that the life of the current supply of disinfectant is properly timed, the disinfectant use cycle can only be interrupted in two ways, i.e., by a manual pump out button and signal **137** provided on the face of the control console **51** or by an emergency pump out button **138** provided at the rear of the housing. The emergency pump out button **138** can be operated at anytime, but the manual pump out button **137** can only be operated in the last 6 hour increment of the 14 day use cycle as will be described hereinafter.

The approaching end of the use cycle is signalled six hours prior to the end of the cycle by an order-disinfectant light **266** on the face of the control console **51**. This light **266** and an associated flasher **267** are energized by the closing of switch **S61M** of the stepping timer **1M** 6 hours before the end of the use cycle. This causes the light **266** to flash on and off and thereby reminds the operator to order or obtain a new supply of disinfectant. At the same time, switch **S81M** of the stepping timer is energized to power the manual pump out button **137** through switch **S111M** which is already closed and connected to the feed line **262** energized from the main power line **245** through Cam No. **2** of the decontamination cycle timer. This allows the manual pump out button **137** to be operated as indicated above. However, the disinfectant supply ordinarily would not be pumped out until the end of the use cycle which is reached 6 hours later. At that time, switch **S101M** is de-energized by Cam No. **9** of the stepping timer to remove power from the disinfectant use cycle timers **1M** and **12H** and from the auxiliary power line **231** which must be energized to initiate a new decontamination cycle. From this point on, the unit cannot be operated until the current disinfectant supply is removed and a new supply is pumped into the disinfectant tank **44**. There is only one exception to this, namely, that any remaining portion of a decontamination cycle in progress at the end of the disinfectant use cycle can be completed prior to the unit becoming inoperative. This is assured by Cam No. **2** of the decontamination cycle timer which continues to energize the master power line **244** for the unit throughout a given decontamination cycle. This cam then de-energizes the master power line and energizes the feed line **262** at the end of the decontamination cycle as described hereinbefore. As soon as this occurs, the unit no longer can

be operated. The end of the disinfectant use cycle is signalled by the lighting of a replace disinfectant light **268** on the face of the console **51** which is energized by the closing of switch **57** of the one minute timer 1M.

When the manual pump-out button **137** is pushed in it energizes the 5 minute timer (reset timer 5M) and the relay R2 through the normally closed switch S25M of the reset timer and directly energizes the disinfectant drain solenoid **139**, the latter immediately opening the disinfectant drain valve **135** which allows the disinfectant to be pumped from the unit. The relay **R2** closes the two contacts **R2**, one of which bypasses the manual pump-out button **137**, and the other of which energizes a signal light **269** which shines through the pump-out button **137** and indicates that the disinfectant supply is being drained from the unit. Then, Cam No. **5** of the reset timer **5M** closes switch **S15M** which powers relay **R6** through the disinfectant tank float switch. Relay **R6** closes the contacts **R6**, which energize the disinfectant transfer solenoid **130** and the disinfectant pump motor **127** to begin to pump disinfectant supply from the disinfectant tank and out of the unit through the disinfectant drain valve **135**.

The disinfectant pump **127** remains connected through the disinfectant tank float switch **129** for slightly over 4 minutes as shown in FIG. **30**. As explained hereinbefore in connection with the operation of the disinfectant transfer system, the pump only will run in this direction for so long as there is disinfectant above a designated level in the disinfectant tank float switch **129**. When the disinfectant drops below this level, the float switch stops the pump until the switch again is filled with disinfectant. Since the 4 minute period referred to above is more than adequate to drain the disinfectant tank, the time required for the disinfectant pump to operate for this purpose actually is controlled by the disinfectant tank float switch.

The disinfectant tank float switch **129** finally is de-energized when Cam No. **5** of the reset timer **5M** opens switch **S15M** and closes switch **S55M**, energizing the relay **R3** which closes the contact **R3** and thereby energizes the rapid advance drives of the timers **1M**, **12H** and **5M** through switches **S51M**, **S312H** and **S45M**, respectively. These three switches remain closed as the timers home in on their respective starting positions where their arrival is signalled by the bottom to top lift of their respective switches. During this time, the relay **R3** remains energized to maintain the contact **R3** closed and power the homing circuit for so long as any one of the timers has not yet reached its starting position. This is accomplished by the switches **S31M**, **S412H** and **S35M**, one of which will remain closed to energize the relay **R3** for so long as its corresponding timer has not been reset. In the meantime, the switches **S25M** and **S55M** have been opened to disconnect the 5 minute timer from the pump out controls. Then when all of the timers have been reset, i.e., they have homed in on their starting positions, the relay **R3** will be de-energized and the disinfectant use timing circuit again is ready to time another disinfectant use cycle, with one exception. The unit, itself, and the disinfectant use cycle cannot be started until the disinfectant tank **44** is filled with a new supply. However, this can be accomplished at any time by filling the tank to the proper level to activate the disinfectant level switch **146** which, when closed, energizes the relay **R4** to again power the disinfectant use timing circuit and through the switches **S101M** and **S65M** the auxiliary power line **231** which is needed to start a new decontamination cycle.

