Aug. 11, 1953 S. Y. GIBBON 2,648,327

INFANT INCUBATOR EQUIPMENT

Filed Aug. 5, 1949 2 Sheets-Sheet 1

Fig. 1.

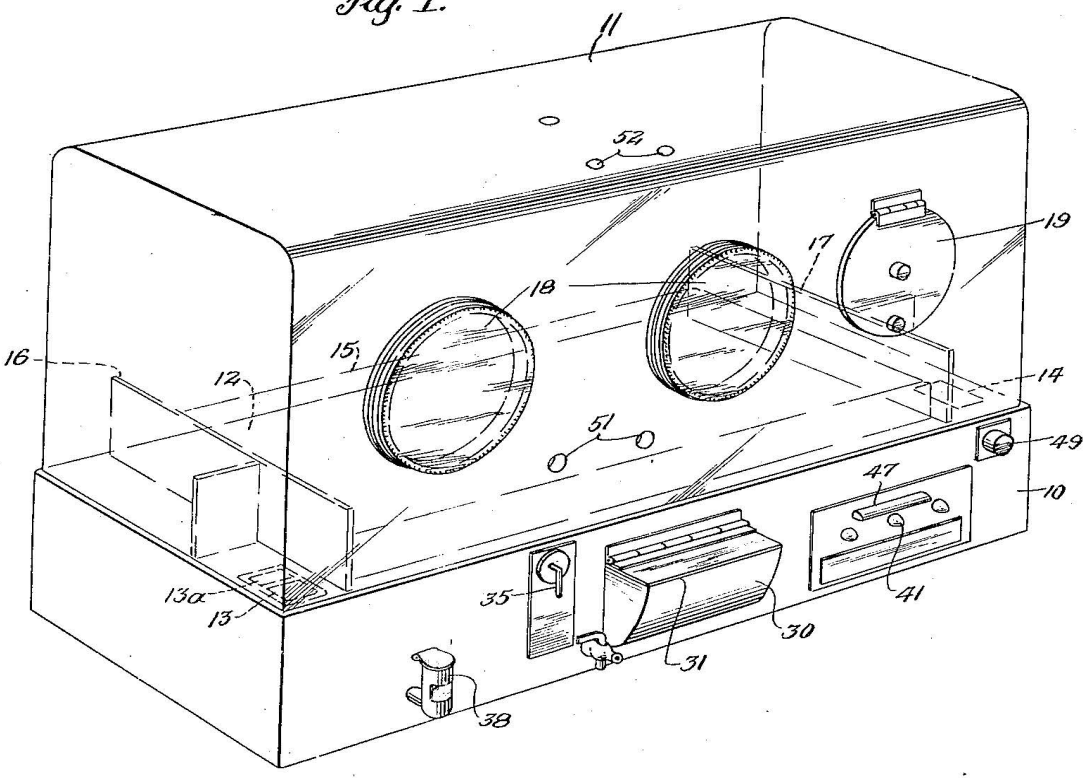
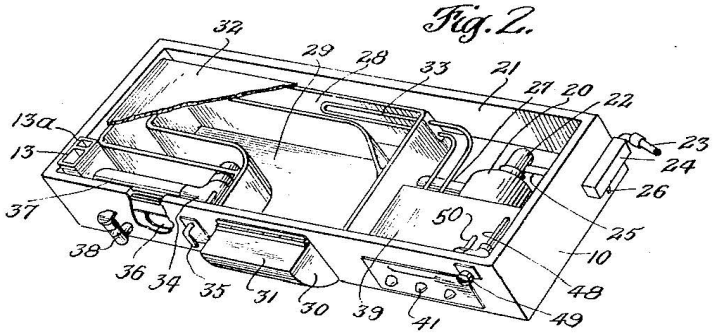


Fig. 2.



