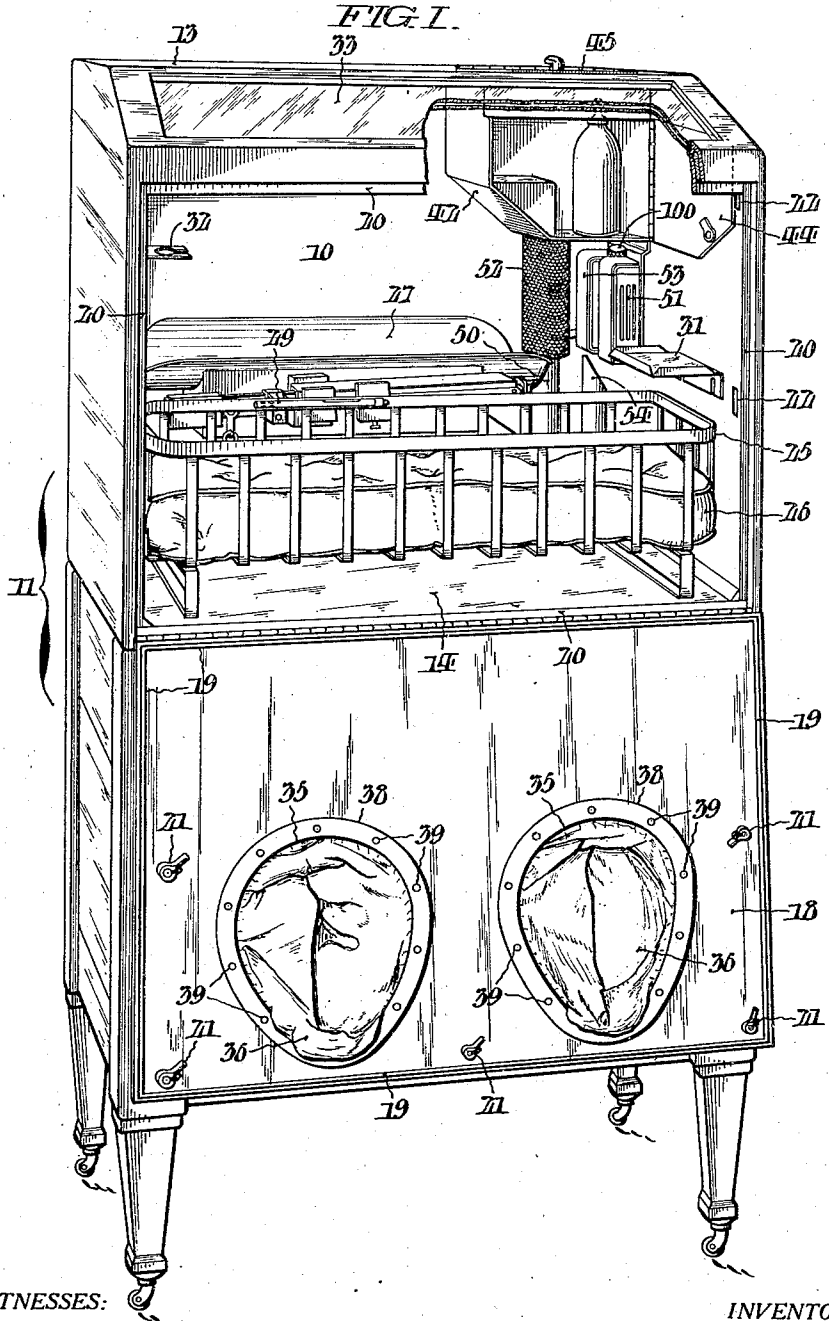
June 3, 1941. C. C. CHAPPLE 2,243,999

BABY INCUBATOR AND THE LIKE

Filed March 4, 1938 4 Sheets-Sheet 1

FIG. 1.



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June 3, 1941. C. C. CHAPPLE 2,243,999

BABY INCUBATOR AND THE LIKE

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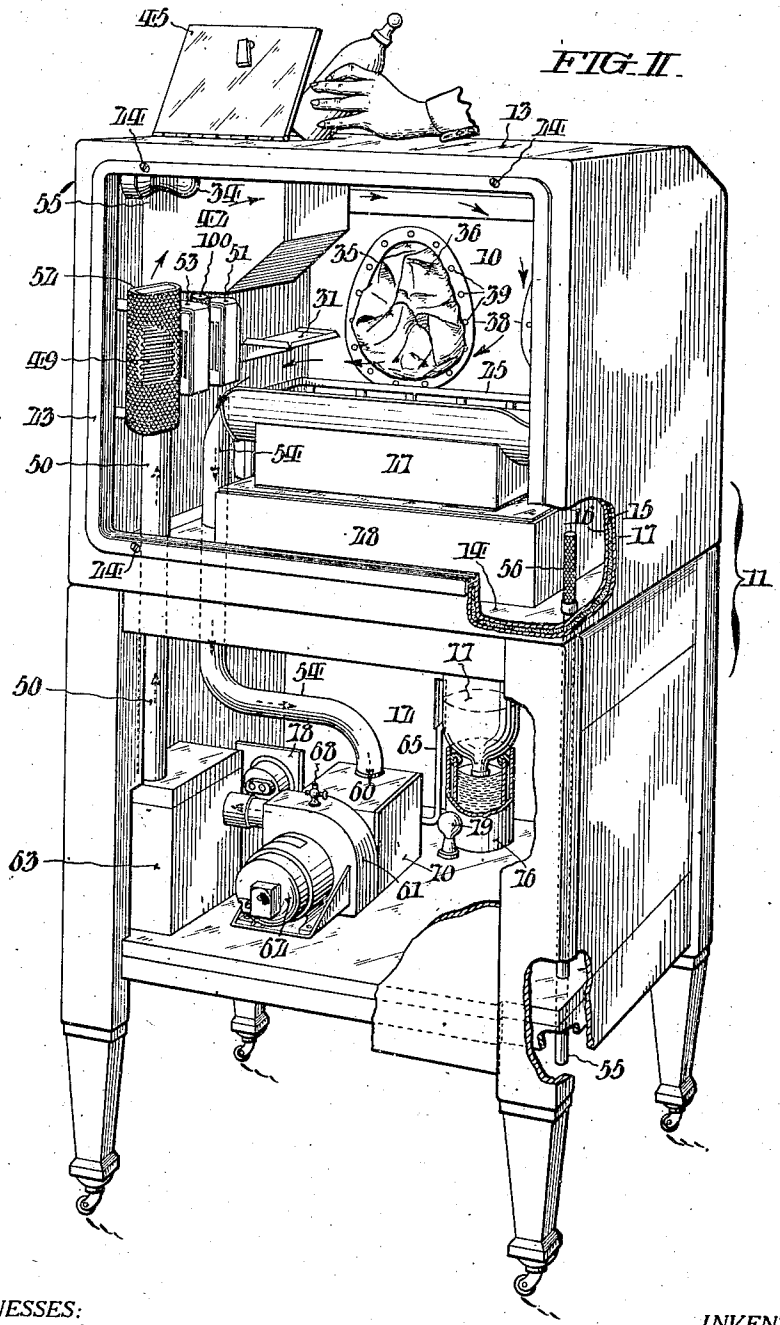
FIG. II.



