April 28, 1942. J. I. TAGGART 2,281,339

INCUBATOR

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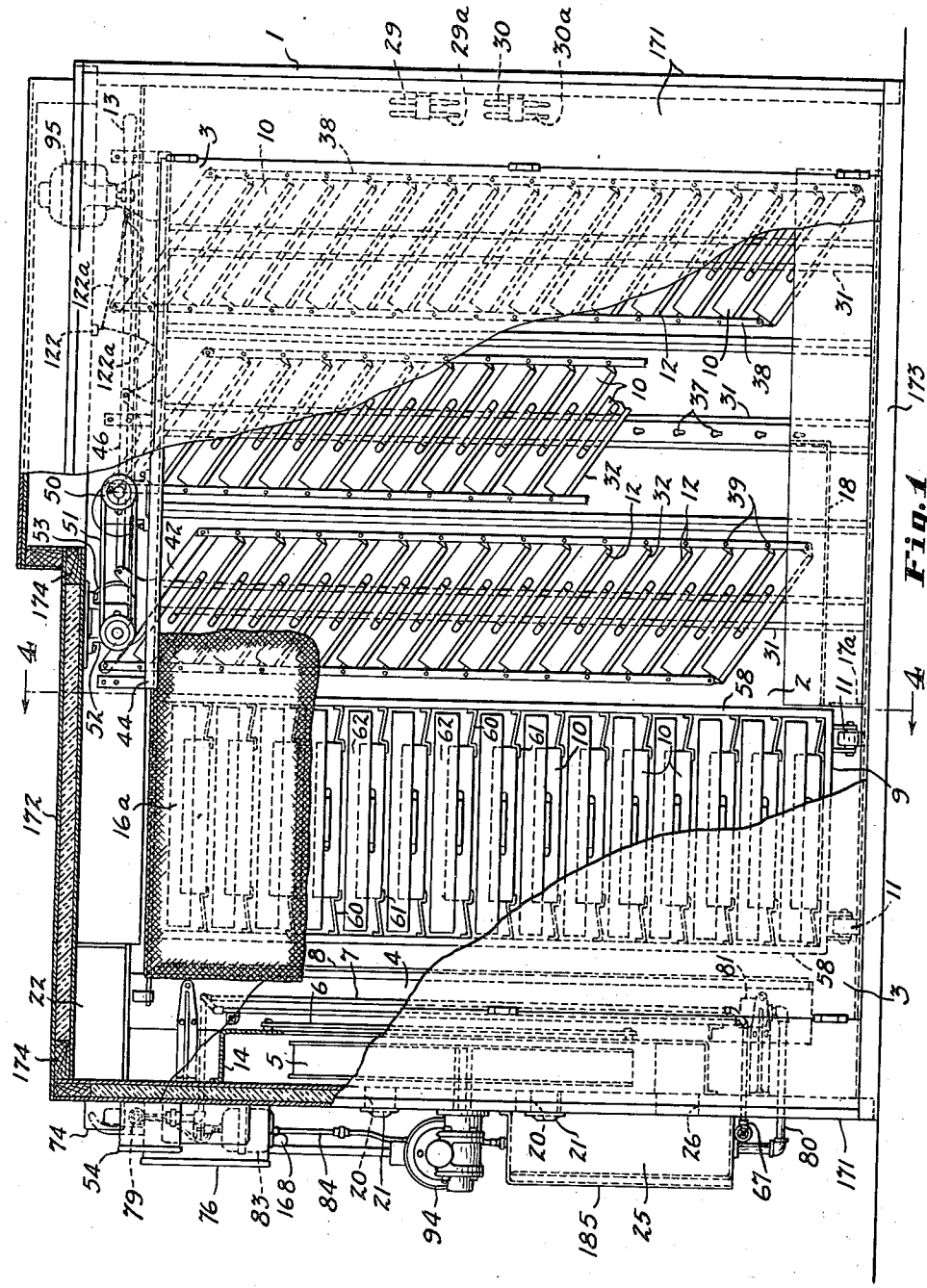