Normally, the new disinfectant supply will be taken into the unit by the hose connection **145** between the flasks or bottles **144** in which the disinfectant is acquired or stored and the disinfectant filling valve **134** connected to the disinfectant transfer piping system. In this case, the disinfectant fill valve **134** is open and the disinfectant pump motor **127** is started in a direction opposite to that used for drainage merely by depressing the disinfectant filling switch button **141** on the back of the housing. This energizes relay **R5** by connecting it to the feed line **262** and thereby closes contacts **R5** to energize the disinfectant pump motor **127** and open the disinfectant transfer valve **131** underneath the tank through its solenoid **130**. The disinfectant filling switch button **141** is held in until the required amount of disinfectant is pumped into the tank **44**.

The emergency pump out button **137** is only intended to be used in an emergency situation when the disinfectant supply must be removed from the unit prior to the final 6 hour period of the normal disinfectant use cycle. This is accomplished merely be depressing the emergency pump out button on the back of the unit to energize the relay **R10** by connecting it to the feed line through the normally closed contact **R3**. This, in turn, closes the contacts **R10**, one of which bypasses the pump out button **137** and the other connects the 5 minute timer, the relay R2 and the disinfectant drain solenoid **139** to the feed line **262**, and thereby starts the pump out and reset cycle controlled by the 5 minute timer as described above in connection with the manual pump-out.

As indicated hereinbefore, an emergency stop switch **246** on the front of the console **51** above the dial **225** is provided for use only when it is desired to remove all power from the unit quickly in an emergency situation. The closing of this switch de-energizes the relay CR1 which opens the normally closed contacts CR1 to disconnect the auxiliary power line **231** from the main power line **245** and interrupt the main power line to de-energize the operating circuitry of FIG. **29B** and thereby remove all power from the operating parts of the unit. However, this does not remove power from the disinfectant use cycle timing circuit of FIG. **29C** which assures that the life of the disinfectant supply will be properly timed whether or not there is an emergency. Normally, however, it should not be necessary to use the emergency stop switch **246** since the unit is easily stopped for the inspection of its contents by lifting the tub cover or lid **48** to open the lid switch which stops the unit.

Having now described the invention in specific detail and exemplified the manner in which it may be carried into practice, it will be readily apparent to those skilled in the art that innumerable variations, applications, modifications, and extensions of the basic principles involved may be made without departing from its spirit or scope.

What is claimed is:

1. A washing device for hollow articles which comprises: a tub adapted to hold a supply of washing liquid; a drive shaft entering the bottom of said tub; a foraminous basket for drivably mounting from said shaft a plurality of hollow articles having generally tubular open end portions; automatic oscillating means driv-

ably connected to a motor for rotating said shaft back and forth, first in one direction and then in the other, to agitate said articles in the washing liquid held in said tub; drain means for removing liquid from said tub; means connected to said motor for spinning said shaft relatively rapidly in one direction to complete the removal of the liquid from said articles when the washing liquid is removed from said tub; and a contoured wall in said basket extending from a point adjacent the outer periphery of said basket to a point adjacent said shaft for holding the articles in relatively fixed positions wherein the liquid is forced into the articles during the aforesaid oscillation and removed therefrom by centrifugal force during said spinning.

2. A washing device according to claim **1,** wherein said wall extends radially outwardly and obliquely away from the radii of said shaft in an angular direction opposite to the direction in which said shaft is spun.

3. A washing device according to claim **2,** wherein said wall is curved in the form of a lobe.

4. A washing device according to claim **3,** wherein said holding means comprises two lobes.

5. A washing device according to claim **2,** wherein said holding means is a foraminous retaining wall extending substantially parallel to said shaft and being spirally curved in a plane perpendicular to said shaft.

6. A washing device according to claim **5,** wherein said holding means is two concentric spirally curved retaining walls.

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