United States Patent

[11] 3,529,590

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[54] PORTABLE INCUBATOR FOR INFANTS

21 Claims, 15 Drawing Figs.

[52] **U.S. Cl.** **128/1**
[51] **Int. Cl.** **A61b 19/00**
[50] **Field of Search** 128/1; 5/97; 312/307, 308; 5/93, 94, 97, 100

[56] **References Cited**

UNITED STATES PATENTS

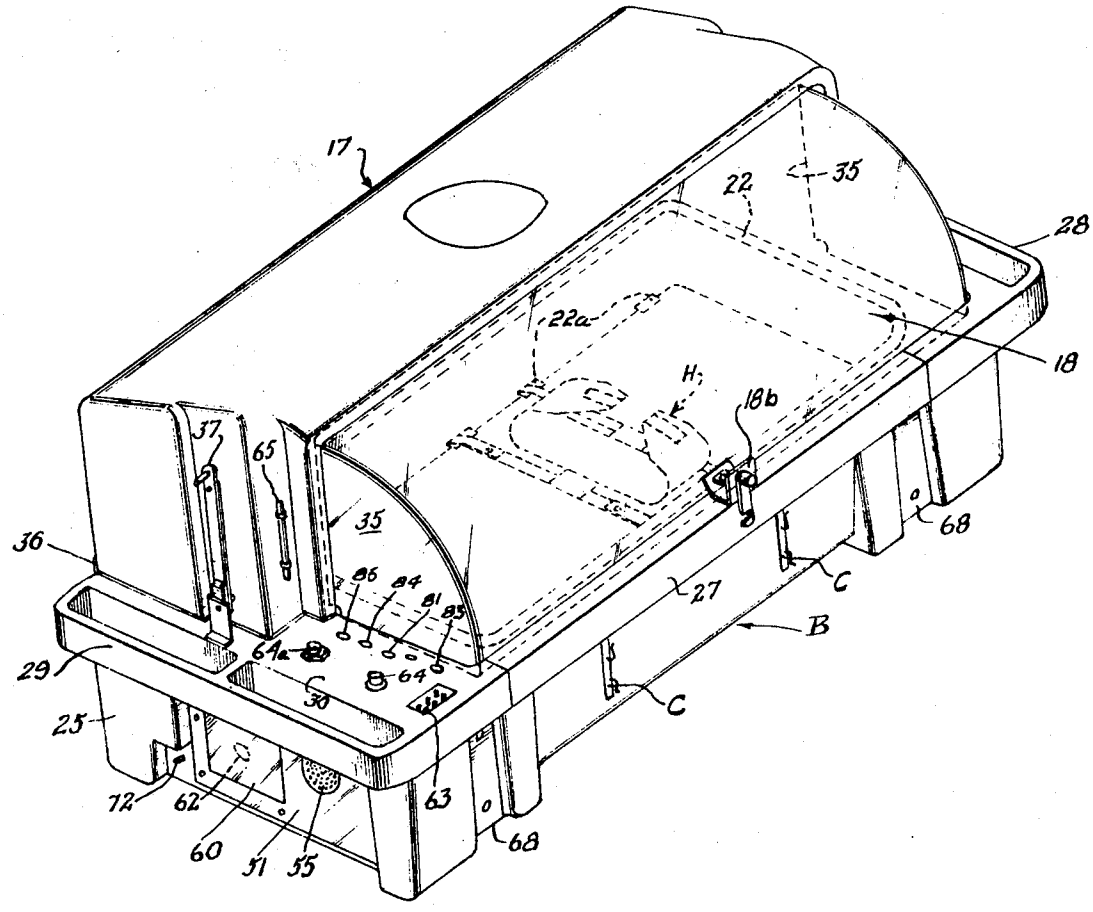
2,353,536	7/1944	Abbott et al.	128/1
3,005,673	10/1961	Smith et al.	128/1
3,158,150	11/1964	Croasdaile	128/1
3,187,744	6/1965	Dorsak et al.	128/1

FOREIGN PATENTS

24,231	11/1962	Germany	128/1
837,873	11/1938	France	128/1
1,082,381	9/1967	Great Britain	128/1

Primary Examiner—L. W. Trapp
Attorney—Synnestvedt and Lechner

ABSTRACT: An incubator especially adapted for portable use and having a base and a hood having front and rear portions both of which are openable for access to a removable bassinet, the base walls and a portion of the hood being heat insulated and provided with extended surface heater elements, and one portion of the hood being transparent, the incubator further having temperature control, air circulation and humidification systems; and an optionally usable accessory frame adapted to carry a battery, a battery charger and an oxygen bottle.



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Fig. 1.

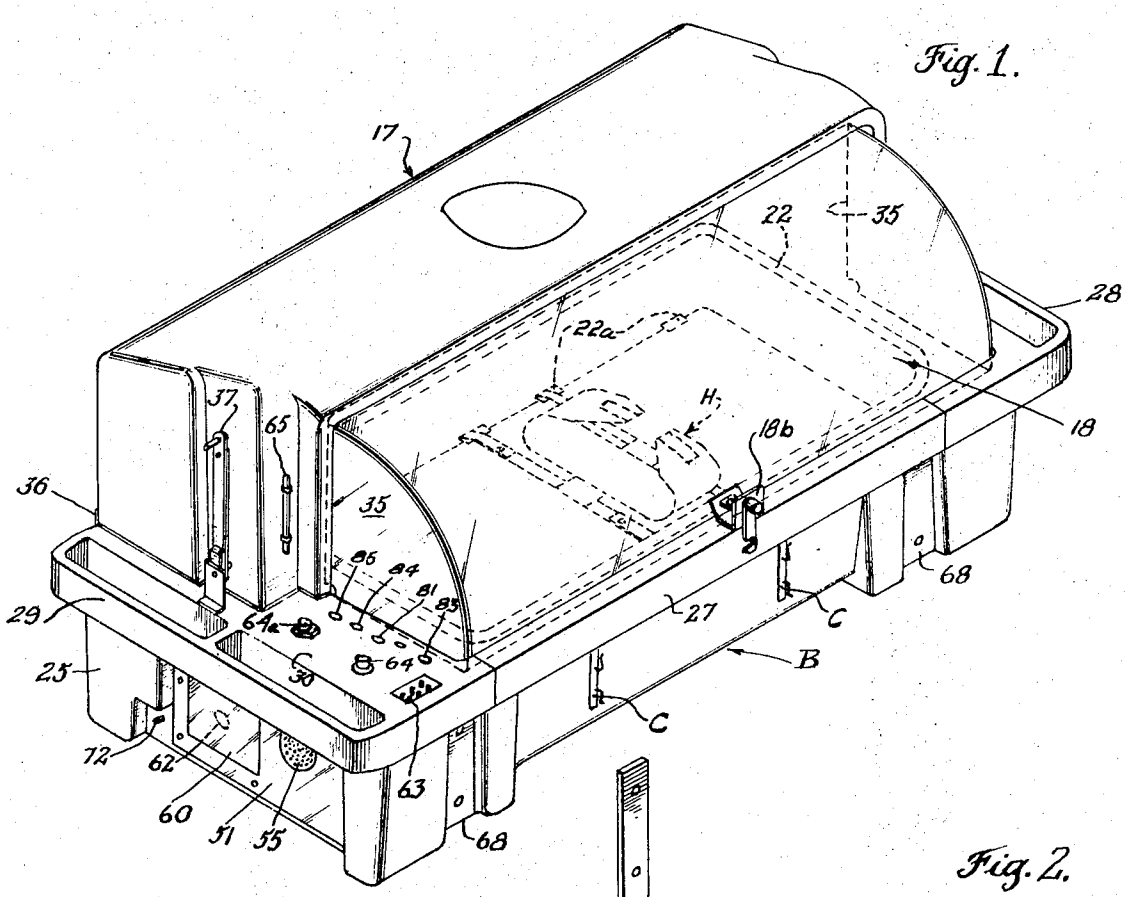
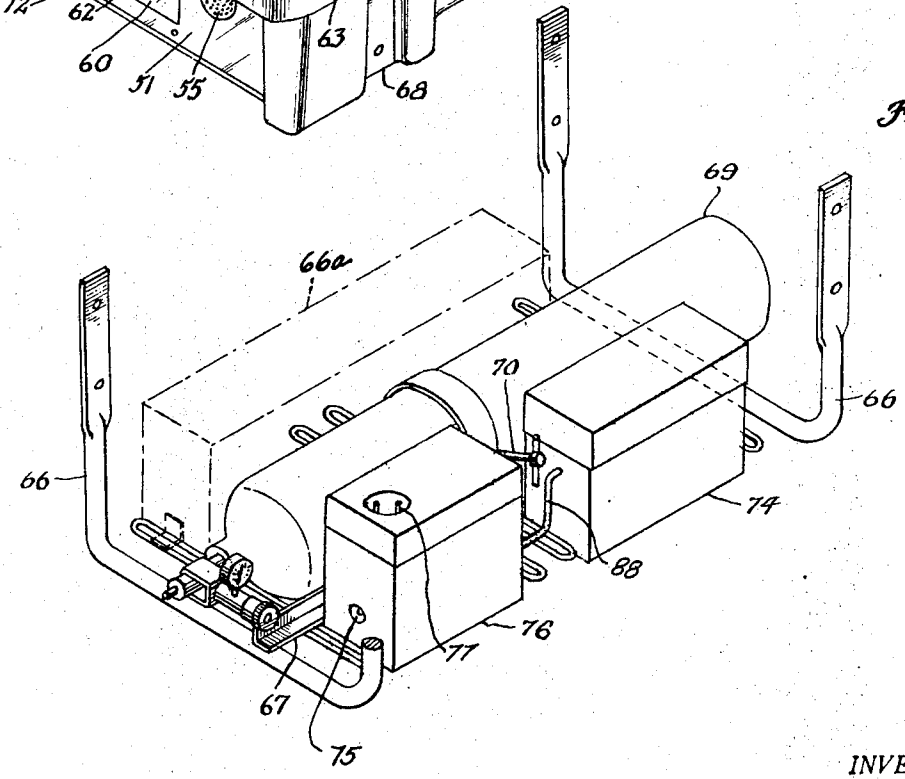