Fig. 1

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INCUBATOR

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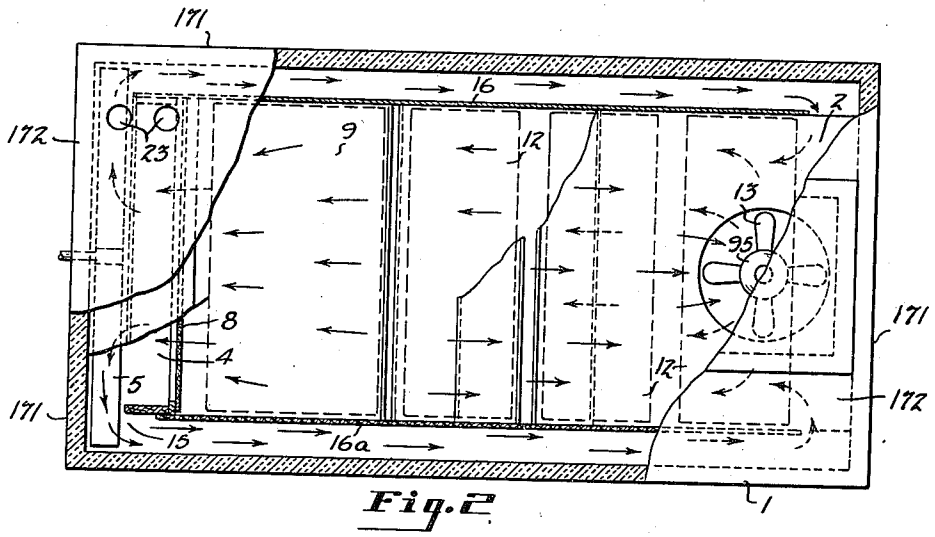