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June 3, 1941. C. C. CHAPPLE 2,243,999

BABY INCUBATOR AND THE LIKE

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FIG. VIII.

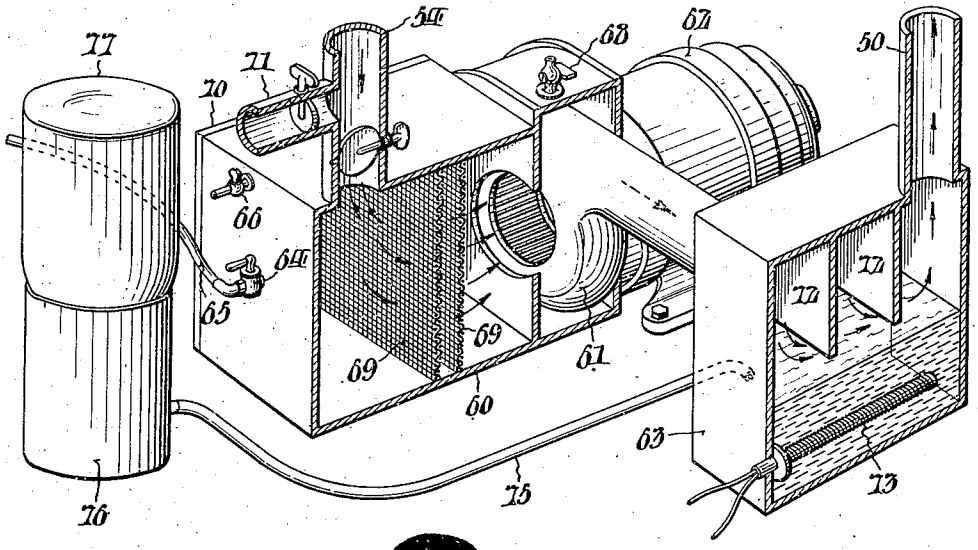
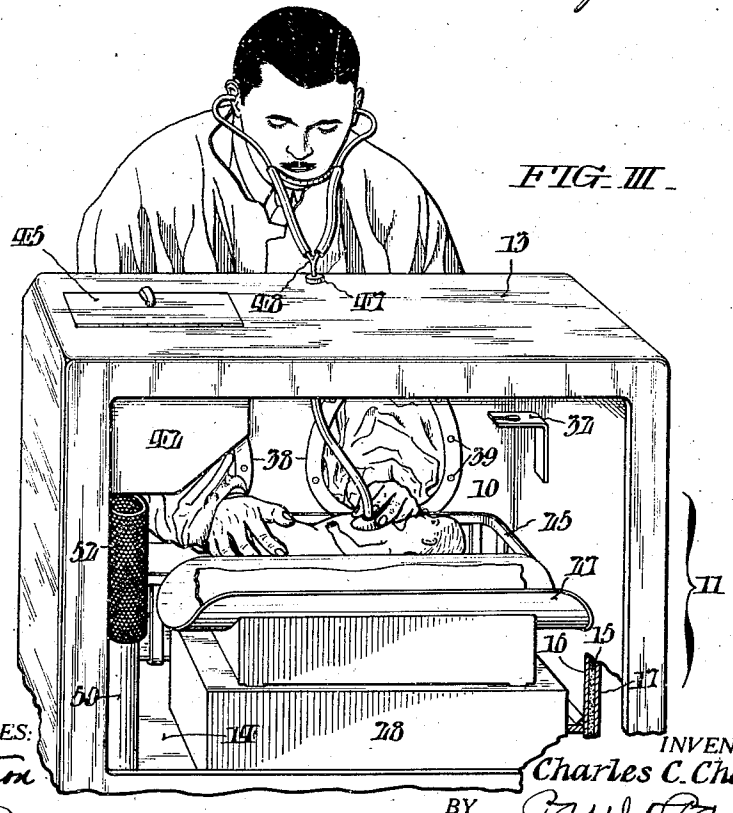


FIG. III.



