United States Patent [19]

Decupper

[11] **3,816,074**

[45] **June 11, 1974**

[54] **APPARATUS FOR DISINFECTING AN AREA WITH FORMALDEHYDE**

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[73] Assignee: **DETEC S.A.,** Geneva, Switzerland

[22] Filed: **June 18, 1973**

[21] Appl. No.: **370,859**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 114,112, Feb. 10, 1971, abandoned.

[30] **Foreign Application Priority Data**

Feb. 13, 1971 Switzerland 2092/71

[52] **U.S. Cl.** ..... **21/110,** 21/57, 21/118, 21/119, 21/74 R

[51] **Int. Cl.** **A61l 3/00**

[58] **Field of Search** ..... 21/53, 54 R, 55, 56, 74 R, 21/108–111, 117–119

[56] **References Cited**

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Primary Examiner—Barry S. Richman
Assistant Examiner—Dale Lovercheck
Attorney, Agent, or Firm—Robert E. Burns

[57] **ABSTRACT**

Method and apparatus for disinfecting an area with formaldehyde using a combination of heating the area and adjusting the humidity to certain controlled conditions before releasing the formaldehyde in the area. After a predetermined period the formaldehyde vapour in the area is neutralized with ammonia vapour.

2 Claims, 5 Drawing Figures

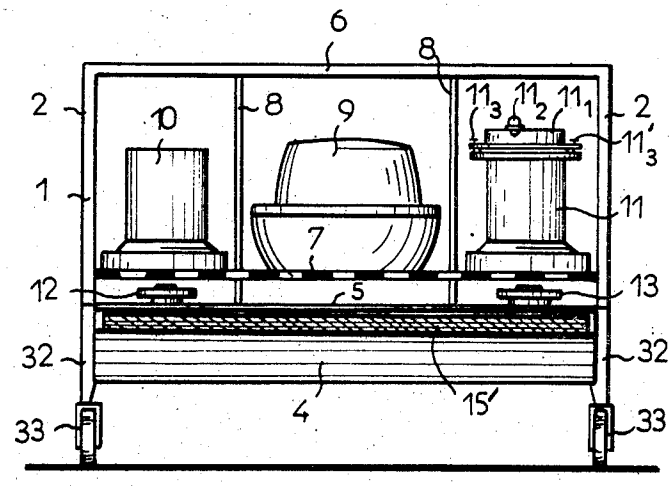

FIG.1