Fig. 2

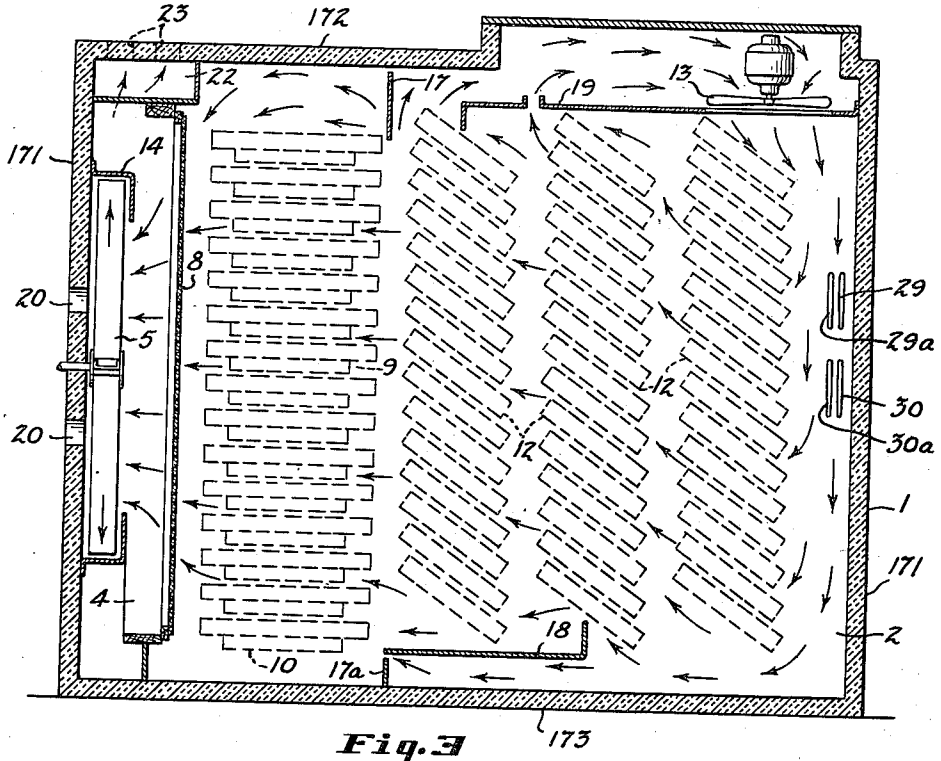


Fig. 3

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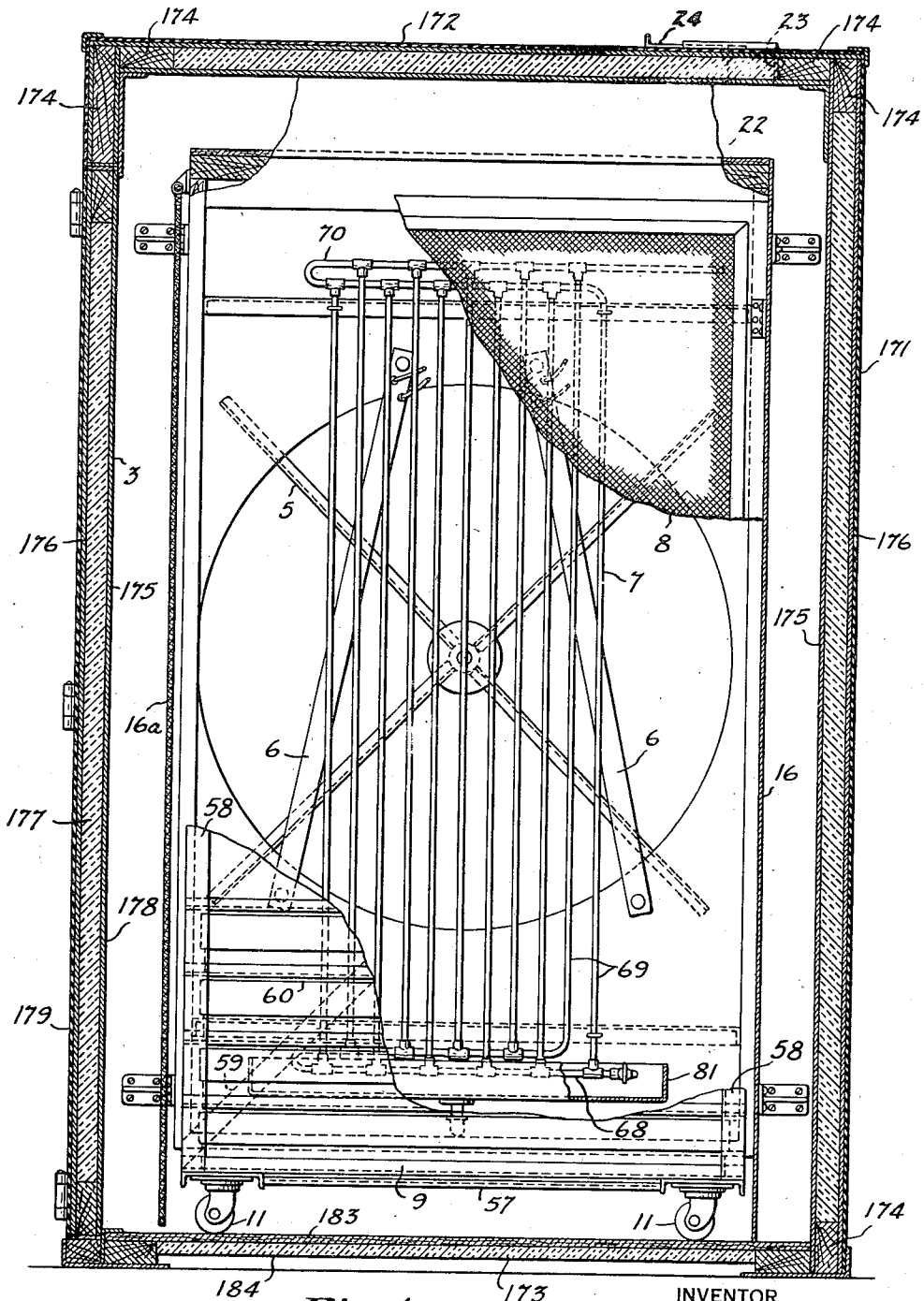