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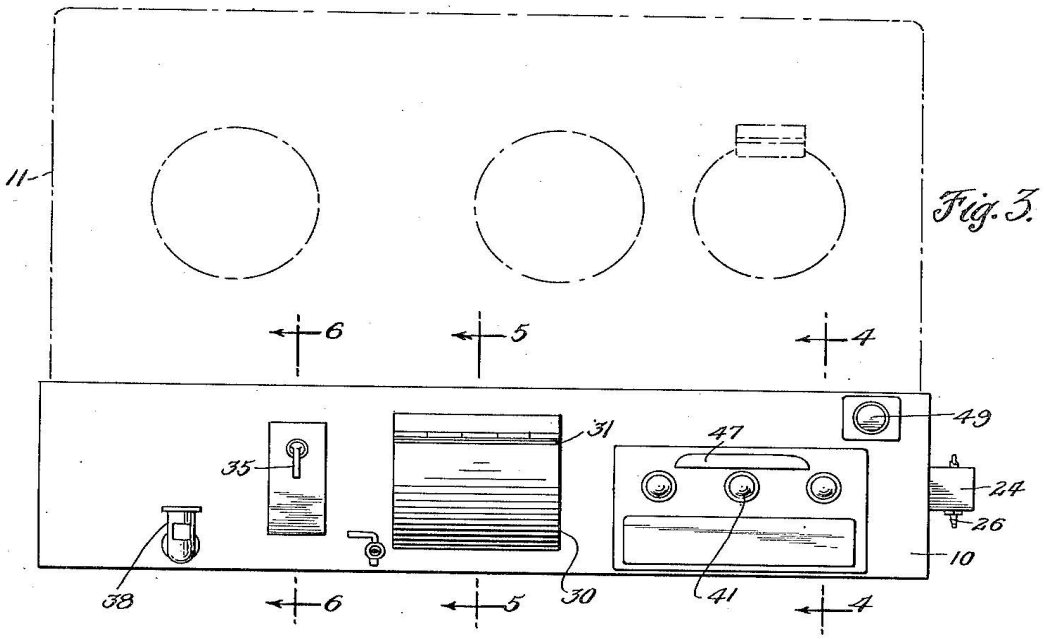


Fig. 3.

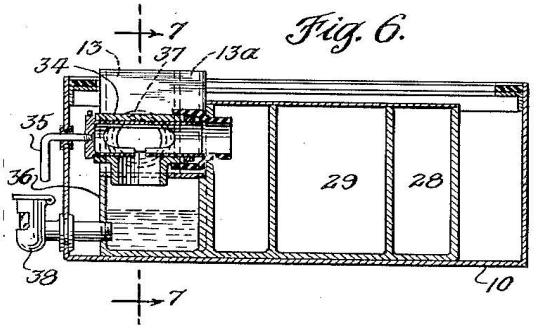


Fig. 6.

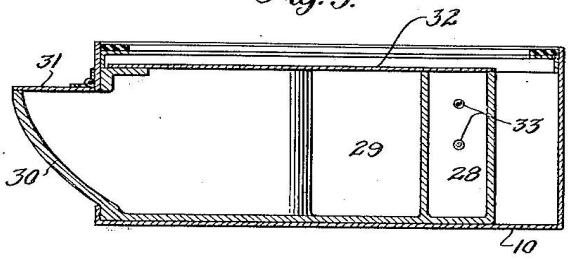


Fig. 5.

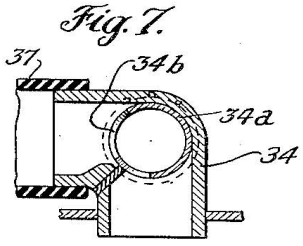


Fig. 7.

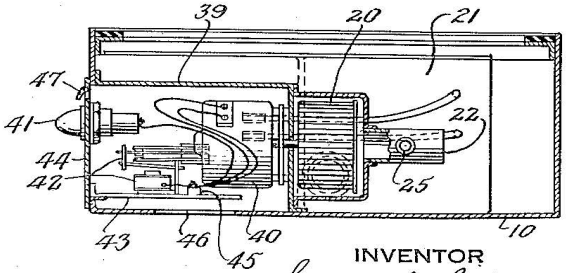


Fig. 4.