Fig. 2.



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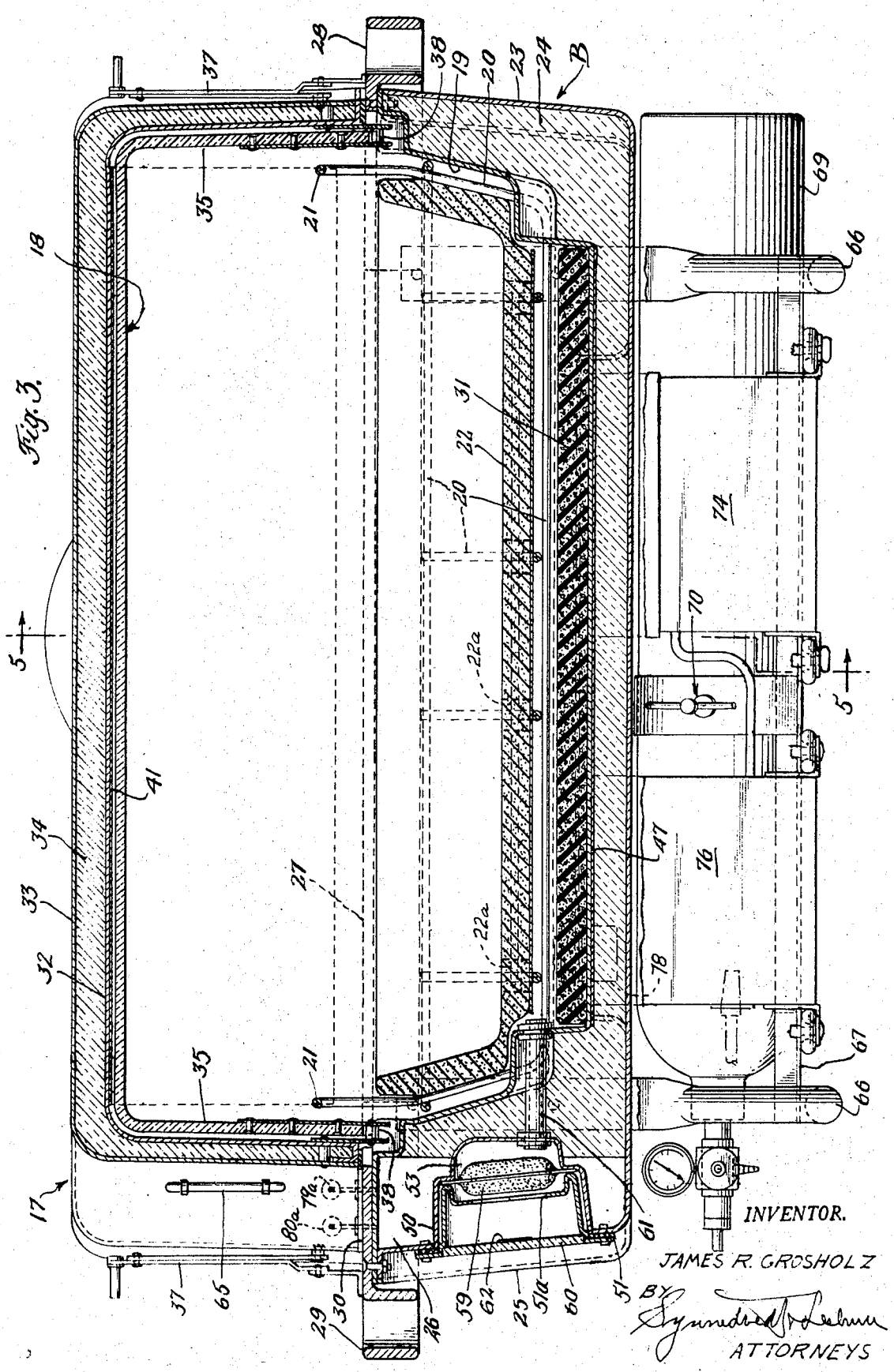

Fig. 3.
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Fig. 5.

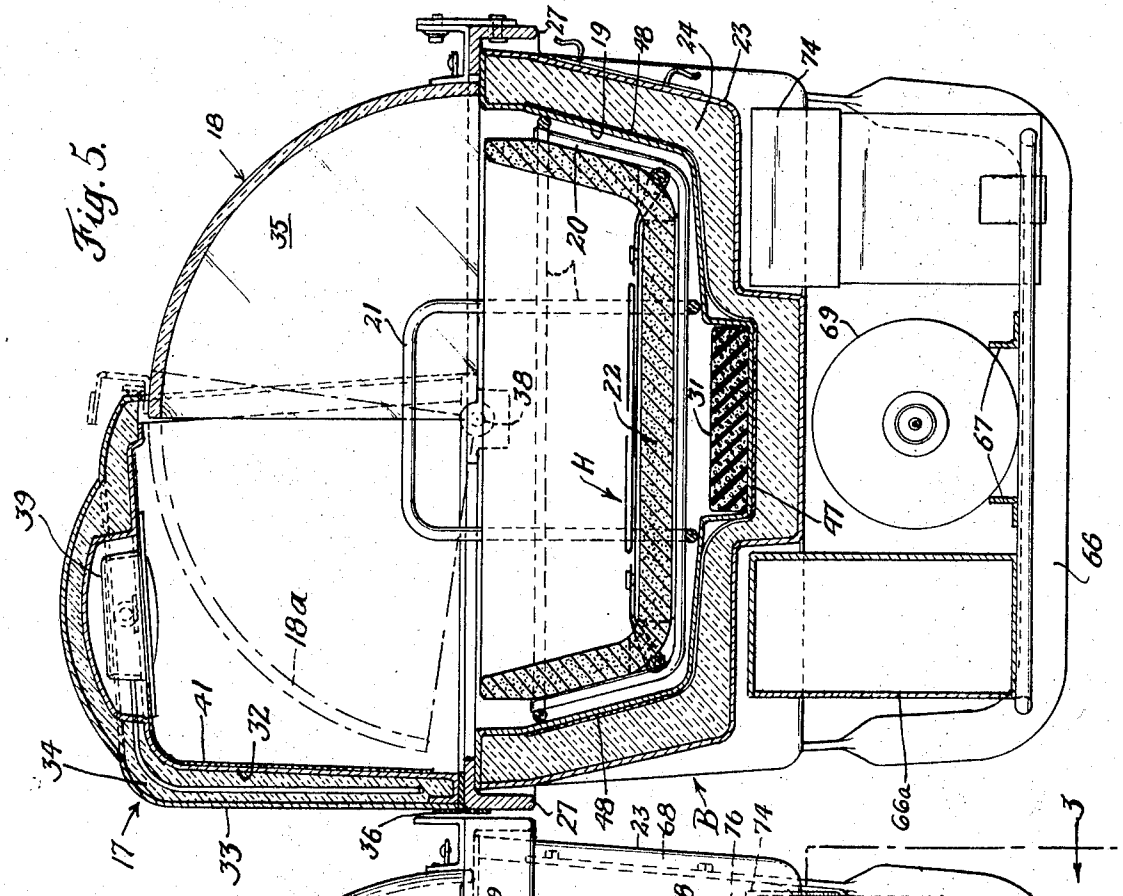
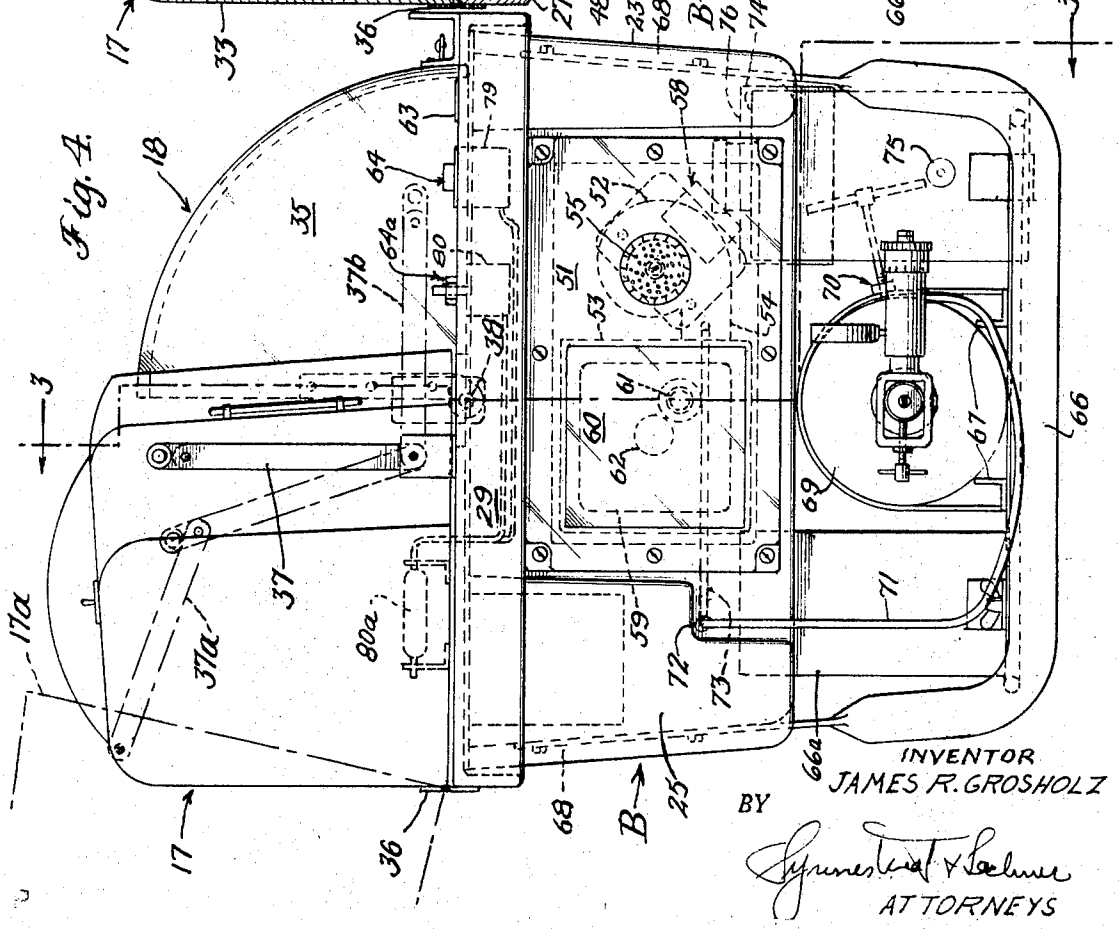