Fig. 4

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INCUBATOR

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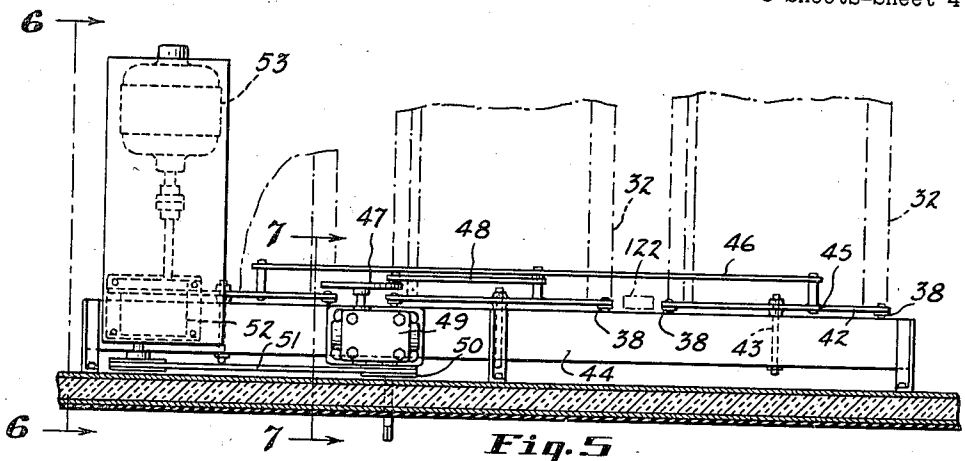