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INFANT INCUBATOR EQUIPMENT

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Application August 5, 1949, Serial No. 108,825

10 Claims. (Cl. 128—1)

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This invention relates to incubator apparatus suitable for use in the special care of infants such as those which are prematurely born or those requiring isolation or special care. The invention is particularly concerned with improvements in the air conditioning and circulating equipment and its assembly.

In incubator apparatus of this nature it is desirable to provide an upper enclosure chamber for the occupant and a unit incorporating the conditioning, circulating and control apparatus. Disclosures of this general type of incubator arrangement are made in application 28,603, filed May 22, 1948, now Patent No. 2,600,240 and application 45,670, filed August 23, 1948, now Patent No. 2,598,532.

An important object of the invention is to provide an improved arrangement of the air conditioning system parts to give increased operating efficiency and improved control of the conditioning action, particularly the heating and cooling operations, by the use of an improved heating duct arrangement including a large area duct arranged in a circuitous path.

An other object of the invention is the provision of greater safety and improved accessibility by isolating the electrical equipment and connections in a sealed compartment separate from the circulating system, thus preventing the danger of fire or fumes which might be caused by failure of electrical apparatus from reaching the occupant's chamber.

A further object of the invention is to provide unitary construction for the cooling chamber and delivery duct in a fashion which provides a heavy walled unit to simplify the manufacture and assembly of the apparatus and to provide improved heat transfer to or from the circulated atmosphere.

A still further object of the invention is the provision of an improved humidifying system and control.

How the foregoing and other objects and advantages of the invention are accomplished will be evident from the following description of the drawing in which—

Figure 1 is a perspective view of an incubator incorporating the features of the present invention.

Figure 2 is a perspective view looking into the top of the lower unit of the incubator.

Figure 3 is a front elevation of the lower unit of the incubator, the upper unit being shown in broken outline.

Figure 4 is a sectional view taken in the direction of arrows 4—4, Figure 3, showing the interior of the electrical chamber and adjacent parts.

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Figure 5 is a sectional view taken in the direction of arrows 5—5, Figure 3, showing the cooling chamber and delivery duct.

Figure 6 is a sectional view taken in the direction of arrows 6—6, Figure 3, showing the construction of the humidifier and bypass.

Figure 7 is a sectional view in the direction of arrows 7—7, Figure 6, showing details of the humidifier control valve.

Referring to Figure 1, it will be seen that the incubator consists chiefly of the lower or machinery unit 10 which is in the form of a relatively shallow box and the upper occupant's chamber 11 which is in the form of an inverted transparent box hinged to the lower unit 10 along a bottom edge. By this construction all of the equipment required for the circulation, heating, cooling and humidifying of the air in the occupant's enclosure, including the controls, is contained in a single compact unit or base assembly leaving the occupant's space completely free of any control or electrical apparatus. The floor member 12 for the occupant's enclosure 11 acts as the lid for the lower box 10 and may be removed for cleaning purposes or for access to the equipment compartment for service. Opening 13 in the floor member 12 provides for the delivery of air from the lower unit 10 to the occupant's compartment. The return air passes through openings 14 back to the lower compartment for recirculation and conditioning. A mattress 15 may be placed directly on the floor member 12. This is maintained in correct position within the occupant's enclosure by means of low walls 16 and 17 which are built integrally with the transparent enclosure 11 and preferably of the same material as the enclosure. In addition to maintaining the mattress 15 in proper position walls 16 and 17 are located and proportioned so as to guide the airflow in a manner which provides even distribution of temperature throughout the enclosure.