Fig. 4.



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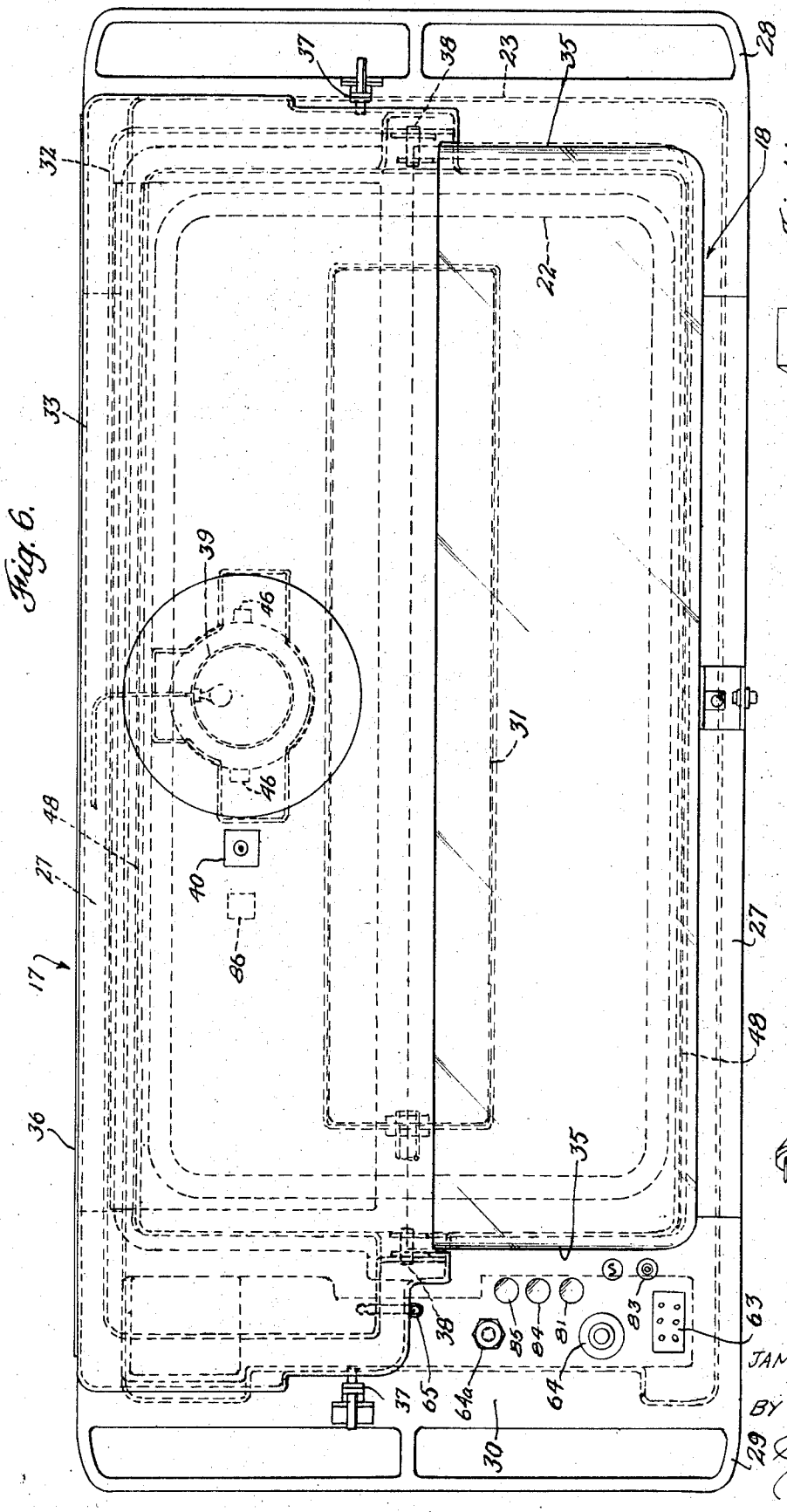


Fig. 6.

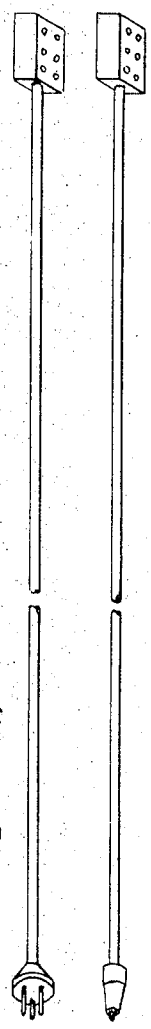


Fig. 11.

Fig. 12.

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Fig. 8.

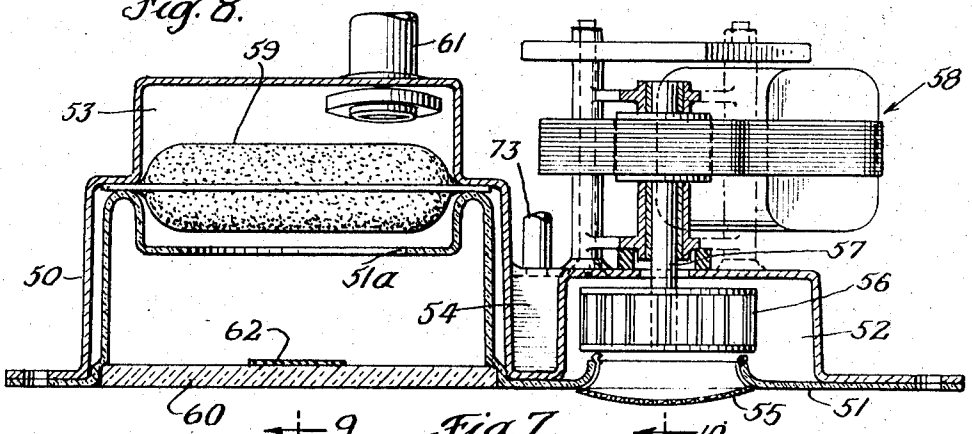


Fig. 7.