Fig. 5

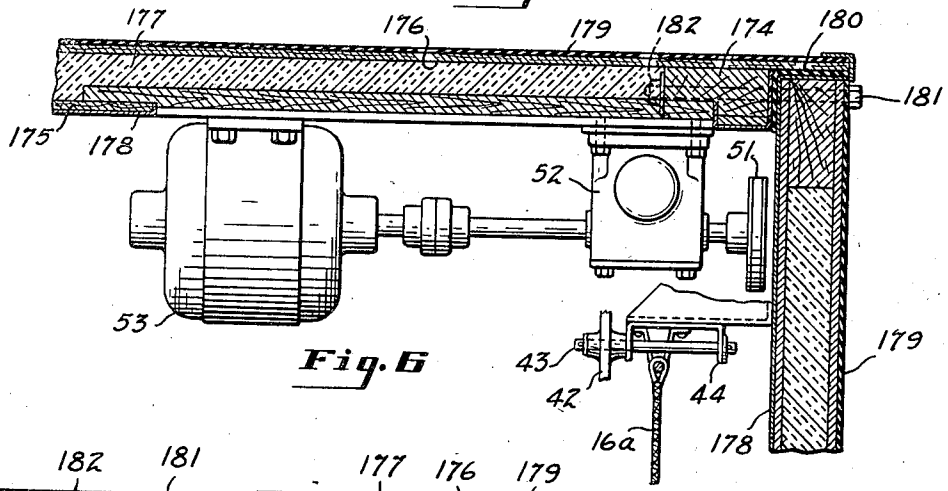


Fig. 6

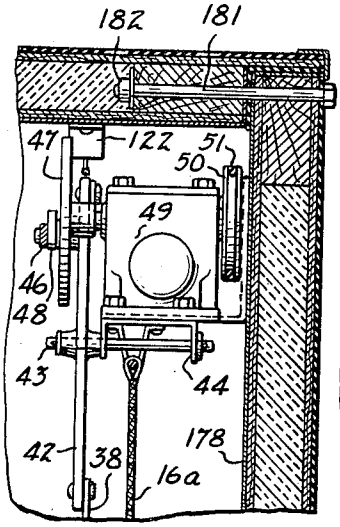


Fig. 7

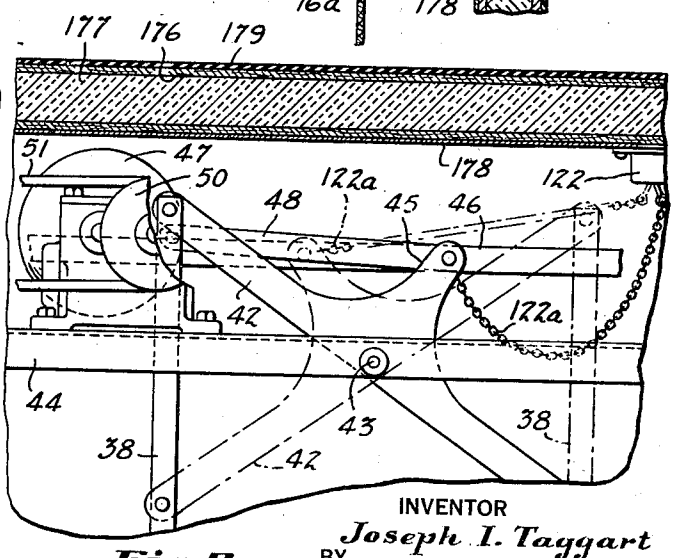


Fig. 8

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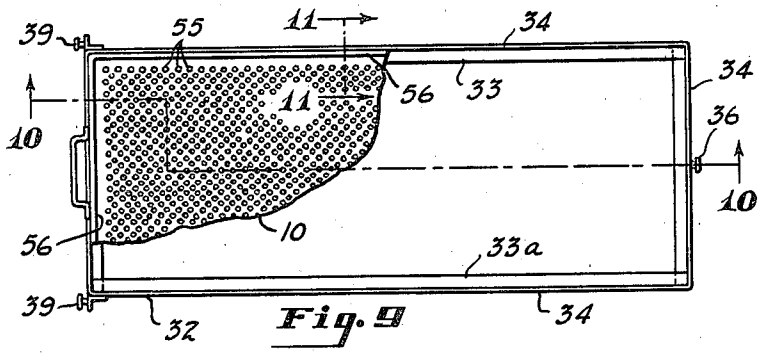