To provide for care of the infant while maintaining complete isolation, arm-hole openings 18 are provided in the side of the enclosure 11, these arm-holes being equipped with suitable closure sleeves or similar devices for the purpose of preventing ingress of room air during the time an attendant is working with the infant. The access door 19 is also provided in the enclosure to permit inserting necessary articles such as feeding bottles, diapers and the like. Since a positive pressure is maintained in the enclosure in a

fashion to be described below, accidental ingress of air is prevented when the access door is opened momentarily, and thus, danger of entrance of contaminated air is greatly reduced.

Referring to Figures 2 and 3, the arrangement and construction of the circulating and conditioning apparatus will be clear. The blower fan **20** is located in a chamber near one end of the box unit and draws air from the chamber **21** into the intake opening **22** for recirculation through the conditioning apparatus and the occupant's compartment. A proportion of fresh air is supplied from an outside source through the flexible pipe **23** and is carried to the blower through a valve member **24** which contains a screen or filter device to remove any dust particles from the air. Pipe **25** then delivers the fresh air to the suction side of the blower **20**. In case pure oxygen is to be added to the air supply this is supplied through the small tube **26** which may be attached to the valve member **24**. Suitable automatic valve devices are incorporated in the valve structure to control the flow of oxygen and to close off the oxygen opening when the oxygen flow is shut off.

After passing through the blower the air at a positive pressure is forced through tube **27** to the large area duct **28**. The large area of the duct allows a relatively low velocity of air flow, thus giving increased time for heat transfer. Duct **28** follows a circuitous path around the outside of the cooling chamber **29**. According to a feature of the present invention the duct **28** and cooling chamber **29** are made as a single integral inner box unit in a form which will provide a high degree of heat transfer while occupying a relatively limited space. In the arrangement illustrated the cooling chamber is made in a general L shape with the short leg of the L terminating in an ice delivery chute **30** which projects outside of the external box or case of the lower unit. A cover **31** is provided for the ice chute **30**. The air channel **28** extends completely around the long leg of the L shaped cooling chamber having two right-angle bends which serve to mix the air and bring it into intimate contact with the wall surface to increase the efficiency of heat transfer. A lid **32** which is fastened securely in position on the upper surface of the cooling chamber and air duct unit serves to provide an effective air seal so that air from an outside source cannot enter the duct. Thus by this effective system delivery of air of proper temperature may be made to the chamber even though the outside air may be considerably above body temperature.

A heater unit **33** is inserted in the duct **28**. This heater is preferably of the enclosed type consisting of a relatively long heater rod distributed throughout a considerable length of the duct **28**. With this arrangement the heat may be applied over a large area, thus requiring a lower temperature for the heating element and permitting more accurate and uniform temperature control of the air flow. The heavy walls with their large area retain heat and this is transferred to the air stream between normal operating cycles of the heater. The circuitous path further serves to provide mixing action which minimizes fluctuations in temperature within the occupant's space.

After the air has been properly conditioned as to temperature it passes from the duct **28** into a valve **34**. By setting the valve handle **35** any desired proportion of the air may be forced through the humidifier chamber which is located below valve **34**. This chamber is indicated by numeral **36** in Figure 6, where the relationship of the parts is shown more clearly. The construction of the valve **34** is more clearly indicated in Figure 7 where it will be seen that the internal sleeve **34***a* is rotated by the valve handle **35**. Opening **34***b* in the member **34***a* is in the form of a T shape. The opening may be rotated to any position between full air delivery through the humidifier chamber **36** to full delivery through the by-pass **37**. The particular shape for the opening **34***b* provides for more accurate control when only a small increase in humidity is desired. When a high degree of humidity is not needed, valve handle **35** is adjusted so as to permit a portion of the air to flow directly through the by-pass duct **37** from which it enters the occupant's compartment through the outlet **13**. The portion of the air flowing through the humidifier chamber enters the occupant's space by means of a separate channel **13***a* of the outlet duct **13**. As will best be seen in Figure 6 the humidifier chamber **36** is kept supplied with water by means of filler **38** which extends outside the base box **10**. Filler **38** includes a visual water level gauge.