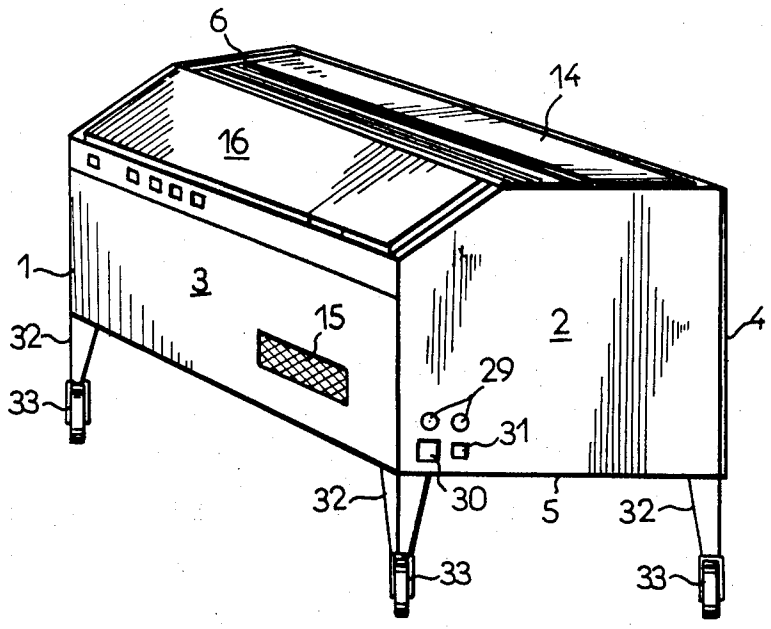

FIG.2

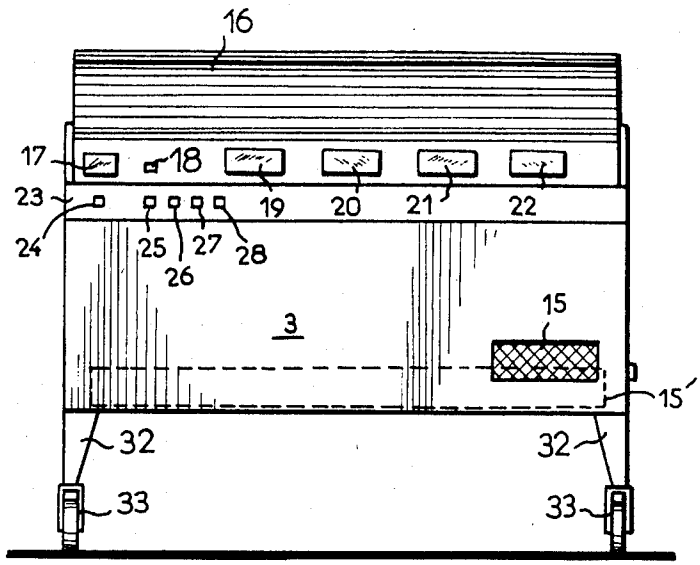
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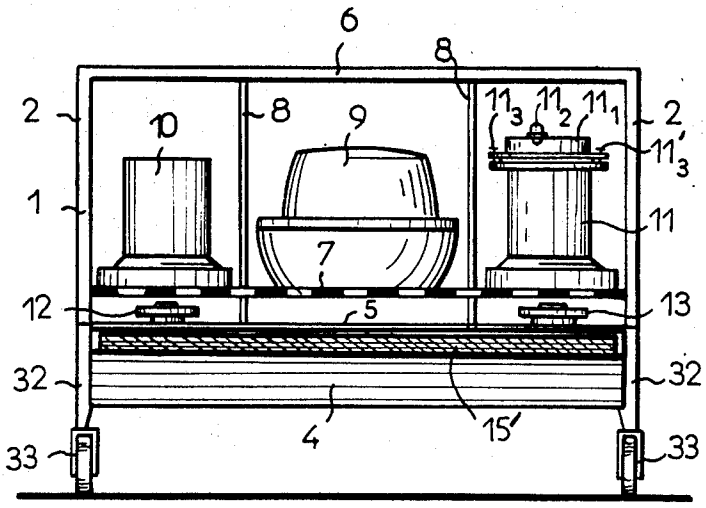
FIG.3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10
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11 3
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11 3
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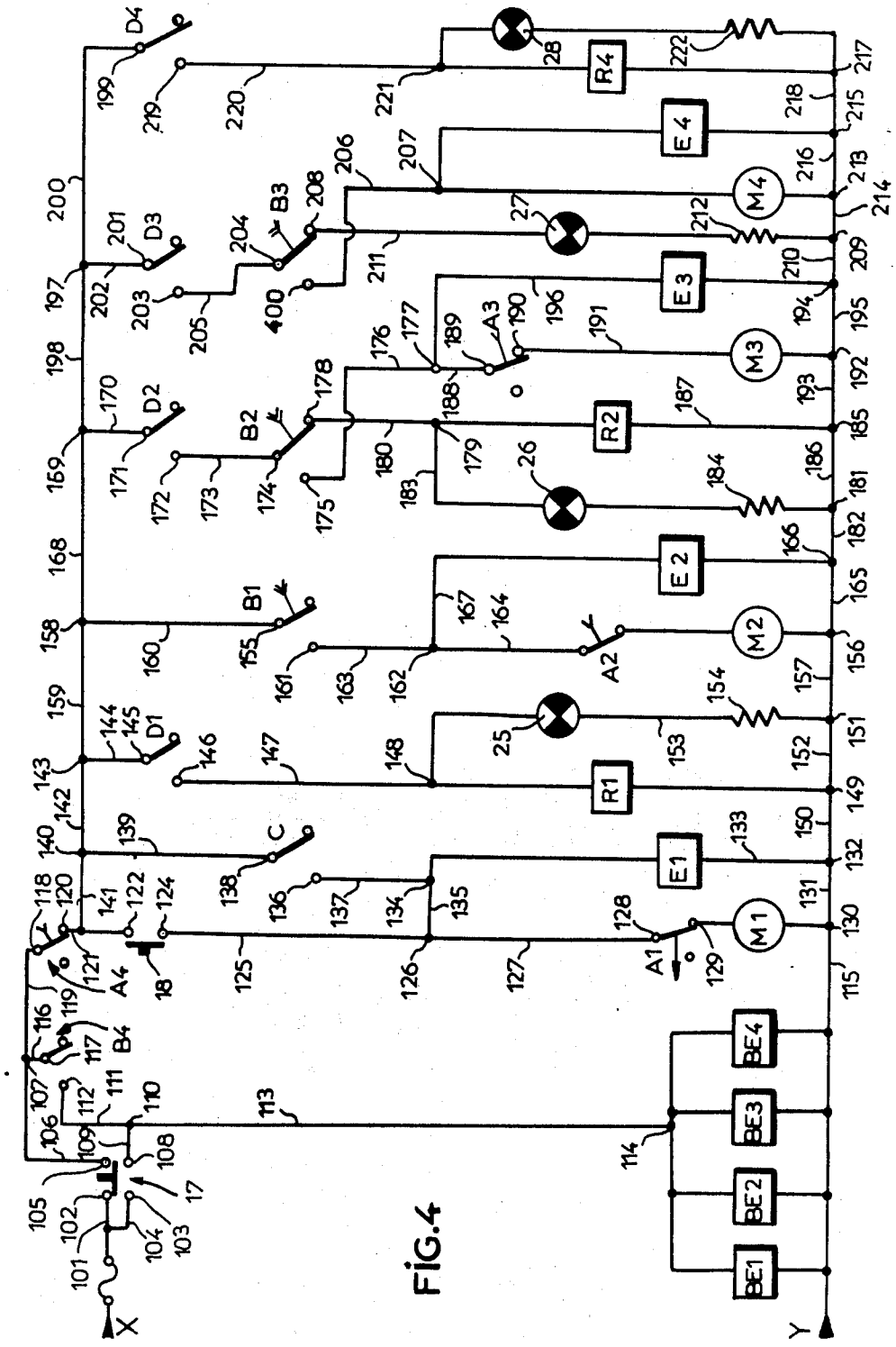
D4
D3
D2
D1
B4
B3
B2
B1
C
A4
A3
A2
A1
R4
R2
R1
E4
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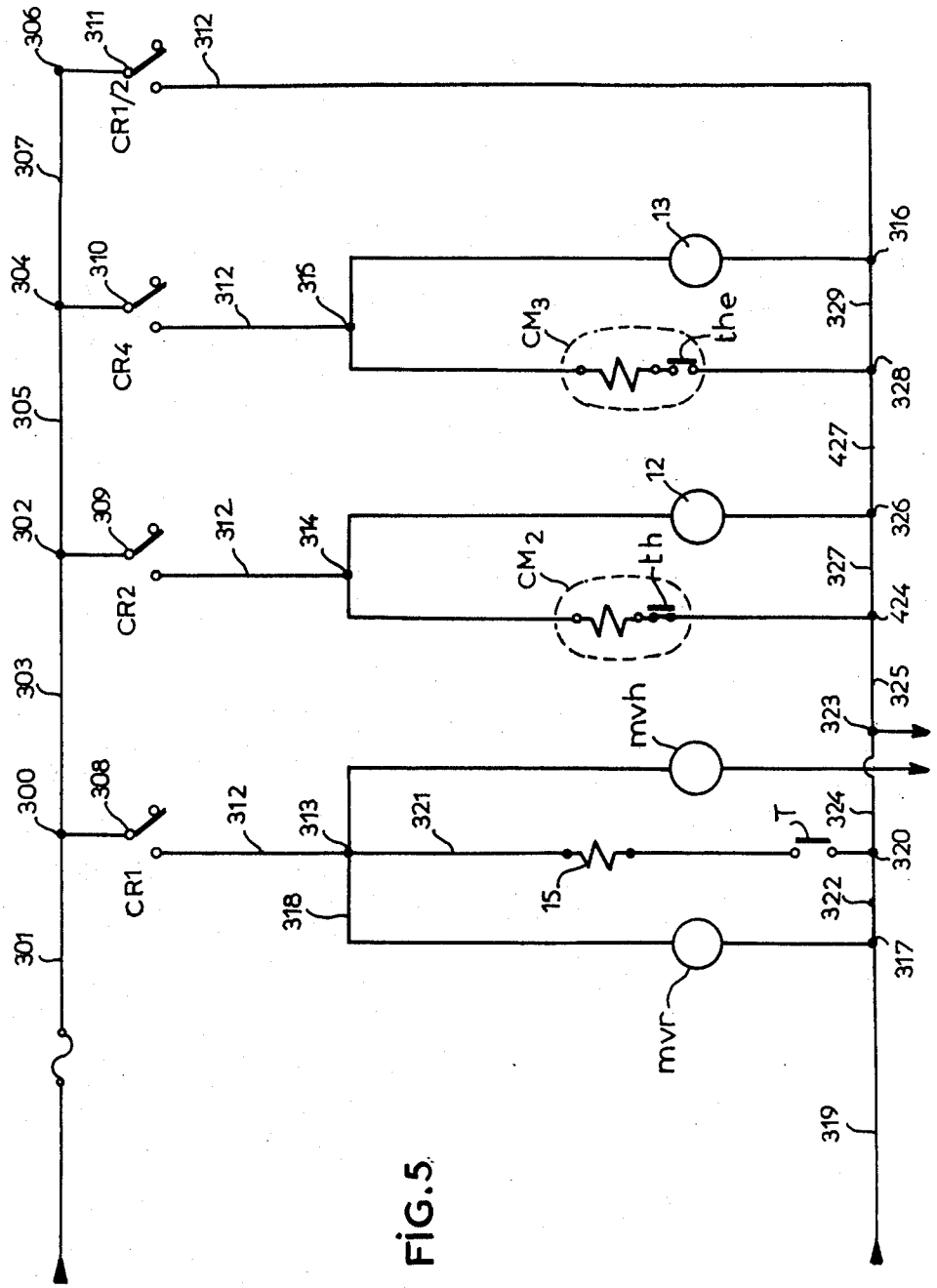
E1
M4
M3
M2
M1
BE4
BE3
BE2
BE1
X
Y