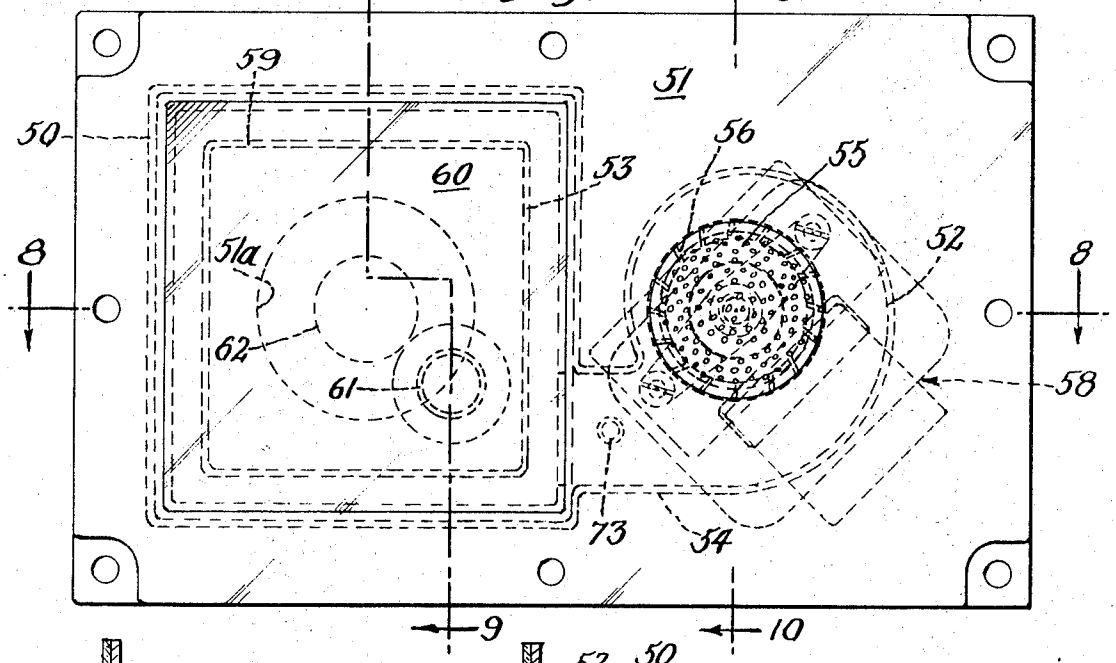


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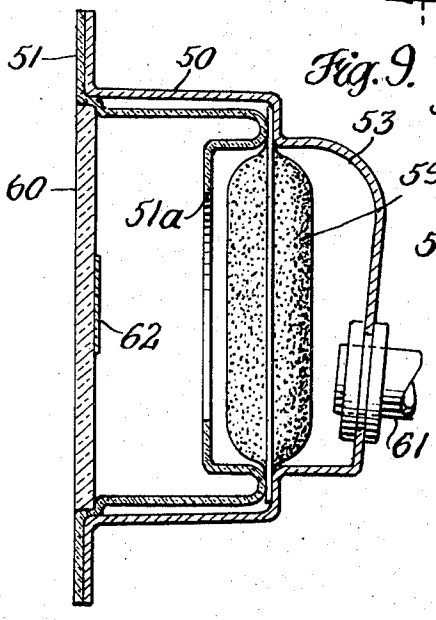
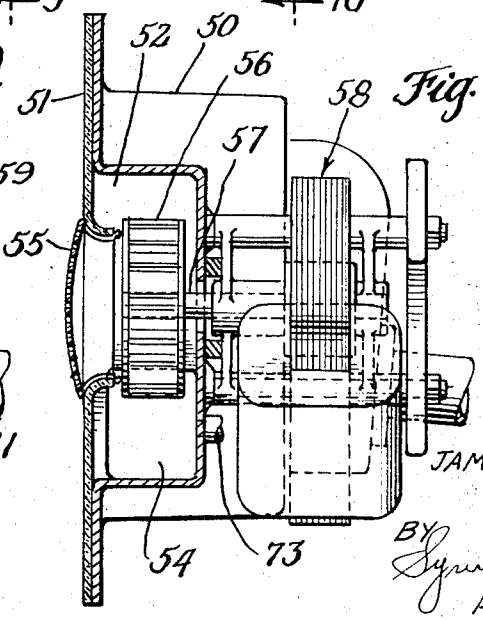


Fig. 10.



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Fig. 13.

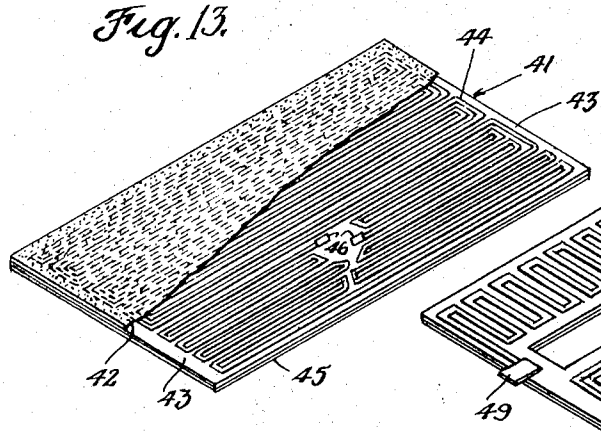
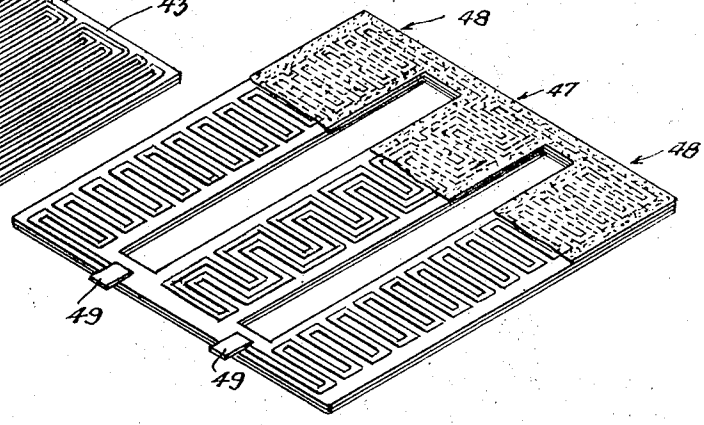


Fig. 14.