With this circulating system the air under pressure is delivered through the main duct and is heated or cooled therein so that the desired temperature is attained before it reaches the humidifying location. By this sequence relatively accurate control of the humidity may be obtained by varying the setting of the control handle **35**. For example, with the arrangement shown, opening the valve **34***a* to one-quarter position will normally produce a relative humidity of 50 to 65 per cent. With three-quarter handle position the relative humidity produced will be 80 to 95 per cent. When ice cooling is used the humidity valve is turned to full open.

As will be best seen from Figures 2, 3 and 4, the electrical equipment including the electric motor, control relays, indicator lights, wiring and the like, is all enclosed in chamber **39** which is sealed with respect to the inside of the box unit **10**. The electric motor **40** is shown supported on the rear wall of the enclosed chamber **39**, the blower **20** being mounted on the motor shaft on the opposite side of the wall. The indicator lights **41** are mounted on an external plate member which closes the opening from the chamber **39** to the outside of the outer box **10**. The general location of the control relays and warning buzzer is indicated by numeral **42**. These are mounted on a horizontal plate **43** which is attached to the vertical closure plate **44**. The plate **43** on which the relays **42**, the terminals **45** and wiring are mounted, is securely fastened to the front plate **44** and may be withdrawn from chamber **39** so as to expose all of the wiring connections outside the box **10** and to permit easy access to the rest of the electrical equipment. With the plates **44** and **43** removed access may be had to the motor **40**, its mounting screws and its electrical connections. To provide for circulation of air to the electrical compartment **39** to carry away any heat developed, an opening **46** in the lower surface and a louvre **47** in the front plate are provided.

The temperature of the air circulated through the occupant's compartment is controlled by means of a thermostat **48** which is located just below the return air outlet **14** from the occupant's compartment. Thermostat **48** may be adjusted by means of knob **49** to provide for selection of the desired temperature within the enclosure. In addition, a small fixed thermostat **50** is provided as a safety measure. This is set to actuate a danger signal in the form of a red light and a buzzer if the temperature in the enclosure should

exceed a maximum safe temperature, e. g. 102 degrees. Excessive temperature might develop through faulty operation of the heater or the controls, or if the incubator should be left in direct sunlight for an extended period. In case of failure of power, openings as indicated at 51 and 52 are provided in the enclosure 11. These will permit sufficient circulation of air through the incubator to support life within the incubator. Under normal operation the positive pressure within the enclosure 11 prevents the ingress of room air through openings 51 or 52. These openings serve to permit the escape of a small amount of circulated air sufficient to compensate for the fresh air added through the intake 23.

From the foregoing it will be seen that I have provided improved construction for infant incubators particularly with respect to improved efficiency and compactness. The improved interior arrangement for the cooling chamber and delivery duct provides for controlled delivery of air under pressure by forcing it to intimately engage the cooling surface through an extended and circuitous path. This construction permits the application of heat to the air over an appreciable distance along the duct by a low temperature enclosed type heater. The improved humidifier construction assures maximum humidification when needed and permits control to the desired degree of humidity at all times. The special walls or baffles within the occupant's chamber provide for improved circulation and heat distribution, while at the same time, serve to retain the proper location for the occupant's mattress, thus eliminating the need for projecting walls on the floor member. The relative location of the blower unit and the electrical chamber with respect to the remainder of the lower unit provides for the concentration of all electrical wiring and equipment within a confined area, thereby reducing the amount of wiring required and eliminating the need for wiring having metal casing for safety purposes. With the arrangement shown all of the wiring and electrical equipment is completely separated from the air stream which may often have a high oxygen content. Separation of the electrical equipment in this manner thus avoids danger of fire from this source. In addition, a greatly improved assembly and service arrangement results.