Fig. 9

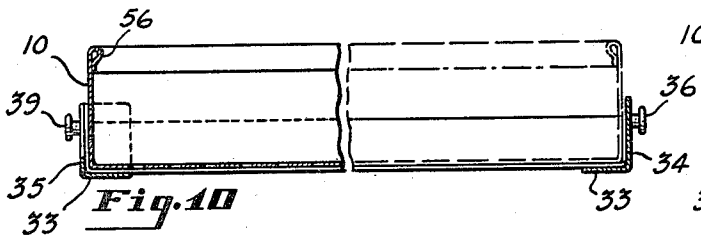


Fig. 10

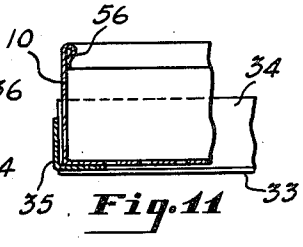


Fig. 11

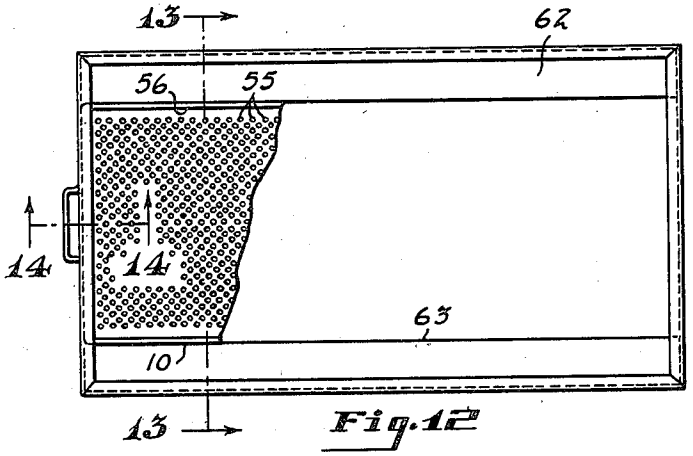


Fig. 12

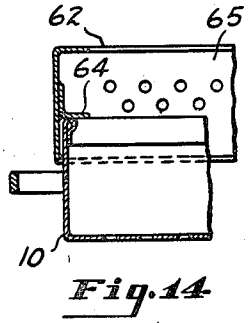


Fig. 14

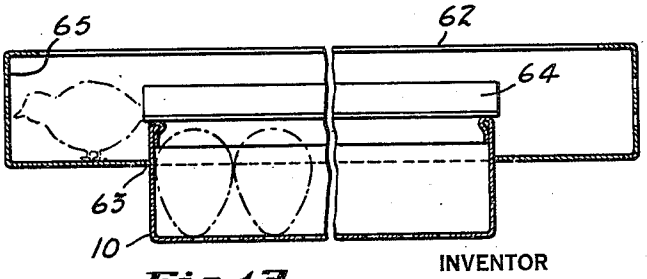


Fig. 13

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INCUBATOR

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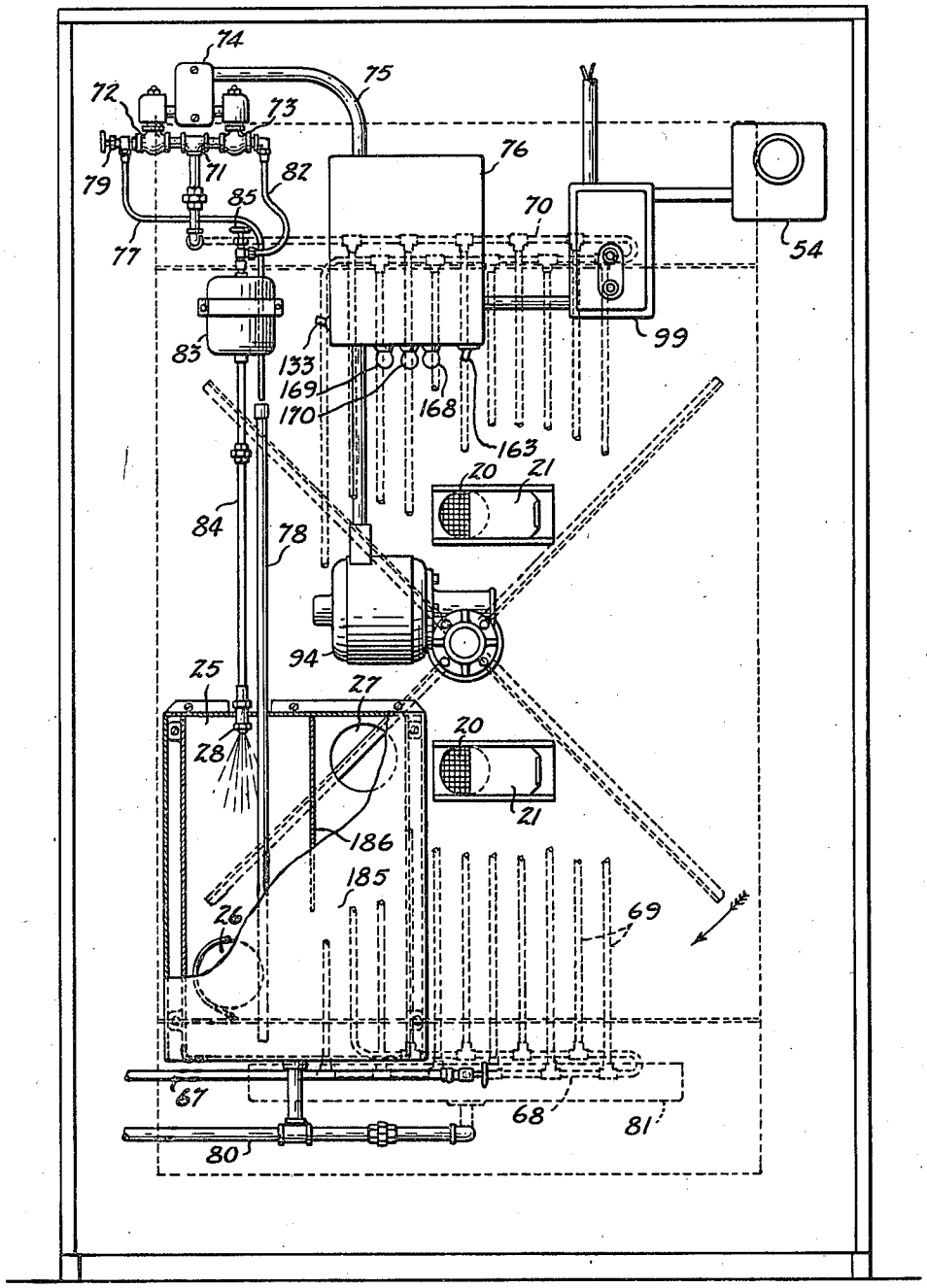