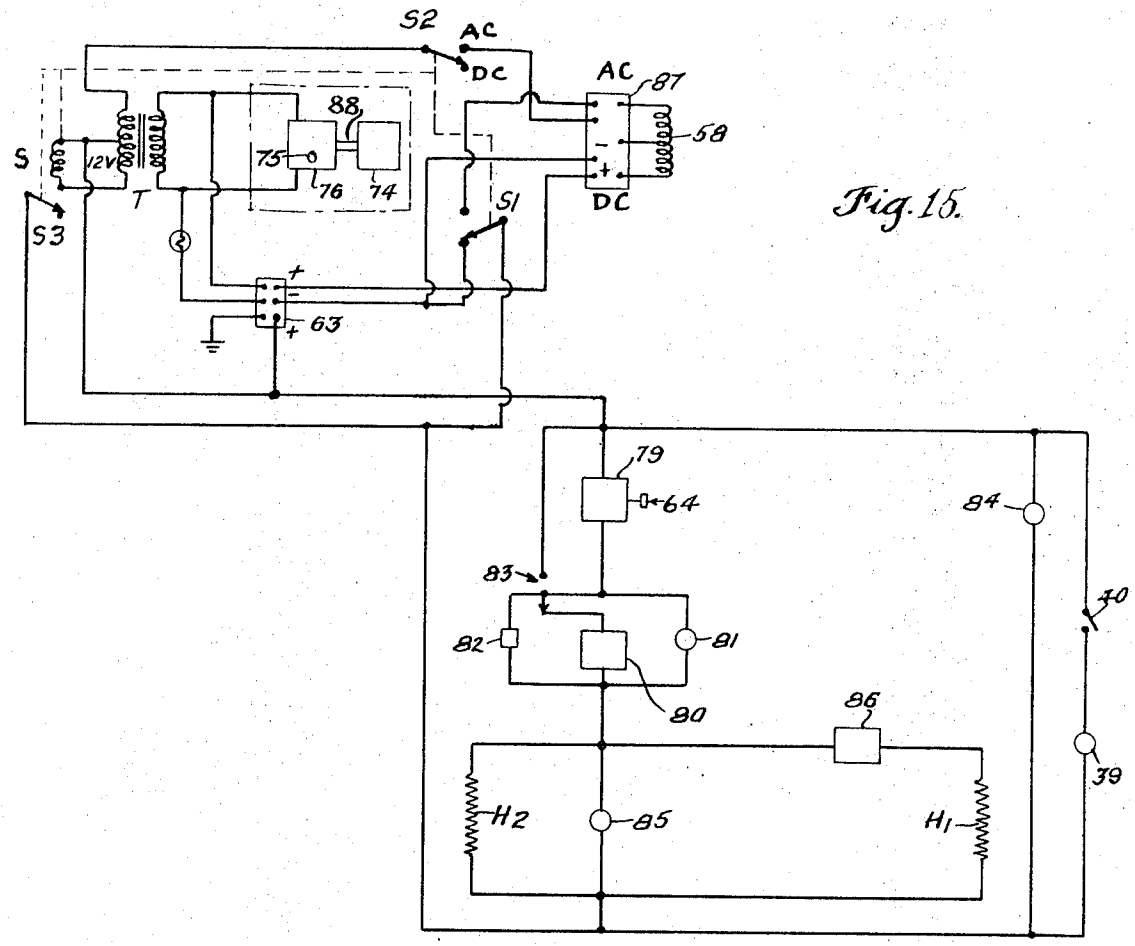


Fig. 15.

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PORTABLE INCUBATOR FOR INFANTS

This invention relates to incubators and the invention is particularly concerned with an incubator adapted for use in the transportation of infants, for instance in instances where an infant is prematurely or unexpectedly born and is required to be transported to a hospital.

One of the major objectives of the invention is to provide a portable incubator which will not result in adverse influences upon the infant as a result of various of the conditions encountered in transportation of the incubator, particularly in an automobile or an ambulance. Thus, the incubator of the present invention is arranged to retain the infant in proper position within the bassinet in the incubator, notwithstanding encountering substanital inertia forces, such as acceleration forces resulting from rapid movements of the vehicle in which the incubator is carried when making turns and the like.

In accordance with another aspect of the invention, a heating system is provided and provision is made for heat insulation of the incubator to an extend adequate to maintain a desired warm atmosphere, notwithstanding the wide fluctuations in the ambient temperatures which must necessarily be encountered in the transit of an incubator, particularly in winter or cold seasons or climates in which the incubator may be subjected to ambient temperatures as low as 0°F. or even lower, depending upon the area or climate where the incubator is used.

It is a further object of the invention to provide the incubator with a self-contained air circulation system, so that in transit adequate fresh air and/or oxygen will be supplied to the infant.

For operating both the heating and air circulation systems, provision is made for the input of electrical power to the incubator and it is an object of the invention to adapt the power input arrangement to the portable use of the incubator, preferably providing alternatively for connection to the standard 110v 60 cycle power supply, or to a battery, such as the common 12v battery of automotive vehicles.

A further object of the invention is to provide a humidification system which will also be unaffected by inertia forces encountered in transit, so that there will be no danger of spillage of water employed for humidification.

Still further it is an object of the invention to provide an optionally usable accessory frame preferably carrying not only a battery which may be employed as the source of power for the incubator, but also a battery charger arranged to effect charging of the battery whenever the incubator is connected with a 110v 60 cycle supply line. In this way the local battery which may be carried with the incubator in transit may already be charged and thus prepared for use of the incubator in transit.

How the foregoing objects and advantages of the invention are attained will be clear from the following description referring to the following drawings illustrating a preferred embodiment of an incubator according to the invention, and in which:

FIG. 1 is an isometric view of the preferred embodiment;

FIG. 2 is a similar isometric view of the optionally usable accessory frame;

FIG. 3 is a longitudinal vertical section through the incubator and the accessory frame assembled therewith, the view being taken as indicated by the section 3—3 on FIG. 4;

FIG. 4 is an end elevational view of the incubator and accessory frame taken from the left hand end of the incubator as viewed in FIG. 3;

FIG. 5 is a vertical transverse sectional view taken as indicated by the section line 5—5 on FIG. 3;

FIG. 6 is a top plan view of the incubator of FIGS. 1 to 5;

FIG. 7 is an enlarged elevational view of the cover overlying the area of the filter chamber and air circulation fan;

FIG. 8 is a horizontal sectional view taken as indicated by the line 8—8 on FIG. 7;

FIG. 9 is a vertical sectional view through the filter chamber taken as indicated by the line 9—9 on FIG. 7;

FIG. 10 is a vertical sectional view through the fan chamber taken as indicated by the line 10—10 on FIG. 7;

FIGS. 11 and 12 are views of separable power cords adapted for alternative use with 110v a.c. power and with 12v battery power;

FIG. 13 is an isometric view with a part broken away, illustrating a heater element employed in the hood of the incubator;

FIG. 14 is a view similar to FIG. 13 but illustrating a heater element employed in the base of the incubator; and

FIG. 15 is a circuit diagram illustrating various parts of the electrical system and controls embodied in both the incubator and the devices associated with the accessory frame.

Referring now to the drawings, and particularly to FIG. 1, the incubator comprises, in general, a base B and a hood structure above the base. The base is provided with an upwardly open chamber adapted to receive a support for the infant, and the hood comprises a rear portion 17 preferably of double wall insulated construction, and a front portion 18 in the form of a parti-cylindrical transparent element which is openable, as will be further described, and which provides for visual observation of the infant within the incubator and for removal and insertion of the infant either with or without the infant support.

Turning now to the construction of the base in greater detail, reference is made not only to FIG. 1 but also to FIGS. 3—6 inclusive. The base comprises an inner wall 19 having side, bottom and end portions defining the upwardly open chamber for receiving the infant support, preferably a bassinet which is formed of framing elements 20 having handles 21 at the ends thereof, the bassinet also being provided with a foam rubber lining 22 having bottom, side and end portions, with the side and end portions of substantial width so that the bassinet is of considerable depth, thereby providing for cushioning within the bassinet not only in the bottom wall, but also in the side and end walls, for the protection of the infant being transported. As seen in FIGS. 1 and 5, a harness H is fastened to the bassinet and is adapted to encircle the infant in order to make sure that the infant remains in proper position in the bassinet. The portions of the harness extended around the infant may be fastened together in any suitable manner, preferably by interengaging fibrous type of pile and hook elements of known construction, one example of which is commercially available under the tradename Velcro. The harness is fastened to the bassinet framing 20 by means of straps which extend through apertures 22*a*, as seen in FIG. 5.

The base also comprises an outer wall 23 having bottom, side and end portions spaced from the corresponding portions of the inner wall to accommodate insulation, for instance polyurethane foam indicated at 24. From FIGS. 3 and 4 it will be noted that the end portion 25 of the outer wall of the base is specially shaped to accommodate certain of the equipment associated with the incubator as will later be described, the insulation 24 being terminated short of the wall 25 in order to leave a space 26 at the left end of the incubator when viewed as in FIG. 3 for the purpose of accommodating the equipment mentioned below.

Around its upper edges, the base is provided with frame members, including the longitudinal members 27, 27, which are interconnected at their ends by handles 28 and 29, the handles 29 being provided with a horizontal deck 30 serving as a control panel on which certain control devices are mounted (see FIGS. 1 and 6).

The base also has a channel in the bottom wall thereof extended throughout the length of the infant-receiving chamber below the bassinet, to receive the elongated cellular element or sponge 31 (see FIGS. 3 and 5) which is adapted to absorb a substantial quantity of water and serve as a source of moisture for humidification within the incubator in a manner which will be described more fully hereinafter.

The rear portion 17 of the hood, like the base, has an inner wall 32 and an outer wall 33, spaced from each other to receive polyurethane or similar cellular or foam insulation such as indicated at 34. In general the rear portion of the hood has rear and top walls and also end walls overlying the end

walls of the base. The rear portion of the hood extends over approximately the rear half of the base chamber.

The front portion **18** of the hood comprises a transparent member representing approximately one-quarter of a cylinder, but with end walls **35, 35**. This portion of the hood is desirably formed of transparent plastic material, such as polymethylmethacrylate.

The inner and outer walls **19** and **23** of the base and the inner and outer walls **32** and **33** of the rear portion of the hood are advantageously molded of resin material, a particularly useful material for this purpose being acrylonitrile butadiene styrene, this resin material being flame retardant.