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June 3, 1941. C. C. CHAPPLE 2,243,999

BABY INCUBATOR AND THE LIKE

Filed March 4, 1938 4 Sheets-Sheet 4

FIG. VII.

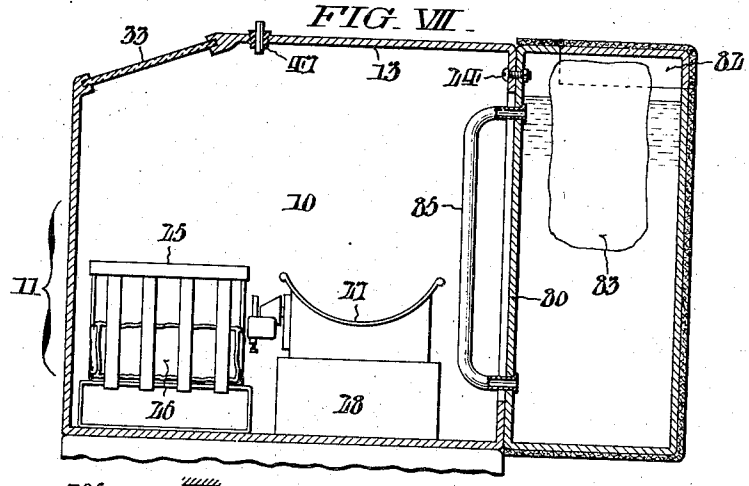

FIG. IX.

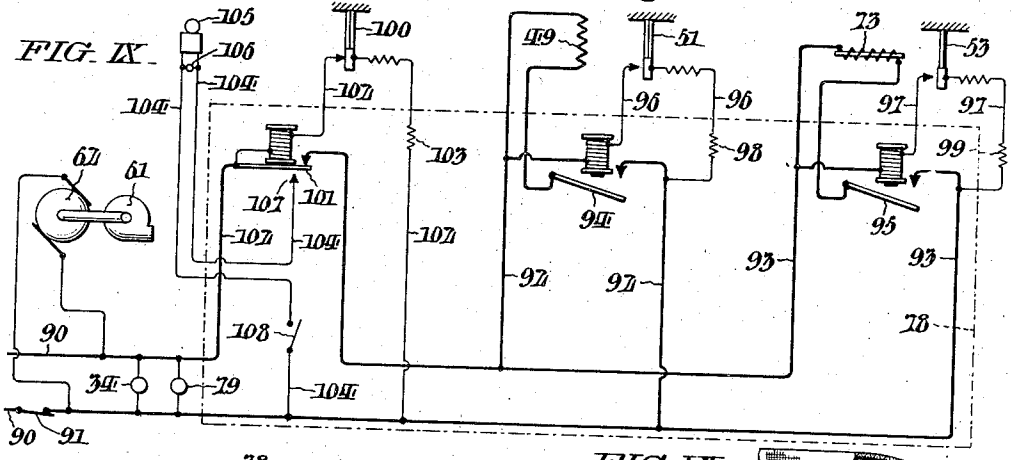

FIG. IV.

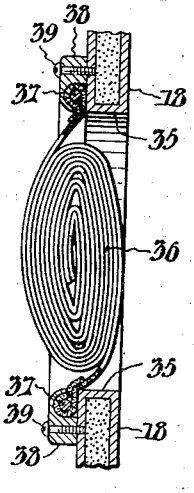

FIG. V.

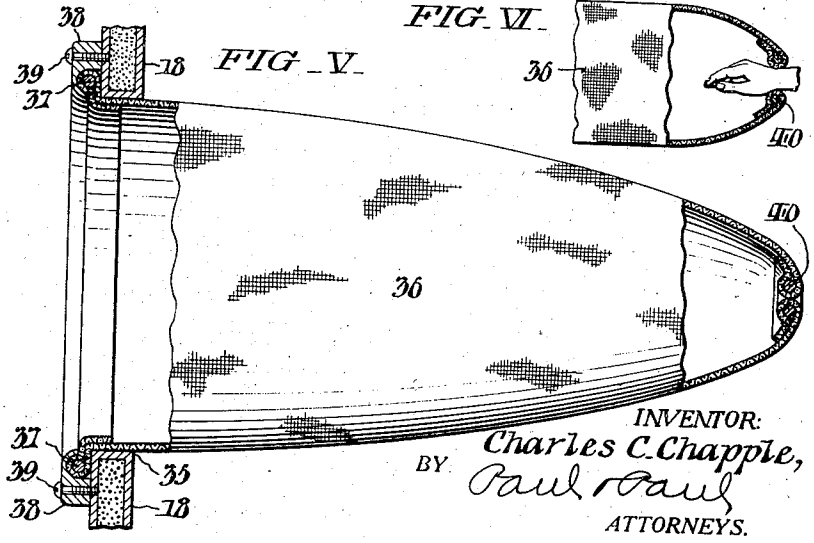

FIG. VI.

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Patented June 3, 1941 2,243,999

UNITED STATES PATENT OFFICE

2,243,999

BABY INCUBATOR AND THE LIKE

Charles C. Chapple, Philadelphia, Pa., assignor to The Children's Hospital of Philadelphia, Philadelphia, Pa., a corporation of Pennsylvania

Application March 4, 1938, Serial No. 193,883

9 Claims. (Cl. 128—1)

My invention relates to incubators useful for the prematurely born, or for infants that are otherwise delicate or sick, or when special care after birth is desired for any reason. The incubator may also be found useful for young or sick animals, in some cases.