FIG.4


306
311
312
CR1/2
307
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316
CR4
CM3
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329
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305
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302
309
312
314
12
326
CR2
CM2
th
327
424
303
325
mvh
323
300
308
312
313
321
T
324
320
CR1
15
322
318
317
301
mvr
319

FIG.5

APPARATUS FOR DISINFECTING AN AREA WITH FORMALDEHYDE

This is a continuation-in-part application of my co-pending application Ser. No. 114,122 filed Feb. 10, 1971 and now abandoned.

The present invention is concerned with a method of disinfecting an area with formaldehyde and with equipment for carrying out the method.

The use of formaldehyde has already been suggested for the purpose of disinfecting areas such as sick-rooms and operating theatres by releasing the vapour in the areas or by introducing the vapour into the areas.

This vapour should take effect during a period of between **48** hours and **3** days so as to give good results, and since it is harmful to the human being, it is obvious that the room or theatre in which the vapour has been released must remain unoccupied during this period. This has the effect of putting the room or theatre out of use; which is undesirable, particularly in the case of operating theatres.

This procedure can therefore be used only on very exceptional occasions in hospitals.

To obviate this drawback, there has been proposed a method which consists in firstly releasing in the area to be disinfected formaldehyde vapour which is allowed to take effect for a time necessary for achieving efficient disinfection, and then in releasing in the area ammonia vapour which neutralizes the formaldehyde vapour.

However, by this kind of procedure, the period during which the area treated is unoccupied, which is not more than 24 hours, is still too long, and this is generally due to the following. The formaldehyde vapour released in the area to be disinfected partially condenses on the walls or on objects located in the area. The vapour is then fully neutralized by the ammonia, but since the latter only neutralizes the formaldehyde in its vapour form, the condensed crystals (polymeric formaldehyde) remain, and when the disinfected area has been ventilated, said crystals release formaldehyde vapour by sublimation, and this vapour renders the area dangerous for people occupying it. To some extent, the crystals act as a secondary source of emission of formaldehyde vapour.

The method in accordance with the invention enables the above-mentioned drawbacks to be avoided or mitigated.

The method in question comprises disinfecting an area with the help of formaldehyde vapour, and of neutralizing the vapour with ammonia, and the method is mainly characterised by firstly heating the area to be disinfected to a temperature of the order of 32° to 35°C, adjusting its relative humidity to approximately 75 percent, then releasing formaldehyde vapour in the area and finally, after a period necessary for disinfection, neutralizing this formaldehyde vapour by ammonia vapour. The area, after neutralization, is ventilated for a short period and immediately becoming usable again.

The humidity level used enables the formaldehyde vapour to diffuse in a better manner in the air of the area to be disinfected, whilst the temperature of 32° to 35°C to which the walls, ceilings and various objects located in the area are raised, prevents the formation and deposition of formaldehyde crystals (polymeric formaldehyde) which are created in the known processes, as

secondary sources from which formaldehyde may be emitted.

In particular, the method of the invention is characterised in that first the area is heated and its humidity is adjusted in such manner that when the formaldehyde vapour is released in the area the temperature of the area is of the order of 32° to 35°C and its relative humidity is approximately 75 percent. These values are necessary for preventing the formaldehyde vapour from polymerizing upon contact with the walls, ceilings or other surfaces encountered. After the formaldehyde vapour has been released, it is kept in contact with the atmosphere of the area during a selected period, after which said formaldehyde vapour is neutralized by releasing ammonia vapour during a predetermined period.