The rear portion **17** of the hood is hinged at **36** to the rear frame rail **27** of the base in order to provide for pivotal opening movement of the rear portion of the hood, for instance to the position indicated by dot and dash lines **17***a* in FIG. **4**. Scissors linkage **37** may be employed as a means for limiting the opening movement of the hood part **17***a*, this linkage being indicated at **37***a* in FIG. **4** in the position occupied when the hood is opened. The hood **17** is effectively locked in its closed position when the scissors linkage **37** is in the full line position shown in FIG. **4**. Swinging of the linkage to the position indicated at **37***b* will permit the hood to be opened.

The front portion of the hood **18** is pivotally connected by pivots **38, 38** with the rear hood portion **17**. These pivots **38** interconnect the lower rear corners of the end walls **35** of the front portion of the hood **18** with the lower front corners of the end walls of the rear portion of the hood **17**, so that, as viewed in FIG. **5**, the front portion of the hood **18** may be swung into a position nested within the rear portion of the hood, as indicated at **18***a*. A releasible latch **18***b* serves to retain the hood portion **18** in closed position.

Opening movement of the front portion of the hood provides an access opening into the chamber within the incubator so that the infant in the incubator may be given attention and also so that the bassinet within the incubator may be removed or reinserted to the position indicated in FIGS. **1, 3** and **5**.

With the front portion **18** of the hood opened to the nested position within the rear portion of the hood, the rear portion may then also be swung upwardly and rearwardly in the manner indicated in FIG. **4**, thereby opening the entire top of the base for full access to any part of the interior.

The rear portion **17** of the hood is provided with an internal recess or cavity in the top wall thereof, in order to receive the lighting fixture **39** which is provided with a control switch **40** (see FIGS. **5** and **6**).

In the preferred embodiment, as illustrated particularly in FIGS. **3, 4, 5, 13** and **14**, the heater elements employed in the incubator are electrical heater elements in a special form, *i.e.*, a form which in effect, comprises extended surface heater elements disposed over a substantial portion of the area of certain walls of the incubator, notably the side and bottom walls of the base and the rear and top walls of the rear portion **17** of the hood.

Thus, the rear and top walls of the hood are virtually covered with a heater element indicated at **41** in FIGS. **3, 5** and **13**. In effect this heater element is in sheet form and is flexed so that a portion of the element lies at the rear wall and a portion at the top wall of the hood part **17**. The heater element comprises a lamination of several plies including a top sheet **42** formed, for example, of Mylar resin material which may have a thickness of the order of 0.0015", with a pressure sensitive adhesive at the exposed face of the sheet. An additional sheet of Mylar resin material indicated at **43**, appropriately of thickness of about 0.00075", is included, and the two Mylar sheets **42** and **43** are laminated together with an interposed metallic foil heater element indicated at **44** having many turns or runs over the surface of the heater element so that, in effect, the heater is a surface heater element. A bottom coating, for instance an aluminized coating **45** may also be provided.

As seen in FIG. **13** the metallic foil element **44** may have terminal connection tabs **46**, these tabs, in the particular heater shown in FIG. **13** being arranged in a region lying within the overall area of the heater corresponding to the location of the lighting fixture **39**, and the turns of the foil **44** are preferably arranged to leave an opening through which the lighting fixture may project. When installed the pressure sensitive adhesive serves to secure the heater element against the inside surface of the inner wall **32** of the hood portion **17**.

A laminated sheet type heater element of the same general type of construction is also used in the base of the incubator, this element being shown in FIG. **14**. As there seen, the heater element comprises three interconnected strips **47** and **48, 48**. These strips are arranged and proportioned to lie respectively at the bottom of the base under the cavity in which the humidifier sponge is located, and at the two side walls of the base, as clearly appears in FIG. **5**. Connection tabs **49** (see FIG. **14**) are provided for delivering the heating current to this heater element. In the case of the heater element for the base, it is advantageous to adhesively apply this element to the outer face of the inside wall **19** of the base, so that, in effect, the heater element lies at the inner surface of the insulation layer **24** in the base. It will be understood that a flexible wire connection (not shown) extends from the base to the hood to supply current to the hood heaters and lamp.

The arrangement of the heater elements as described above provides for warming the air within the incubator, both by convection and by radiation. The embodiment of the heaters with extended surface area provides for adequate warming action, while maintaining the heater elements at a relatively low and therefore safe temperature.

In considering the air circulation system of the incubator, attention is directed to FIGS. **1, 3** and **7—10**. In the space **26** below the deck **30** of the handle structure **29**, there is a partition **50** having a cover plate **51** associated therewith, the partition **50** being shaped to define an inlet or fan chamber **52** and a filter chamber **53**, the two chambers having intercommunication as indicated at **54** in FIG. **7**.

An opening is provided in the cover plate **51** in registration with the fan chamber **52** and this opening comprises the air inlet opening for the incubator, a strainer **55** being provided over this opening to prevent entrance of dirt or other undesirable material into the air stream of the incubator. A small squirrel cage fan **56** is disposed within the fan chamber **52** and serves to draw air inwardly through the strainer **55** and to deliver the air through the connection **54** into the upstream side of the filter chamber. The fan is mounted by means of a shaft **57** driven by a motor **58**.

A filter element **59** is adapted to be clamped at its edges between parts of the partition **50** and the cover **51**. The cover **51** is provided with an aperture at **51***a* at the upstream side of the filter. The outer side of the filter chamber itself (at the upstream side of the filter element **59**) is closed by means of a transparent partition **60**, formed for example of polymethylmethacrylate. At the downstream side of the filter element a duct **61** serves to deliver the filtered air from the filter chamber **53** into the incubator, this duct being extended to deliver the incoming air into the space between the bottom of the bassinet and the top of the humidifying sponge **31** endwise thereof. From this region, the air flows upwardly at the sides of the bassinet and through various openings in the liner **22**, for instance openings indicated at **22***a* in FIG. **5**. Ultimately, the air is discharged through openings or cracks between parts of the hood and the base, notably between the upper rear edge of the openable hood portion **18** and forward edge of the hood portion **17**. In this way a constant stream of fresh air is delivered through the incubator.

Several points are to be noted in connection with the air supply system, as follows:

In the first place it will be observed that the fan, including the fan operating motor is disposed entirely externally of the infant receiving chamber in the base of the incubator. Moreover, it will be noted that the fan is at the upstream side of the filter and that there is no connection between the fan chamber or the upstream side of the filter chamber and the in-

cubator except through the filter. In view of this, the problem of sterilization and maintaining aseptic conditions within the incubator is greatly simplified.

In addition, it will be observed that the arrangement of the air supply system, including the provision of the transparent cover **60** for the filter chamber makes it possible to observe the condition of the filter without removal of any cover or other closure. Advantageously the inside surface of the transparent cover **60** is provided with a half-tone gray spot **62** in a position which is in the normal line of vision when observing the filter. With a filter of appropriate construction (for instance, mat type glass fibers with a resin binder), the dust and other foreign material accumulating on the surface of the filter has a grayish tone and by employing a spot **62** on the cover **60** matching the color of the material ordinarily building up on the filter, the attendant may gauge the condition of the filter visually. Thus, when the spot in effect disappears, because of the filter assuming the same color as the spot, the attendant will know that the filter should be changed.

Still another aspect of the air supply system which should be noted is that the operation of the fan may be observed through the cover **51** which, like the cover **60**, is also formed of transparent plastic material. In this way the attendant may readily note whether or not the air circulation fan is in fact operating.

It is contemplated that the deck **30** of the handle structure **29** at the left end of the incubator be provided with certain devices associated with the power supply and control system. Thus, as seen in FIGS. **1** and **6**, a power input connection device **63** is provided, with which either of the power cords shown in FIGS. **11** and **12** may cooperate. The connection device **63** preferably has projecting prongs and the complementary part of the power cords shown in FIGS. **11** and **12** are preferably in the form of receptacles. On the front of the base of the incubator (see FIGS. **1** and **5**) hangers C are provided so that the power cord of FIGS. **11** or **12** which is not in use in any given time may be wound on the hangers and thus kept in readiness with the incubator.

An adjustment device **64** is also provided for an air responsive control device within the incubator in order to provide for setting the operation of the heaters at a level to maintain an appropriate temperature within the incubator. Still further a device **64*a*** is provided for fixedly setting an adjustment for a limiting thermostat responsive to the air temperature in the incubator, as will be further explained herebelow in connection with the operating and control circuit for the incubator. The deck **30** also carries certain signal lights as will further be explained.

A thermometer indicated in FIGS. **1**, **3** and **6** at **65** serves to indicate the temperature established within the incubator.

As above noted, the incubator may be used substantially in the form above described, or may alternatively or optionally be used in association with an accessory frame which is illustrated in FIG. **2** by itself, and which appears in association with the incubator in FIGS. **3**, **4** and **5**. This accessory frame is conveniently formed of a pair of U-shaped tubular members **66**, **66** interconnected by longitudinal angle members **67**. The upper ends of the tubular member **66** are desirably flattened as clearly appears in various of the figures and are adapted to be received in the vertical grooves **68** which are provided in the base, being disposed in pairs at opposite sides of the base toward each end. Appropriate fastening bolts or studs may be used for interconnecting the accessory frame and the base.