An important aim of the invention is to isolate the patient in the incubator from all outside influences or infections, and to provide definite and controllable conditions in the incubator chamber, including an atmosphere of determinate characteristics, if desired, such as may be most advisable in each case. Another aim of the invention is to provide for the necessary care, examinations, and treatment of the patient in the incubator,—or for any other attention,—without any interruption or impairment of the favorable conditions, and without need to withdraw the patient temporarily for any purpose. Other purposes, features, and advantages of the invention will appear from the following description of one species or form of embodiment, and from the drawings. All the features and combinations shown or described are, indeed, of my invention, so far as novel.

Inasmuch as the atmosphere maintained in my incubator may sometimes include more (or less) oxygen than ordinary air, or may include carbon dioxide or other gas not appreciably present in ordinary air, or may even be entirely artificial or synthetic, I have hereinafter generally used the expression "respiratory gas," or "gas" simply, to cover natural air and all modifications thereof or substitutes therefor.

In the drawings,

Fig. I is a front perspective view of one form of incubator conveniently embodying the invention, with the front wall closure swung down to open position, and with a portion of the upper wall and roof structure broken out.

Fig. II is a rear perspective view of the incubator, with parts of the rear wall broken away or removed.

Fig. III is a partial rear perspective view illustrating the use of certain features of the invention by a physician, as for examining a baby in the incubator.

Fig. IV is a fragmentary sectional view showing an armlet or sleeve device attached to the incubator around an arm-port in its wall, but rolled up and secured or stowed as when not in use; Fig. V is a similar view with the armlet or sleeve device unrolled as for use, the ends of the sleeve being partly broken away and in section; and Fig. VI is a fragmentary view, partly sectional, showing how a hand is initially inserted in the end of the sleeve.

Fig. VII is a somewhat diagrammatic sectional view of the incubator chamber, equipped with a cooling arrangement for hot weather.

Fig. VIII is a perspective and sectional view of certain apparatus for maintaining the desired atmospheric conditions in the incubator, the view being from the left of Fig. II.

Fig. IX is a wiring diagram illustrating the automatic control and regulation of the atmosphere in the incubator.

In Figs. I and II, the incubator chamber 10 is shown as a top compartment in a cabinet structure 11, which also has a lower shelf or bottom compartment 12 for accessory equipment. The incubator compartment 10 is completely enclosed, and all its walls (including top or roof 13 and bottom 14) may be thoroughly thermo-insulated: this is suggestively indicated in Fig. II by a thermoinsulative layer 15 included in the wall thickness, between inner and outer wall shells 16 and 17, which may be of metal or other suitable material. The equipment shelf or compartment 12 is also shown as enclosed and completely separate from the incubator compartment 10, though without any attempt at thermoinsulation.

As shown in Fig. I, the entire front of the incubator chamber 10 is formed by a bottom-edge-hinged door 18, which has a lateral gasket 19 to make a tight joint against a rabbetted seat 20 in the edges of the walls, and is provided with swing-fasteners 21 for engaging in sockets 22 in the walls, behind the seat 20. In Fig. I, the door 18 is shown swung down to open position, affording free access for cleaning, sterilizing, or other purposes, as well as a free view of the interior; and in Fig. II, the rear wall panel of the compartment 10 has been omitted from its frame 23 (which is removably secured by screws or bolts 24), and the rear wall of the compartment 12 has been largely broken away, to reveal the interiors of compartments 10 and 12. Actually, however, the incubator chamber 10 can be kept entirely closed when in use. This is made possible not only by special respiratory provisions, but also by the equipment of the incubator chamber 10, including special provisions for the introduction and withdrawal of everything useful for the patient, and for proper care, examination, treatment, or other attention by nurses, physicians, or other attendants. Even when a baby occupies the incubator for months, therefore, it is rarely necessary to open up the cham-

ber 10,—which would interrupt or impair the favorable conditions, and expose the patient to infections or drafts.

As shown in Figs. I and II, the equipment in the incubator chamber 10 includes a metal-basket baby-bed 25, with mattress 26, preferably at the front of the chamber. There are also precision baby-scales 27, preferably at the rear of the chamber 10, and elevated above the bed 25, as on a pedestal 28. As is apparent from Figs. I, II, III and VII, the pan of the scales 27 may serve as an alternative rest for the baby, in lieu of the bed 25, as when the latter is being changed. A thermometer 29 is shown mounted on the rear rail of the bed 25, where it will give the temperature immediately affecting the patient lying on the mattress 26. On the chamber wall above one end of the bed 25 is shown a shelf 31 for conveniently holding articles temporarily not in actual use; and on the opposite wall, higher above the bed, there is a bracket 32 for holding a gavage funnel while liquid is administered to the patient therewith. Preferably the shelf 31 and bracket 32 are removable. An observation window 33 is provided in the top or roof 13 of the incubator chamber 10, directly over the bed 25 and the devices 31, 32, to give a clear view of the whole interior of the chamber. It is preferably set on a slope of some 30° or less, and may have double panes of uninflammable, shatter-proof character, suitably spaced for thermo-insulation. For illuminating the interior of the chamber 10, an incandescent electric lamp 34 may be conveniently placed therein, as in an upper rear corner, with suitable screening to prevent glare in the patient's eyes.

To permit necessary access to the interior of the incubator chamber 10 without opening it, it has wall openings or armports 35, 35, preferably in its front wall 18, with provisions to prevent influx or efflux of air or gas when the hands (and arms) of an attendant are inserted through them. For this purpose, flexible tubular armlets or "sleeves" 36, 36 of gasproof fabric (e. g., balloon cloth) are attached to the wall 18 around the openings 35, 35, as shown in Figs. I, II, III, IV and V. As shown in Fig. IV, each sleeve 36 has a hoop 37 sewn into the hem at one (larger) end, which lies in a groove in a clamping ring 38 that is secured to the inner side of the wall 18 by screws 39. In the wristband hem at the other (smaller) end of the sleeve 36 is enclosed a very extensible elastic (rubber) band 40, which gathers or puckers the wristband fabric together and closes the opening when the sleeve is not in use. This contractile free end of the sleeve 36 fits around an attendant's arm above the hand, and the length of the sleeve permits the hand and arm to be introduced into the incubator chamber and moved around therein freely, as hereinafter described.