I claim:

1. Incubator apparatus suitable for infants having a base unit, heating, circulating and control equipment completely housed in said base unit, an occupant's space formed by an inverted box open at the bottom and adapted to be supported on said base unit, said base unit further being ported adjacent either end thereof for inlet and discharge of air from said box, said box having transverse integral plates extending the full width of the box and attached to its walls adjacent each end near the bottom for controlling air flow and temperature distribution throughout the occupant's space.

2. Infant incubator apparatus including a box-like lower unit, heating, cooling, circulating and control equipment completely housed in said lower unit, said lower unit incorporating an integral sealed unit having an inner chamber for holding a coolant and having a bottom and walls, an outer chamber surrounding a major portion of the inner chamber and having a bottom and outer walls, certain inner and outer wall members being spaced apart to define an air duct, the inner walls of said outer chamber being the outer walls of the inner chamber, a cover member for said integral unit extending over both the outer and inner chambers, a circulating air inlet at one end of said duct and an air outlet at the other end, a circulating fan having its pressure side connected to said duct inlet, the cross sectional area of the duct being at least several times the area of the circulating fan outlet.

3. For an infant incubator, a base box containing cooling and circulating equipment, an integral coolant container and air duct, said container being generally L-shaped and having the cooling duct extending along the back and the front of the main leg of the L-shaped container.

4. For an infant incubator having a separate unit containing the temperature control and circulating equipment, an integrally formed cooling chamber with an air duct surrounding it, said duct being of large cross sectional area to permit relatively low velocity flow, and a circulating fan having an inlet to said duct from the pressure side of said fan.

5. An infant incubator comprising an occupant's enclosure mounted upon a base-box housing air-conditioning mechanism; said air conditioning mechanism including a smaller box positioned within the base box and containing a cooling compartment, the walls of which compartment are laterally spaced from the corresponding walls of said smaller box on at least two sides so as to form an air duct having an angular change of direction; a humidifying tank mounted in said smaller box and communicating with the air duct; and cover means separating the base box from the occupant's enclosure, said cover means being apertured to provide for circulation of air through the occupant's chamber and through both base boxes in series.

6. For infant incubators of the type having an occupant's enclosure completely free of air-conditioning equipment and a machinery base containing air-conditioning equipment with means affording a circulation of air through the occupant's enclosure and machinery base in series, an oxygen intake, a blower, and a heating element and thermostat therefor, all extending into the path of air flow; a blower motor, electrical connections for said heating element, thermostat and motor and a housing completely isolating said motor and connections from the remainder of said machinery base.

7. An incubator as defined in claim 6 wherein said housing incorporates a removable external wall panel, an indicator light and connections therefor, a horizontal plate integral with said removable panel upon which electrical connections are mounted.

8. An infant incubator having an occupant's enclosure supported on a machinery box, air circulation means comprising an oxygen intake, a blower and a circuitous air duct in said machinery box, and a floor member between said enclosure and said box having ports establishing communication between said occupant's enclosure and said circulation means; a heating element and a thermostatic control for the element lying in the path of air flow, a motor for the blower, an indicator light, and electrical connections for blower, motor, thermostat heating element, and light, and a sealed compartment isolating the motor and all of the electrical connections from the path of air flow.

9. An infant incubator comprising an occupant's enclosure and a shallow machinery box supporting the same, said machinery box com-

prising an outer housing and a smaller box in said housing having an elongated section to receive coolant, a marginal air duct extending the full height of the smaller box surrounding at least a major part of the periphery of said coolant section; and a humidifier receiving air from said duct; said machinery box having openings to deliver air from the humidifier to the occupant's enclosure and to receive air from the occupant's enclosure for re-circulation.

10. For an infant incubator having a separate box containing the temperature control and circulating apparatus, a heat transfer compartment including an air duct and heat transfer devices having heat conducting surfaces positioned along the path of air flow through said duct, said compartment occupying a large part of the volume of said box, and a blower fan having the pressure side thereof connected to said duct and the suction side of said blower fan being located in the portion of said box representing the minor volume thereof.

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