The equipment for performing the method stated above comprises heating apparatus controlled by a thermostat so as to obtain a temperature of 32° to 35°C, a humidifier controlled by a hygrostat to give a relative humidity of approximately 75 percent, containers for the formaldehyde and ammonia solutions, means for heating these containers likewise thermostatically controlled, and programming apparatus for controlling the above-mentioned apparatus, which programming apparatus can be variably adjusted for the purpose of selecting the duration of the various phases of the disinfection procedure as a function of the total time of the complete cycle and of the degree of asepsis required in the area.

The attached drawing illustrates schematically and by way of example one form of construction of the equipment in accordance with the invention.

FIG. **1** is a perspective view of this apparatus or equipment.

FIG. **2** is a front elevation, the upper cover being shown opened.

FIG. **3** is a rear elevation of the equipment, the lower panel being shown in the lowered position.

Referring to the drawing, the equipment or apparatus for disinfecting an area with formaldehyde comprises a support frame **1** for the various items of the apparatus. This frame **1** is covered by side walls **2**, a front wall **3**, a rear wall **4**, a lower wall **5** and an upper wall **6**. Inside the frame there is located a perforated horizontal shelf **7** carrying vertical partitions **8** which divide the interior space into three compartments for accommodating the various items of the apparatus, in particular a humidifier **9**, a means **10** for releasing formaldehyde vapour, and a means **11** for releasing ammonia vapour (NH_3). These units **10** and **11**, i.e., the means for releasing formaldehyde vapour and ammonia vapour respectively, each comprise a container for the formaldehyde and ammonia solutions respectively, these containers being provided with heating means controlled by a thermostat. Blowers **12** and **13** are located below the units **10** and **11** for the purpose of emitting puffs of formaldehyde vapour and ammonia vapour respectively from the frame **1**. It will be noted that the upper wall **6** has an elongated opening **14** along its rear edge for permitting the discharge of the formaldehyde and ammonia vapours. The lower wall **5** is of course likewise perforated to facilitate the circulation of air through the equipment.

In the lower portion of the frame there is fitted a thermostatically controlled heating apparatus **15** of which

only its hot-air outlet, seen on the front face of the equipment, is shown in the drawing.

The upper front corner of the frame comprises an inclined panel **16** which forms a cover enabling the various programming units of the installation to be operated from the front. Referring to FIG. **2**, the following are arranged from left to right below the cover **16**:

a stop-start switch **17**,
a push-button **18** for initiating the cycle,
a heat and humidity programmer **19**,
a formaldehyde programmer **20**,
a contact-time programmer **21**, and
an ammonia programmer **22**.

The front face **3** comprises a control panel **23** for the various items of apparatus. Mounted on this control panel are:

an emergency stop push-button **24**,
a heat-humidity indicator **25**,
a formaldehyde indicator **26**,
a contact-time indicator **27**, and
an ammonia indicator **28**.

On the right-hand side wall **2** are provided a cutout **29**, a supply connector **30** and a connector **31** for the hygrostat.

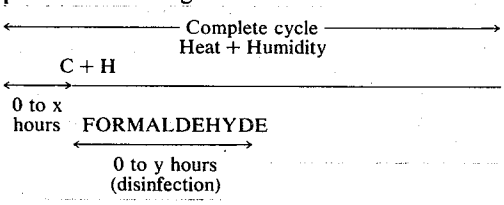
The frame **1** as a whole is supported on feet **32** mounted on pivoting castors **33**, enabling the equipment to be easily moved from place to place.

It wwll be noted that the form of the frame and of the various panels constituting the "body-work" impart to the equipment a desk-like shape.

The above-described equipment functions in the following manner:

After the equipment has been connected to the current supply and when the units **10** and **11** have been supplied with formaldehyde and ammonia solutions respectively, the programmers **19** to **22** are set, taking into account the total period of the complete operating cycle of the equipment, of the volume of the room in which the equipment is placed, and of the degree of asepsis required. The various programmers then first of all start up the heating apparatus and the apparatus for regulating the humidification of the area, so that the atmosphere is brought to a temperature of the order of 32° to 35°C and to a relative humidity level of approximately 75 percent. When a certain temperature, approximating to the ideal, has been reached, the apparatus **10** releases formaldehyde vapour during a predetermined period corresponding to the disinfection phase of the equipment. After cessation of the release of formaldehyde vapour, brought about by the programmer **20**, this disinfection phase is followed by a phase during which the formaldehyde vapour is in contact with the surrounding atmosphere, this contact phase being regulated by the programmer **21**. The programmer **22** then starts off the release of ammonia vapour, this corresponding to the neutralization phase, i.e., to the post-germicidal phase.

The installation then has to operate automatically after the various programmers have been set in accordance with previously prepared time-tables. An example of a time diagram is shown below:



The heating apparatus preferably comprises a hotair blower with a thermostat, set to give the required temperature of 32° to 35°C.