When an attendant wishes to use one of the sleeves 36, its elastic 40 readily allows the wristband to expand for insertion of a hand, as shown in Fig. VI. The hand being thus inserted through the wristband and inside the sleeve 36, it is pushed inward through the sleeve and through the armport 35, carrying the wristband with it. The sleeve 36 reverses or turns "inside out" as it follows the hand through the armport 35, allowing insertion of the arm into the chamber 10 to any extent desired. The flexibility and length of the sleeves 36, 36 allows the attendant to move his hands and arms about freely in the incubator chamber 10, to do whatever is needed to or for the patient, as indicated in Fig. III,—while all the time observing everything in the chamber as he stands in front of it, looking down through the window 33. If the attendant wishes, he can readily slip his hands under a baby lying on the bed 25 in Fig. III, lift him upward and rearward, and place him on the scales 27 and weigh him, and afterward return him to the bed again,—the range and freedom of movement allowed by the sleeves 36, 36 being ample for this.

When the attendant has done everything desired, he merely draws his arms out through the openings 35, 35 and steps back away from the incubator, thus drawing out and reversing the sleeves 36, 36 through the openings 35, 35 and finally withdrawing his hands through the wristbands,—when their ends are at once automatically closed by the elastics 40, 40, as shown in Fig. V. Then the sleeves 36, 36 may be twisted ½ turn, rolled up, and tucked into themselves, so to speak, in the armports 35, 35,—or otherwise compactly stowed or secured,—as shown in Figs. I, II, and IV.

For conveniently passing articles (such as milk-bottles) into and out of the chamber 10, an "air-lock" 42 is shown at or in an opening through the chamber wall, with closures or doors 44, 45 for preventing loss of interior air from the incubator and to prevent outside air from entering, only one door being opened at a time. To avoid any objectionable external projection on the cabinet 11, the air-lock chamber 42 may extend into the chamber 10, preferably in its upper portion at one end, above the bed 25 and the scales 27. As shown in Figs. I and II, the inner lock door 44 forms the front lock wall and is hinged to swing open horizontally, against the end wall of the chamber 10, while the outer door 45 is in the top or roof of the air-lock 42 and of the chamber 10, and is hinged to swing open upward and rearward, Fig. II. Internally, the bottom of the lock-chamber 42 is shown stepped, affording convenient places for a number of tall milk bottles, and for shorter articles. With the lock 42 in the location shown, its inner door 44 and its interior are readily accessible to an attendant's hand when inserted through one of the sleeves 36, as he stands in front of the incubator in Fig. III; and the outer lock door 45 is also within easy reach of his (other) hand. Moreover, the lock chamber 42 serves as a screen or shield to keep the light 34 from shining in the patient's eyes. Very small articles can either be passed in and out through the lock 42, or introduced and withdrawn in the hand, through one of the sleeves 36.

As shown in Figs. III and VII, an apertured plug-in fitting is provided in the top or roof of the incubator chamber 10, consisting of an elastic vulcanized rubber stopper 47 with a hole through it. This device allows tubular connections to be made therethrough from the baby to a point outside the chamber roof, adjacent the attendant's head as he stands at the window 33. For this purpose, one or more metal or other tubes 48 may be inserted in the rubber stopper 47, from the inside or the outside, or both, and rubber tubing may be attached thereto inside the chamber 10, and also outside if required. By means of such tubular connections, many operations can be conveniently effected,—such as administration of emergency oxygen and carbon dioxide, aspiration, or stethoscopic examination as shown in Fig. III, etc. As is apparent from Fig. III, such tubular connections do not interfere

with the attendant's view through the window 33 as he stands with his hand (s) inserted through the sleeve (s) 36.

Complete isolation of the patient in the closed incubator chamber 10 is in itself a very helpful protection against infection, as well as against drafts. The uninterrupted closure of the chamber 10 is also helpful toward maintaining the most suitable temperature in the chamber, and avoiding undesirable changes of temperature. For warmth, there is an (electric) heater 49, here shown as associated with a conduit 50 for supplying air or respiratory gas to the chamber 10. The operation of the heater 49 may be automatically controlled and regulated by a thermostatic device 51 located at a suitable point in the chamber 10, so as to respond to the atmospheric temperature affecting the patient. As shown in Figs. I and II, the thermostat 51 is mounted on the end wall of the chamber 10 beneath the air lock 42, but well above the bed 25, alongside a protective foraminous metal grillage 52 surrounding the open discharge end of the air supply conduit 50 and the air heater 49,—said heater 49 being in this instance located within the chamber 10 itself, and wound on or around the upper end of the conduit 50. The thermostat 51 and the heater 49 serve to maintain a substantially constant and uniform temperature in the incubator chamber 10, regardless of outside variations. Located as shown, the thermostat 51 is easily reached through one of the sleeves 36, for the purpose of setting it to maintain the exact temperature desired from time to time.

In the case of the prematurely born, fairly high temperatures are desirable for the air breathed, as well as for the general environment: e. g., some 85–90° F., for example. The isolation of the incubator chamber 10 and the effective control and uniformity of the temperature therein afford the further advantage that clothing can be gradually reduced, and even discarded altogether after a baby has become accustomed to the incubator: e. g., a shirt and diaper are quite sufficient clothing. This not only simplifies the care of the baby without opening the incubator, and facilitates examining him in any and every way, but allows him freedom of exercise, as well as skin ventilation.