The accessory frame is adapted to carry an oxygen bottle of standard size indicated at **69**, this bottle being removably fastened by means of a clamping device **70**, so that the bottle may be changed when desired.

The oxygen bottle may be connected with the air supply system by means of a flexible tube **71** indicated in FIG. **4**, which is adapted to be connected with the nipple **72** of the oxygen supply pipe **73** (see FIGS. **1** and **4**), the pipe **73** being extended to deliver the oxygen into the duct **54** between the fan chamber **52** and the upstream side of the filter chamber **53** (see FIG. **7**). By this arrangement the oxygen supply will mix with the incoming air and is introduced into the system at the upstream side of the filter.

The accessory frame also carries a battery **74** preferably having a power output connection **75**. Advantageously this connection **75** is appropriate for mating with the plug at the left end of the battery power cord shown in FIG. **12**, so that this power cord may then be used to connect the battery on the accessory frame with the power input connector **63** on the base of the incubator.

The accessory frame still further carries a battery charger **76** so that whenever the accessory frame and the incubator are assembled and at the same time the incubator is being operated on a source of 110v current (which condition is established by use of the power cord shown in FIG. **11**, plugged into a suitable 110v receptacle and also connected with the device **63**) the battery **74** will receive charging current from the charger **76**.

The portions of the electrical components mounted on the accessory frame on the one hand and on the incubator on the other hand are adapted to be interconnected by means of a plug **77** (FIG. **2**) associated with the charger **76**, and a complementary receptacle **78** (FIG. **3**) mounted on the bottom of the base of the incubator in position so that when the accessory frame and the incubator are assembled, the plug **77** and receptacle **78** will interengage.

The accessory frame still further may be employed to mount a box or container **66*a*** which may have an appropriate access lid, providing for the storage of any equipment or supplies desired to be transported with the incubator.

In FIG. **15** there is illustrated a circuit diagram showing all of the electrical components diagrammatically and illustrating the manner of interconnection thereof when the accessory frame and the incubator are interconnected. The battery **74** and the charger **76** carried by the accessory frame are indicated in FIG. **15** enclosed within a dot-dash line and it will be understood that the interconnection of the charger with the remainder of the circuit as shown in FIG. **15** is actually effected by interconnection of the plug and receptacle **77** and **78** shown respectively in FIGS. **2** and **3**.

The power input connector is again indicated at **63**, the winding of the fan motor is indicated at **58**, and the heater elements of FIGS. **13** and **14** are indicated at **H1** and **H2**, the former representing the heater element applied in the portion **17** of the hood, and the latter the heater element mounted in the base of the incubator.

The adjustment device **64** for the heat control element is indicated by the same numeral and it may here be mentioned that this unit may conveniently comprise a thermostat diagrammatically indicated at **79** (FIGS. **15** and **4**).

A limiting thermostat **80** having a device **64*a*** for fixed setting (FIG. **4**) is arranged in series with the adjustable thermostat **79** and serves as a safety device. The operating bulbs **79*a*** and **80*a*** (FIGS. **3** and **4**) for both of the thermostats **79** and **80** are, of course, exposed to the air within the incubator. Safety signals are provided in the form of a red light **81** and a buzzer **82** both of which will be activated whenever the thermostat **80** opens. A double throw test switch indicated diagrammatically at **83** serves the purpose of checking the safety alarm devices **81** and **82** regardless of whether the thermostats **79** and **80** are open or closed.

The dome light in the portion **17** of the hood is shown in the diagram at **39** as is also the switch **40** for controlling the dome light. The signal light **84**, for instance a white light, serves to indicate that there is power in the system. Still another signal light **85**, for instance a yellow light, indicates that current is being supplied to the heaters.

The heater **H1** which is arranged in the portion **17** of the hood is further provided with a surface temperature thermostat **86** (see also FIG. **6**). This thermostat is applied to the surface of the heater element **41** and is responsive to its surface temperature, thereby serving as a limiting or safety device preventing rise in temperature of this element to a value which would be in any way injurious, even upon contact with the heater element.

The connector **63** is provided with six contacts, the three toward the right as viewed in FIG. **15** being utilized in connection with the operation of the incubator on battery power (or if desired any other source of low voltage d.c. current). With the power cord of FIG. **12** connected with a battery and with the receptacle thereof associated with the connector **63**, the top and bottom contacts are interconnected and are connected to one side (the positive side) of the battery, and the intermediate contact is connected with the negative side of the battery, thereby delivering the battery current to the convertor **87**, as is indicated in the diagram of FIG. **15**. The positive and negative sides of the battery are also connected with the heater operating circuit, the latter connection being effected through a switch indicated at S1, so that both the circulation fan and the heaters, as well as the dome light **39** will now all be operating on battery power. Switch S1 is one of three (the other two being identified at S2 and S3) which are ganged together and which represent parts of a switching mechanism operated by a solenoid indicated at S. The positions of all three of these switches as shown in FIG. **15** are those occupied when operating on battery power, the solenoid S being de-energized at this time and the switches being maintained in the positions shown, for instance by a return spring.

The battery power cord shown in FIG. **12** may be connected either with the battery **74** carried in the accessory frame or with some other battery, for instance a battery in an ambulance. If the battery **74** is to be used, the plug at the left end of the cord shown in FIG. **12** will be plugged into the receptacle shown at **75** in FIGS. **2** and **15**, the current from the battery being delivered through the conductors **88** which interconnect the battery and the charger.

The three contacts of the connector **63** to the left as viewed in FIG. **15** are adapted to be associated with the 110v cable shown in FIG. **11**, providing a grounding point as indicated and also supplying the 110v 60 cycle current both to the charger **76** and also to the primary winding of the step-down transformer indicated at T. In this mode of operation the charger **76** serves to recharge the battery **74**, and the lower voltage, for instance about 24v of the secondary of the transformer T is delivered to the convertor **87** with which the motor winding **58** is associated in order to effect operation of the air circulation fan. It will be observed that the secondary winding of the transformer T is center-tapped, to provide a source of 12v current to the solenoid S, operation of which results in upward movement of the switch blades of all of the switches S1, S2 and S3, in order to effect the connection of the secondary of the transformer to the convertor **87** and thereby deliver the desired current to the motor winding. In this mode of operation the 12v current is also delivered to the heater operating circuit, as will be seen.

By the circuit arrangements described above, including the alternative employment of the 110v cable of FIG. **11** or the 12v battery cable of FIG. **12**, provision is made for operation of the incubator on either type of current and also for charging of the battery carried in the accessory frame, whenever the accessory frame is associated with the incubator and a connection is made from a 110v supply line to the connection device **63**. Still further the circuit, switching and cabling arrangements are arranged so that it is not possible to concurrently connect the battery **74** to the load when the system is connected with a 110v line. This prevents an undesirable condition in which the charger might be activated the same time the battery is connected to the load. The interconnection between the battery and the charger is also indicated in FIG. **2** at **88** and preferably this interconnection includes a disconnectible plug system in order to facilitate replacement of batteries.

Another important advantage of the arrangement providing for alternative use of the two power cords of FIGS. **11** and **12**, is that this eliminates the necessity for using a selector switch, for instance a manually operable selector switch on the control panel, when changing over from one source of current to another. The arrangement of the application is therefore more foolproof, requiring no attention to a selector switch when changing from one current to another.

With regard to the heater operating and control system it should be observed that the heat control device **79** which has an adjustable control **64** may be set at the desired air temperature value in order to provide the desired warmth for the infant in transit. The thermostat **80** is in the nature of a air temperature limiting thermostat and represents a safety feature. This thermostat is not normally adjusted in use of the incubator but is adapted to be fixedly set by the device **64***a*. The surface thermostat **86** also represents a safety feature, in order to limit the temperature of the heater element in the hood so that there is no danger of injury even from contact with that heater element.

According to the foregoing, an incubator is provided which, in a variety of different respects, is especially adapted to portable usage, the infant being well protected as against injury from dynamic forces and also being protected as against extreme temperature changes. Moreover, an adequate and filtered air supply is assured. Numerous safety features or precautions are also embodied in the system considered as a whole, including the alarm test arrangement, and also the arrangement for visual observation of the operation of the air circulation fan and of the condition of the air filter.

Although various values have been referred to in connection with battery and alternating current voltages, it will be understood that those values are given only by way of illustration and that others can be used.