The humidifier is itself regulated by a hygrostat to provide the required relative humidity level of 75 percent. The containers for the formaldehyde and ammonia solutions are heated by hot-plates fitted with thermostats, so as not to exceed the limiting temperatures beyond which the formaldehyde and ammonia are degraded.

Programmers of the sequence type can be variably set to provide very considerable latitude in all the phases of the disinfection cycle. The process operates in one direction only, with the automatic system for the heating and humidification phase set for a period of 2 hours for example, the area will be progressively heated during this period of time and its level of humidity will be obtained in suitable conditions. This automatic system will initiate the phase in which the formaldehyde vapour is released, this phase also being variable in duration depending upon the degree of asepsis required, the size of the room, etc.

At the end of the disinfection period, the programmer **21** operates the automatic system whereby the formaldehyde vapour remains in contact with the surrounding atmosphere for a certain period of time. During this period of time when only the formaldehyde vapour will be active the heating and humidifying means continue to operate. Then, at the end of this cycle, the programmer **22** causes ammonia vapour to be released to initiate the phase in which the formaldehyde vapour is neutralized, after which the programming units return to their initial positions and a new cycle can be programmed.

Equipment of this kind thus calls for minimum supervision once the programming units have been set to give the ideal operating conditions. Thus, there is not danger of the equipment inadvertently emitting formaldehyde vapour for too long a period for example, and the apparatus ensures ideal conditions for the disinfection of the area. The neutralization of the formaldehyde by ammonia enables a disinfected area to be occupied without danger.

Numerous variations of the construction of this equipment or apparatus are of course possible. Thus, instead of being designed as a mobile unit as illustrated in the drawing, the equipment could be of stationary construction secured for example in a wall of an operating theatre, the wall of course containing various openings to enable the various units constituting the equipment to act upon the atmosphere of the area to be disinfected.

It may happen that, with the equipment as described, the heat which it releases could cause ammonia vapour to form before the neutralization phase has started, so

that the ammonia is released at the same time as the formaldehyde vapour and neutralizes this vapour as it is being formed. To avoid this drawback, the container 11 is capped by a gas-tight cover 11_1 secured by screw-bolts 11_3, and it comprises a needle-valve 11_2 which is lifted from its seat when the pressure in the container 11 reaches a level corresponding to a temperature of 80° in the ammonia solution in the container.

The partitions 8 and the shelf 7 are with advantage made of a heat-insulating material. They are for example coated with polyurethane lacquer to prevent heat transfer between the compartments accommodating the ammonia source, the formaldehyde source and the humidifier, respectively.

FIGS. 4 and 5 are electrical wiring diagrams of the apparatus according to the invention.

FIG. 4 shows the circuit for controlling and programming the power circuit illustrated in FIG. 5.

A conductor 101 connects the terminal X of the power supply system to a contact 102 of a switch 17. Another contact 103 of this switch is connected to the power supply system by a conductor 104. The contact 105, which corresponds to the contact 102 of the switch AR, is connected by a conductor 106 to a terminal 107. The contact 108, corresponding to the contact 103 of the switch 17, is connected by a conductor 109 to a terminal 110. The terminal 110 is connected by a conductor 111 to a terminal 112. In addition, it is connected by a conductor 113 to a terminal 114. Four sets *b*1, *b*2, *b*3 and *b*4 of timing electromagnets are connected in parallel between the terminal 114 and a conductor 115 connected to the terminal Y of the power supply system.

The terminal 107 is connected to a terminal 117 by a conductor 116. In one of its positions, a switch B_4 connects the terminal 112 and the terminal 116.

The terminal 118 of a switch A_4 is connected to the terminal 107 by a conductor 119. The other terminal 120 of the switch A_4 is connected by a conductor 121 to the terminal 122 of a switch 18 whose other terminal 124 is connected by a conductor 125 to a terminal 126. The terminal 126 is connected by a conductor 127 to the terminal 128 of a switch A_1. A timing motor M_1 is connected between the other terminal 129 of the switch A_1 and a terminal 130 to which leads the conductor 115.