Besides temperature, another condition or characteristic of incubator atmosphere which it is highly desirable to control and regulate is the humidity; and as the most advantageous way of doing this, I provide for humidifying the air or respiratory gas supplied to the chamber 10, preferably under the automatic control of a humidostatic device 53 suitably located in the chamber to respond to the humidity there. As shown in Figs. I and II, the humidostat 53 is mounted on the end wall of the chamber 10 adjacent the thermostat 51, well above the bed 25. It is also desirable to purify the respiratory gas supplied to the chamber 10 by filtering or other means, so as to exclude dust and dirt from the chamber. To facilitate the humidifying, heating or cooling, and purifying treatment of the air or gas, I have in this instance provided a recirculatory system of air or gas circulation and conditioning, confined to the chamber 10 and to a closed external circuit, with provisions for introducing any desired amounts of fresh outside air or other gas into the system, and for compensatively venting air or gas from the system, to relieve the pressure that would otherwise tend to build up in the chamber 10.

As shown in Fig. II, the gas supply pipe 50 already mentioned extends from the incubator chamber 10 down into the lower compartment 12, where the treating and circulating equipment of the system is located, as well as some of the control provisions. For withdrawing the air or gas from the chamber 10, an outlet or return conduit 54 extends from the chamber 10 down into the compartment 12. The return conduit 54 may be at the same end of chamber 10 as the supply conduit 50, but its opening is preferably at a lower level than that of conduit 50, though higher than bed 25. The air or gas supplied through conduit 50 rises through the heater 49 at once to the top of the chamber 10 and flows to the other end thereof, where it descends and returns to conduit 54, by reason of the suction therethrough, all as shown by the arrows in Fig. II. Some silk threads 55' hanging in the upper left hand corner of chamber 10, over supply pipe 50, show when the circulation is working properly. Thus the circulation in the chamber 10 is substantially or mainly confined to its upper portion, above the bed 25, leaving the patient on the bed out of the principal path of air flow. As shown, the open upper end of conduit 54 is cut off diagonally, to minimize the possibility of blockage by accidental coverage of the same. At the opposite end of the chamber 10, preferably, from the supply and outlet conduits 50, 54, there is a pressure-relieving air or gas vent pipe 55, extending from the chamber bottom 14 (below the openings of the pipes 50, 54) downward (about 2 ft.) through the compartment 12 and beneath the floor of the latter, where its end is open. A foraminous tubular hood or screen 56 is shown over the open upper end of this pipe 55, to prevent dirt or lint from getting into it and clogging it up. The temperature in the closed chamber 10 makes inflow of air through pipe 55 impossible, being normally higher than the outside temperature. The fact that the vent pipe 55 opens from the chamber bottom below the path of circulation therein assures gradual removal and replacement of the stagnant air in the bottom of the chamber.

The circulating and conditioning equipment in compartment 12 includes (Figs. II and VIII) a receiving, mixing, and filtering chamber in a casing 60; a (centrifugal) blower 61, directly driven by an (electric) motor 62, and preferably of a silent type; and a humidifier in a tank or casing 63, which may serve to wash the air or respiratory gas more or less. Into one end of the chamber 60 are connected the return conduit 54 from the incubator chamber 10 and a valved supply fitting 64, serving for the attachment of a flexible hose 65 leading out of doors, or to any suitable source of pure, fresh air. Another valved supply fitting 66 is shown connected into the same end of the chamber 60, for the attachment of a hose connection (not shown) admitting oxygen or other respiratory gas which it may be desired to mix with that returning through the conduit 54. Into the opposite end of the chamber 60 is connected the (axial) intake of the (centrifugal) blower 61, whose (peripheral) discharge delivers into the upper part of the closed casing or tank of the humidifier 63 at one end. A valve-cock 68 is shown on the blower casing, for taking samples of the incubator atmosphere for test or analysis. At an intermediate point between the connections 54, 64, and 66 and the blower 61, one or more air or gas filtering diaphragms 69 extend entirely

across the interior of the chamber 60. As indicated in Fig. VIII, one side 70 of the chamber or casing 60 is readily removable, to allow inspection or renewal of the filters 69.

As shown in Fig. VIII, a valved exhaust line 71 (leading out of doors) may be connected to the return conduit 54, with suitable dampers or valves, to allow of exhausting the gas from the chamber 10, instead of recirculating it.

As shown in Figs. II and VIII, the air or gas supply conduit 50 is connected into the upper portion of the humidifier tank 63 at the opposite end from the blower 61, so that the air or gas from the blower passes through the tank from end to end, in contact with the body of water in its lower portion. If desired, one or more baffles 72, 72 may extend down from the tank top close to the surface of the water,—and may even dip into the water, if its level is higher than shown in Fig. III,—to compel intimate contact of the air or gas with the water, so as to be cleansed or washed thereby. Immersed in the water in the humidifier tank 63 is shown an (electric) heater 73 for heating and vaporizing the water,—and even boiling it vigorously, if need be,—so as to humidify the air to any degree desired, up to complete saturation. Obviously, the control and regulation of this heater 73 by the humidostat 53 will determine the percentage humidity in the chamber 10.

To assure a substantially constant surface exposure of water to the air in the humidifier 63, it suffices to maintain a substantially constant amount and level of the water. As one way of doing this, water may be supplied to the humidifier tank through a pipe connection 75 from a supply apparatus 76 (resembling a common form of water cooler) comprising a vessel in whose open top sits an inverted bottle 77, so that the level in the tank corresponds to the vertical position of the bottle-mouth. Distilled or boiled water is to be preferred for the humidifier 63.