I claim:

1. An incubator comprising an elongated base portion having side, end and bottom walls defining an upwardly open chamber for receiving a bassinet, and a hood structure above the base comprising a rear portion overlying about the rear half of the base and having end walls above the end walls of the base, the hood structure further including a front portion having a curved transparent wall overlying the front part of the base and having end walls above the end walls of the base but lying in planes between the planes of the end walls of the rear portion of the hood, pivot means interconnecting the adjacent lower corners of the end walls of the rear and front portions of the hood structure and providing for pivotal movement of the front portion from its position overlying the front part of the base to a nested position within the rear portion of the hood to provide an access opening into the incubator, the access opening being proportioned to provide for insertion and removal of the bassinet through the access opening, and pivot means interconnecting the rear portion of the hood to the rear wall of the base and providing for pivotal rearward swinging movement of the hood structure with the front portion nested within the rear portion and thereby provide for uncovering most of the top of the base for ready access to the interior thereof.

2. An incubator according to claim **1** and further including releasible fastening means for restraining the rear portion of the hood against pivotal movement when the front portion is opened.

3. An incubator comprising an elongated base portion having side, end and bottom walls defining an upwardly open chamber for receiving a bassinet, and a hood structure above the base comprising a rear portion, overlying about the rear half of the base and having end walls above the end walls of the base, the base and hood walls at the bottom, sides and top of the incubator comprising cellular heat insulating material, and the hood structure further including a front portion having a transparent wall overlying the front part of the base, and means mounting at least the transparent portion of the hood for displacement movement to provide an access opening into the incubator, the access opening being proportioned to provide for insertion and removal of the bassinet through the access opening.

4. An incubator comprising an elongated base portion having side and bottom walls defining a chamber for receiving an infant, a hood structure above the base comprising a rear portion having walls overlying the rear part of the base chamber and a transparent openable front portion overlying the front

part of the base chamber, and surface heater elements extended throughout at least a major part of the side and bottom walls of the base and also of the rear portion of the hood structure.

5. An incubator comprising an elongated base portion having side and bottom walls defining a chamber for receiving an infant support, a hood structure above the base at least a portion of which is openable for access to an infant on the support in the base, and an electrical heating element having air heating surface extended throughout a large part of the hood surface overlying the infant support.

6. An incubator according to claim 5 further including a control system for the heater element including a device responsive to the temperature of the heater element.

7. An incubator comprising an elongated base portion having side, end and bottom walls defining an upwardly open chamber for receiving a bassinet, a removable bassinet in the base chamber, a hood extended over the base to enclose the top of the base chamber, the bottom wall of the base having a channel formed therein and upwardly open under the bassinet, a sponge in said channel serving as a reservoir for water for humidifying the incubator, and an air circulation system for the incubator having a fresh air inlet positioned to direct air into the incubator in a path extending between the sponge and the bottom of the bassinet.

8. An incubator comprising an elongated base portion having side and bottom walls defining a chamber for receiving an infant, a hood structure above the base for enclosing the chamber above the infant and including a surface extended over said chamber, an electrical heater element in the base below the base chamber, an electrical heater element extended over the said surface of the hood structure and having an air heating surface extended over said chamber, and a heater control circuit for the heater elements comprising an adjustable control device responsive to the air temperature within the incubator for regulating the heating action of both of the heater elements.

9. An incubator according to claim 8 and further including a control device responsive to the temperature of the heater element associated with the hood wall for limiting the temperature of that element.

10. An incubator comprising a base having an upwardly open chamber therein for receiving an infant support, a hood overlying the base and having at least a portion which is openable for access to the interior of the base chamber, an air outlet adjacent the openable portion of the hood, and an air circulation system for the incubator including an air intake, a filter chamber with an outlet delivering the filtered air into the base chamber, and an air circulation fan interposed between the air intake and the filter chamber and providing for forced circulation of air into the base chamber and out of the outlet adjacent the openable portion of the hood.

11. An incubator according to claim 10 in which the filter chamber and fan are mounted on the base but in which the base is provided with a partition wall isolating the filter chamber and fan from the base chamber.

12. An incubator comprising a base having an upwardly open chamber therein for receiving an infant support, a hood overlying the base and having at least a portion of which is openable for access to the interior of the base chamber, and an air circulation system for the incubator including a filter chamber connected with the base and having an outlet for filtered air communicating with the base chamber, an air inlet into the filter chamber, a replaceable filter in the filter chamber, and a cover for the filter chamber at the inlet side of the filter, the cover being transparent and being exposed to view exteriorly of the base of the incubator.

13. An incubator comprising a base having an upwardly open chamber therein for receiving an infant support, a hood overlying the base and having at least a portion which is openable for access to the interior of the base chamber, and an air circulation system for the incubator including a filter chamber connected with the base and having an outlet for filtered air communicating with the base chamber, an air inlet into the filter chamber, an air circulating fan in the inlet to the filter chamber, the fan being exposed to view through said inlet, a replaceable filter in the filter chamber, and a cover for the filter chamber at the inlet side of the filter, the cover being transparent and being exposed to view exteriorly of the base of the incubator.

14. An incubator comprising a base having an upwardly open chamber therein for receiving an infant support, a hood overlying the base and having at least a portion which is openable for access to the interior of the base chamber, and an air circulation system for the incubator including a filter chamber connected with the base and having an outlet for delivering filtered air into the base chamber, an air inlet arranged to receive air exteriorly of the base chamber and to deliver air into the upstream side of the filter chamber, a passage for delivering air from the filter chamber into the chamber for receiving the infant, an outlet opening for the air in the infant's chamber, said outlet opening lying adjacent an openable portion of the hood, and an air circulating fan disposed in the inlet to the filter chamber and serving to force air through the filter into the infant's chamber and out of the outlet opening.

15. An incubator according to claim 14 and further including a removable bassinet in the base chamber, the bottom of the base being provided with an upwardly open cavity for receiving a humidifying sponge below the bassinet, the outlet opening of the filter chamber delivering the filtered air into the space between the bottom of the bassinet and the sponge.

16. An incubator comprising a base having an upwardly open chamber therein for receiving an infant support, a hood overlying the base and having at least a portion which is openable for access to the interior of the base chamber, an electrical heater for the incubator, a heater operating circuit, a separable connection device on the incubator for electrical power input to the heater operating circuit, an accessory frame carrying an electrical power source, the frame and the base of the incubator having separable interfitting elements for interpositioning the frame and the incubator, and separable means for connecting the power source on the accessory frame to the heater operating circuit.

17. An incubator according to claim 16 in which the separable means for connecting the power source on the accessory frame to the heater operating circuit comprises a separable electrical connection device complementary to the connection device on the incubator.

18. An incubator comprising a base having an upwardly open chamber therein for receiving an infant support, a hood overlying the base and having at least a portion which is openable for access to the interior of the base chamber; an electrical heater for the incubator; a power circuit for the incubator, a separable connection device on the incubator for electrical power input to the power circuit, the connection device having connection elements providing alternatively for connection either with an alternating current power source or with a battery, a separable accessory frame carrying a battery and a battery charger, the frame and the base of the incubator having separable interfitting elements for interpositioning the frame and the incubator, separable means for connecting the battery on the accessory frame to said separable connection device, and means interconnecting the battery charger and said circuit when the accessory frame and the incubator are assembled and including means providing for operation of the charger to charge the battery when the separable connection device is connected with an alternating current power source.

19. An incubator comprising a base having an upwardly open chamber therein for receiving an infant support, a hood overlying the base and having at least a portion of which is openable for access to the interior of the base chamber, an electrical heater for the incubator, a power circuit for the incubator, a separable connection device on the incubator for electrical power input to the power circuit, the connection

device having connection elements providing alternatively for connection either with an alternating current power source or with a battery, a battery and a battery charger, separable means for connecting the battery to said separable connection device, and means interconnecting the battery charger and said circuit and including means providing for operation of the charger to charge the battery when the separable connection device is connected with an alternating current power source.

20. An incubator comprising a base having an upwardly open chamber therein for receiving an infant support, a hood overlying the base and having at least a portion which is openable for access to the interior of the base chamber, an electrical heater for the incubator, a power circuit for the incubator, a separable connection device on the incubator for electrical power input to the power circuit, the connection device having means providing alternatively for connection with an alternating current power source or with a battery but providing against concurrent connection with both an alternating current source and a battery, a battery and a battery charger, and circuit means providing for operation of the battery charger to charge the battery whenever the separable connection device is connected with an alternating current source.

21. A portable incubator comprising an elongated base portion having side and bottom walls defining a chamber for receiving a bassinet, a hood structure above the base comprising a rear portion having walls overlying the rear part of the base chamber and a transparent front portion overlying the front part of the base chamber and movable with respect to the rear portion of the hood to provide an openable and closable access opening proportioned to provide for insertion and removal of the bassinet, and electrical heater elements having air heating surface extended throughout at least a major part of the incubator walls defining the base chamber.