A conductor 131 connects the terminal 130 to the terminal 132. A conductor 133 connects the terminal 132 to a terminal 134 with an electromagnet E1 in between. The terminal 134 is connected to the terminal 126 by a conductor 135. The terminal 134 is connected to the terminal 136 by a conductor 137. A switch C_1 enables the terminal 136 to be connected to a terminal 138 which itself is connected by a conductor 139 to a terminal 140. The terminal 140 is connected to the conductor 121 by a conductor 141. A conductor 142 connects the terminal 140 to a terminal 143. A conductor 144 connects the terminal 143 to a terminal 145 of a switch D_1 whose other terminal 146 is connected by a conductor 147 to a terminal 148. The terminal 148 is connected to a terminal 149 which itself is connected to the terminal 132 by a conductor 150 with a contactor R1 in between. The terminal 149 is connected to a terminal 151 by a conductor 152. The terminal 151 is connected to the terminal 148 by a conductor 153 in which a resistance 154 and a pilot lamp 25 are mounted. The terminal 151 is connected to a terminal 156 by a conductor 157. The terminal 143 is connected to a terminal 158 by a conductor 159. The terminal 158 is connected to a terminal 155 of a switch B1 by a conductor 160. The other terminal 161 of the switch B1 is connected to a terminal 162 by a conductor 163. The terminal 162 is connected to the terminal 156 by a conductor 164 with a switch A2 and a timing motor M2 in between. The terminal 156 is connected to the terminal 166 by a conductor 165. The terminal 166 is connected to the terminal 162 by a conductor 167 in which a timing electromagnet E2 is mounted. A conductor 168 connects the terminal 158 to a terminal 169. A conductor 170 connects the terminal 169 to a terminal 171 of a switch D2 whose other terminal 172 is connected by a conductor 173 to a terminal 174 of a change-over switch B2. Another terminal 175 of the change-over switch B2 is connected by a conductor 176 to a terminal 177. The terminal 178 of the change-over switch B2 is connected to a terminal 179 by a conductor 180. The terminal 179 is connected to a terminal 181 which itself is connected to the terminal 166 by a conductor 182 by a conductor 183 in which a pilot lamp 26 and a resistance 184 are mounted. The terminal 182 is connected to a terminal 185 by a conductor 186. The terminal 185 is connected to the terminal 179 by a conductor 187 with a contactor R_2 in between. A conductor 188 connects the terminal 177 to the terminal 189 of a change-over switch A3 whose other terminal 190 is connected by a conductor 191 to a terminal 192 with a timing motor M3 in between. The terminal 192 is connected to the terminal 185 through a conductor 193 and to a terminal 194 by a conductor 195. The terminal 177 and the terminal 194 are connected by a conductor 196 in which an electromagnet E_3 is mounted. A terminal 197 is connected to the terminal 169 by a conductor 198 and to a terminal 199 by a conductor 200. A terminal 201 of a switch D3 is connected by a conductor 202 to the terminal 197. The other terminal 203 of the switch D3 is connected to a terminal 204 of a changeover switch B3 by a conductor 205. Another terminal 400 of the switch B3 is connected by a conductor 206 to a terminal 207. The terminal 208 of the switch B3 is connected to a terminal 209 which is itself connected to the terminal 194 by a conductor 210 through a conductor 211 with a pilot lamp 27 and a resistance 212 in between. A terminal 213 is connected to the terminal 209 by a conductor 214 and to a terminal 215 by a conductor 216. A timing motor E4 is mounted between the terminal 213 and the terminal 207. An electromagnet E_4 is mounted between the terminal 207 and the terminal 215. A terminal 217 is connected to the terminal 215 by a conductor 218. The other terminal 219 of the switch D4 is connected by a conductor 220 to a terminal 221. A contactor R4 on the one hand and a pilot lamp 28 and a resistance 222 on the other hand are connected in parallel between the terminals 217 and 221.

FIG. 5 shows the power circuit of the apparatus according to the invention. A terminal 300 is connected to the terminal X of the power supply system by a conductor 301. A terminal 302 is connected to the terminal 300 by a conductor 303 and to a terminal 304 by a conductor 305. A terminal 306 is connected to the terminal 304 by a conductor 307. The terminals 300, 302, 304 and 306 are connected to terminals 308, 309, 310 and 311, respectively, of switches CR1, CR2, CR_4 and CR1/2. The other terminals of these contactors are

connected by conductors 312 to the terminals 313, 314, 315 and 316, respectively. The terminal 313 is connected to a terminal 317 through a conductor 318 in which the ventilation turbine mvr is mounted. The terminal 317 is connected to the terminal Y of the power supply system by a conductor 319. The terminal 313 is connected to a terminal 320 by a conductor 321 with the resistance 15, which is used to heat the room in which the apparatus is situated to the required temperature, and a thermostat T in between. The terminal 320 is connected to the terminal 317 by a conductor 322 and to a terminal 323 by a conductor 324. The terminal 313 is connected to one of the terminals of a hygrostat with a motor mvh for the humidifier in between, the other terminal of the hygrostat being connected to the terminal 323. A terminal 324 is connected to the terminal 323 by a conductor 325 and to a terminal 326 by a conductor 327. A terminal 328 is connected to the terminal 326 by a conductor 327 and to the terminal 316 by a conductor 329. A ventilation turbine 12 for the formol is mounted between the terminals 314 and 326. A temperature-controlled heater for the formol CM_2 and a thermostat t_h are mounted between the terminals 314 and 324. A ventilation turbine 13 for the ammonia is mounted between the terminal 315 and the terminal 316. A heater CM_3 for the ammonia and a thermostat t_{he} are mounted between the terminals 315 and 328.