As shown in Fig. II, the compartment 12 contains a control-panel 78 carrying various electrical parts and mechanisms, hereinafter set forth. There is also an electric lamp 79 mounted on the floor of the compartment 12, in position to facilitate inspection of the water supply at 77, the control-panel 78, or the filter 69, as well as the making of hose connections to the fittings 64, 66, or the adjustment of their valves to regulate the supplies of air or gas through them.

In hot weather, cooling rather than heating may be required to maintain desired living temperatures of the respiratory gas in the incubator chamber 10. This may be effected anywhere in the circulatory system of the incubator; and one simple way is to do it in the chamber 10 itself. For this purpose, Fig. VII shows the chamber 10 with its usual (thermo-insulative) rear wall panel and its frame 23 removed, and replaced by a cooling wall 80 attached to the incubator by the screws 24 that usually serve to secure the panel frame. As shown, this wall 80 comprises a (thermo-insulated) metal tank with a hinged lid 82, which may contain any suitable cooling medium, such as a body of water, brine, or other liquid, itself kept cool (for example) by pieces 83 of ordinary ice (or dry ice) immersed in the liquid. The cooling effect may be augmented by providing the cooling wall 80 with heat-absorbing means projecting into the chamber 10, such for example as metal tubes 85 having their upper and lower ends secured in the tank wall, so that the cooling liquid in the tank may circulate through them.

Whatever its character and arrangement, the cooling means employed should, of course, be capable of cooling the respiratory gas sufficiently to maintain the desired living temperature in the chamber 10 under all conditions,—even when the external temperature reaches the extreme possible limit of excess. When this is the case, variations of the excessive external temperature will always be compensated for automatically by the heater 49 and the thermostat 51: e. g., if the wall 80 tends to overcool the atmosphere in the chamber 10, the heater 49 will operate enough to maintain the desired constant temperature there, notwithstanding any variations of the excessive external temperature,—just as if the entire surroundings of the incubator were over-cool, rather than overhot.

Fig. IX illustrates one suitable scheme of electrical connections for the incubator, whose main operating electric circuit 90 may be supplied with current (through a flexible cord, not shown) from any suitable A. C. or D. C. source,—such as an ordinary 110–120 volt house lighting circuit (not shown).

As shown in Fig. IX, the main operating circuit 90 is connected to the aforesaid flexible cord (not shown) through a normally closed control switch 91, located in any convenient position on the incubator cabinet 11. Directly across the main incubator circuit 90 are connected the lamps 34 and 79 and the motor 62 that drives the blower 61; so that circulation of respiratory gas through the incubator chamber 10 is assured whenever current is on, and any failure of current supply is obvious at a glance. In parallel across the main circuit 90 are connected supply circuits 92, 93, for the respiratory gas heater 49 and the humidifier water heater 73, controlled by thermostat 51 and humidostat 53, respectively. As shown, the circuits 92, 93 include relay switches 94, 95 which close when their operating coils are energized from control circuits 96, 97 that are connected across the supply circuits 92, 93, and include thermostat 51 and humidostat 53, besides current-limiting resistances 98, 99. Thermostat 51 and humidostat 53 may be of any commercial types that will open the circuits 96, 97 when the temperature and humidity rise to the limits for which they are set, and vice-versa. By reaching through a sleeve 36, they may be set and reset to maintain any temperature and percentage humidity that may be desired from time to time, within a range of deviation not exceeding 1° F. and 5% of saturation.

As a protection against any possible failure of the switches 94, 95 to open when required, or against excessive temperature in the incubator chamber 10 arising from any cause, a safety thermostatic device 100 is shown in Figs. I and II, (and IX), mounted on the end wall of the chamber between thermostat 51 and humidostat 53. This safety device 100 may be set to operate at about 99° F., or at any other temperature above the desired range, but not dangerous to the patient; but it is preferably not resettable by an attendant through a sleeve 36. It may preferably open the main circuit 90 through a relay switch 101 interposed therein at such a point as to shut off current from both circuits 92, 93, while leaving motor 62 (and lamps 34, 79) still in operation. As shown in Fig. IX, safety thermostat 100 is itself in a control circuit 102 con-

nected across the main circuit 90 and including the operating coil of relay switch 101, as well as a current-limiting resistance 103. An alarm-circuit 104 is shown connected across the main circuit 90, and including an audible alarm bell 105 and a (red) light 106 connected in parallel therein, as well as contact 107 arranged to be closed by the relay switch 101 when it drops open, and a control switch 108 of its own. The safety thermostat 100 may be of any commercial type that operates to open its circuit 102 when the temperature rises to the limit for which it is set, and (preferably) requires to be manually closed after each operation. Or, if preferred, the relay switch 101 may be such as to require manual resetting after each operation.

The dot-and-dash outline of the control panel 78 in Fig. IX includes those features of the electrical system which may ordinarily be mounted on this panel in practice.

The use and operation of the incubator and its circulating and conditioning system will for the most part be apparent from what has already been said. Aided by cooling from a wall tank 80 in hot weather, the system is capable of automatically maintaining in the chamber 10 an atmosphere whose essential characteristics of temperature and humidity are definitely determined and kept constant,—its purity being assured by filtering and by admixture of outside air. The fresh air or the recirculated air (or both) may be exposed to ultra-violet light to sterilize the air completely. The exact composition of the incubator atmosphere can be controlled as desired by supplying oxygen or other gas at 66 and by suitably adjusting the valves at 64, 66. If desired, valve 64 can be closed, and the whole system (including chamber 10) may be charged and operated exclusively with special mixtures of gases, supplied for replenishment at 66. Or, by closing both the valves at 64, 66, the gas in the system may be recirculated indefinitely, without substantial addition or loss. Under these circumstances, chemicals for absorbing carbon dioxide, odors, or excess water vapor may be introduced into the circulatory system where most convenient.