The apparatus functions in the following manner: by depressing the switch AR, the terminal 103 is connected to the terminal 108 and the connection between the terminal 102 and the terminal 105 is broken, thus energising the blocks BE1, BE2, BE3, BE4 of the electromagnets of the timeswitches which are reset to zero. The pushbutton of the switch 17 is then released and the pushbutton of the switch 18 depressed. This results in closure of the contacts C1, D1, R1 and CR1 which control heating of the conditioning air and humidification.

By turning, the motor M1 displaces a cam which acts on the contact B1 and then on the contact A1.

The contact B1 closes. The timeswitch M2 is placed under voltage.

The switch D2 closes and feeds the contactor R2 through B2. The contactor R2 excites the contact CR2 which feeds the formaldehyde heater CM2.

At the end of the time shown on the timeswitch M2, the contact B2 is inverted, followed by the contact A2.

This inversion of the contact B2 places the timeswitch M3 under voltage so that the contact D3 is closed and the pilot lamp 27 placed under voltage.

At the end of the time shown on the timeswitch M3, the contact B3 inverts the contact A3. Inversion of the contact B3 places the timeswitch M4 under voltage (ammonia cycle).

D4 closes and feeds the contact R4 which, through its contact CR4, places the heater releasing ammonia under voltage.

At the end of the time shown on the timeswitch M4, the contact B4 is inverted so that the reset electromagnets E1, E2, E3, E4, can be placed under voltage.

A moment later, the contact A4 opens which enables the apparatus as a whole to be deprived of voltage and the four timeswitches generally to be reset.

The apparatus is ready for a new cycle.

Accordingly, the invention provides an apparatus for disinfecting a room comprising a frame, an upper wall of this frame being provided with an opening, a horizontal shelf made of a heat-insulating material being arranged in the frame to define an upper part and a lower part, heating means arranged in the lower part, a vertical partition extending in the lower part and defining therein first and second compartments into which the said opening opens, formaldehyde accommodated in the first compartment and ammonia in the second compartment, humidifying means arranged in the second compartment, first auxiliary heating means for heating the formaldehyde and an electrical control circuit incorporating a timeswitch supplying a signal for actuating the first auxiliary heating means at the end of a given period of time from the activation of the principal heating means and the humidifying means.

Another vertical wall extends through one of the compartments and defines therein first and second chambers accommodating, respectively, ammonia and the formaldehyde or the humidifying means. Second auxiliary heating means can heat the ammonia. These second means are actuated by the electrical circuit at the end of a predetermined time after interruption of the operation of the first auxiliary heating means. The partitions extend up to the upper wall of the chassis or frame.

I claim:

1. An apparatus for disinfecting a room comprising, a frame, an upper wall of said frame provided with an opening, a horizontal shelf made of a heat-insulating material located inside the frame and defining therein an upper part and a lower part, principal heating means located in the lower part, a vertical partition made of a heat-insulating material extending through the upper part and hermetically separating therein first and second compartments into which said openings opens, formaldehyde accommodated in the first compartment, ammonia accommodated in the second compartment, humidifying means arranged in the second compartment, first auxiliary heating means for evaporating formaldehyde, and an electrical control circuit supplying a signal for actuating for a selected time period the first auxiliary heating means at the end of a selected period from the actuation of the principal heating means and humidifying means.

2. An apparatus as claimed in claim 1, comprising another vertical wall extending through one of the compartments and hermetically separating therein first and second chambers accommodating, respectively, the ammonia and the humidifying means, second auxiliary heating means for evaporating ammonia, the circuit supplying a signal for actuating the second auxiliary heating means at the end of a given period from deactivation of the first auxiliary heating means.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,816,074 Dated June 11, 1974

Inventor(s) Jean Alexandre DECUPPER

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

On the title page in column 1, Item [63] change

Ser. No. 114,112 to Ser. No. 114,122;

On the title page in column 1, Item [30] change

Feb. 13, 1971 Switzerland.....2092/71 to

--Feb. 13, 1970 Switzerland.....2092/70--.

Signed and sealed this 5th day of November 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

USCOMM-DC 60376-P69
☆ U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334