Having thus described my invention, I claim:

1. The combination of a closed incubator chamber, with a transparent window at its front, for containing an atmosphere of respiratory gas of determinate characteristics, to be breathed by a patient in the chamber; a rest and weighing scales for the patient in the lower part of the chamber, beneath said window; and flexible sleeves attached to the front chamber wall around arm openings therein and permitting an attendant to insert his hands into the chamber and move them around therein, so as to attend to a patient on the bed while observing him through the window, and to weigh him on the scales, all without substantial influx or escape of air or gas.

2. The combination of a closed incubator chamber, for containing an atmosphere of respiratory gas of determinate characteristics to be breathed by a patient in the chamber; a flexible sleeve attached to the chamber wall around an arm opening therein for permitting the hand and arm of an attendant to be inserted into the incubator chamber and moved about therein without material influx or escape of air or gas; and an air lock for passing articles into the incubator chamber into reach of the attendant's hand inserted into the chamber through said sleeve, and including means for excluding from the lock the respiratory gas and the outside air.

3. In an incubator of the character described, the combination of a closed incubator chamber, with a transparent window at its front, for containing an atmosphere of respiratory gas of determinate characteristics to be breathed by an infant in the chamber; flexible sleeves attached to the front chamber wall around arm openings therein and permitting an attendant to insert his hands into the chamber and move them around therein; and an air lock for passing articles into and out of the incubator chamber comprising a lock chamber in one end of the incubator chamber, accessible to an attendant's hand inserted into the incubator chamber through one of said sleeves, with an inside closure for excluding respiratory gas from the lock chamber, and an outside closure for excluding outside air therefrom located within reach of a hand of the attendant while observing the infant through the window and reaching the air lock with his other hand inserted through one of said sleeves.

4. In an incubator of the character described, the combination of a closed incubator chamber, with a transparent window at its front, for containing an atmosphere of respiratory gas of determinate characteristics to be breathed by an infant in the chamber; a bed in the lower front part of the chamber, beneath said window; weighing scales in the chamber, behind said bed; and flexible sleeves attached to the front chamber wall around arm openings therein and permitting an attendant to insert his hands into the chamber and move them around therein, so as to attend to an infant on the bed while observing him through the window, and to shift the infant from the bed to the scales and weigh him on the latter, all without substantial influx or escape of air or gas.

5. In an incubator of the character described, the combination of a closed incubator chamber, for containing therein an atmosphere of respiratory gas of determinate characteristics to be breathed by an infant in the chamber; a flexible sleeve attached to the chamber wall around an arm opening therein for permitting the hand and arm of an attendant to be inserted into the incubator chamber and moved about therein without material influx or escape of air or gas; and an air lock, for passing articles into and out of the incubator chamber, accessible to the attendant's hand inserted into the chamber through said sleeve, and including both a closure for excluding the respiratory gas from the lock chamber and a closure for excluding therefrom the outside air.

6. In an incubator of the character described, the combination of a closed incubator chamber, and means for circulating respiratory gas therethrough; a humidifier and a heater for the gas thus supplied to said chamber, both including means whereby heat is supplied to the gas; an electric circuit for supplying energy to activate said circulating means, said humidifier, and said gas heater; means responsive to the humidity and the temperature in said chamber for controlling the activation of said humidifier and said gas heater from said electric circuit, without affecting that of said circulating means; and means independently responsive to excessive temperature in said chamber for cutting off both said humidifier and said gas heater from said

circuit, while leaving said circulating means connected thereto.

7. In an incubator of the character described, the combination of a closed incubator chamber, and means for circulating respiratory gas therethrough; a humidifier for the gas thus supplied to said chamber, with means for heating and vaporizing water therefor; a heater for heating said gas; means responsive to the humidity and temperature in said chamber for controlling the heating of the water and the gas, respectively, by the corresponding means aforesaid, without affecting the operation of said gas circulating means; and means independently responsive to excessive temperature in said chamber for rendering both said water heating means and said gas heater inactive, also without affecting the operation of said gas circulating means.

8. An incubator of the character described comprising a unitary upright cabinet with an impermeable dividing floor defining in the cabinet a substantially closed upper incubator compartment and a separate lower machinery compartment; a bed on said floor, in the lower portion of said upper compartment; conditioning means in said lower compartment, including a gas-humidifier; a gas-supply conduit extending from said lower compartment up into said upper compartment, and discharging in its upper portion, substantially above a patient on the bed, and a return conduit drawing from a level in said upper compartment substantially above a patient on the bed and extending down into said lower compartment, so that the patient on the bed is left clear of any draft due to the circulation, and mechanical air circulating means in said lower compartment, beneath said floor, for drawing respiratory gas from said incubator compartment down through said return conduit and passing it through said humidifier and back through said gas-supply conduit into said incubator chamber.

9. In an incubator of the character described, the combination of an incubator chamber; means for supplying to said chamber respiratory gas conditioned as to moisture; means for heating the respiratory gas; regulating means responsive to the temperature in said chamber for controlling the operation of said heating means; and a cooling tank mounted on the chamber wall and provided with heat absorbing means extending through the wall into the chamber and capable of cooling the atmosphere in the chamber sufficiently to maintain a desired temperature therein, even when the external temperature is excessive; so that by the cooperation of said heating and regulating means with said cooling means, a substantially constant desired temperature and humidity may be maintained in the chamber, notwithstanding variations of the excessive external temperature.

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