Fig. 15

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INCUBATOR

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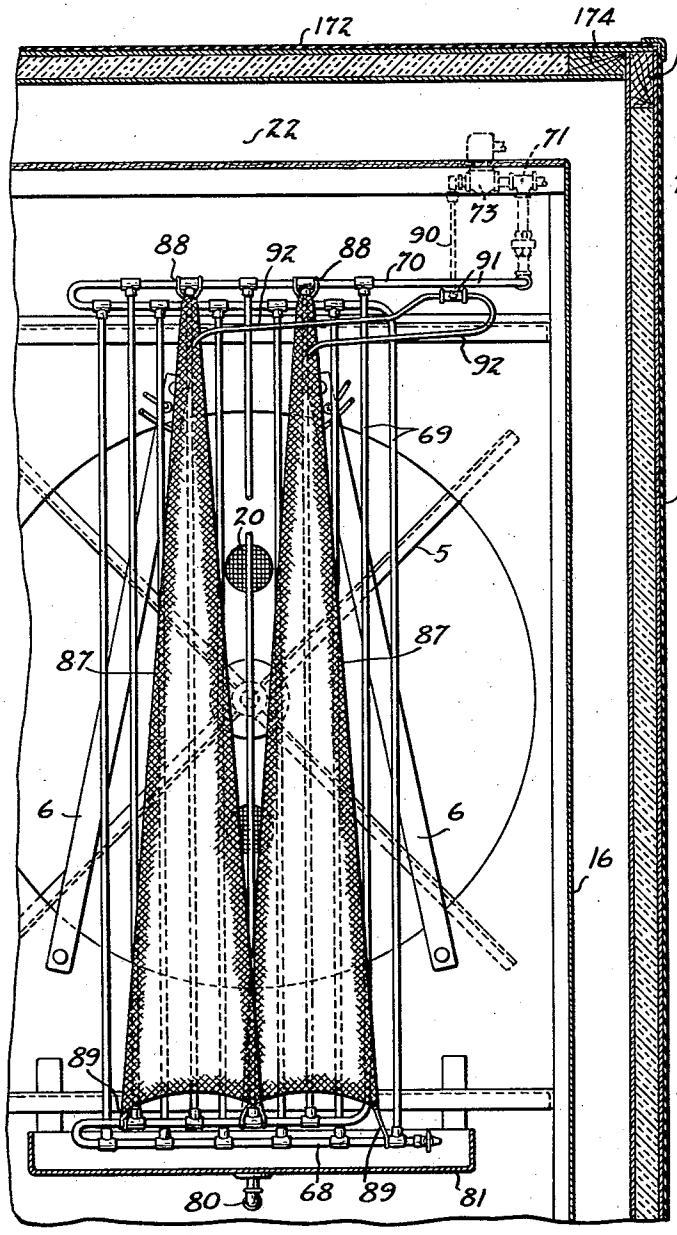


Fig. 17

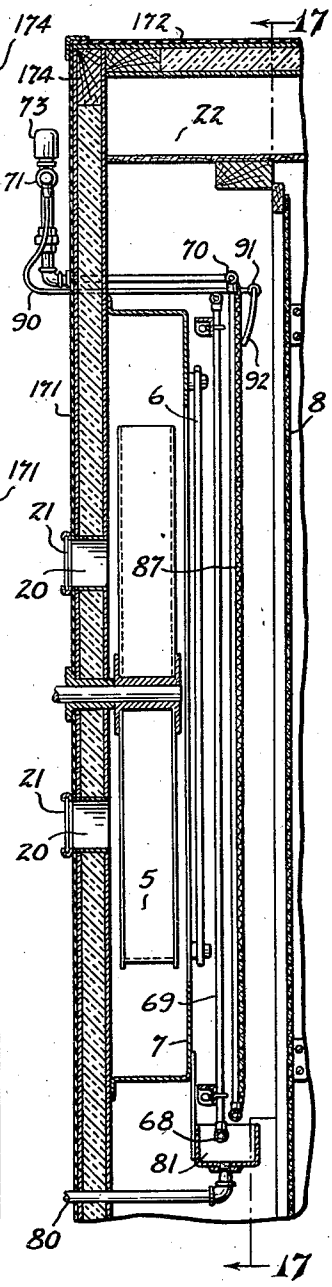


Fig. 16

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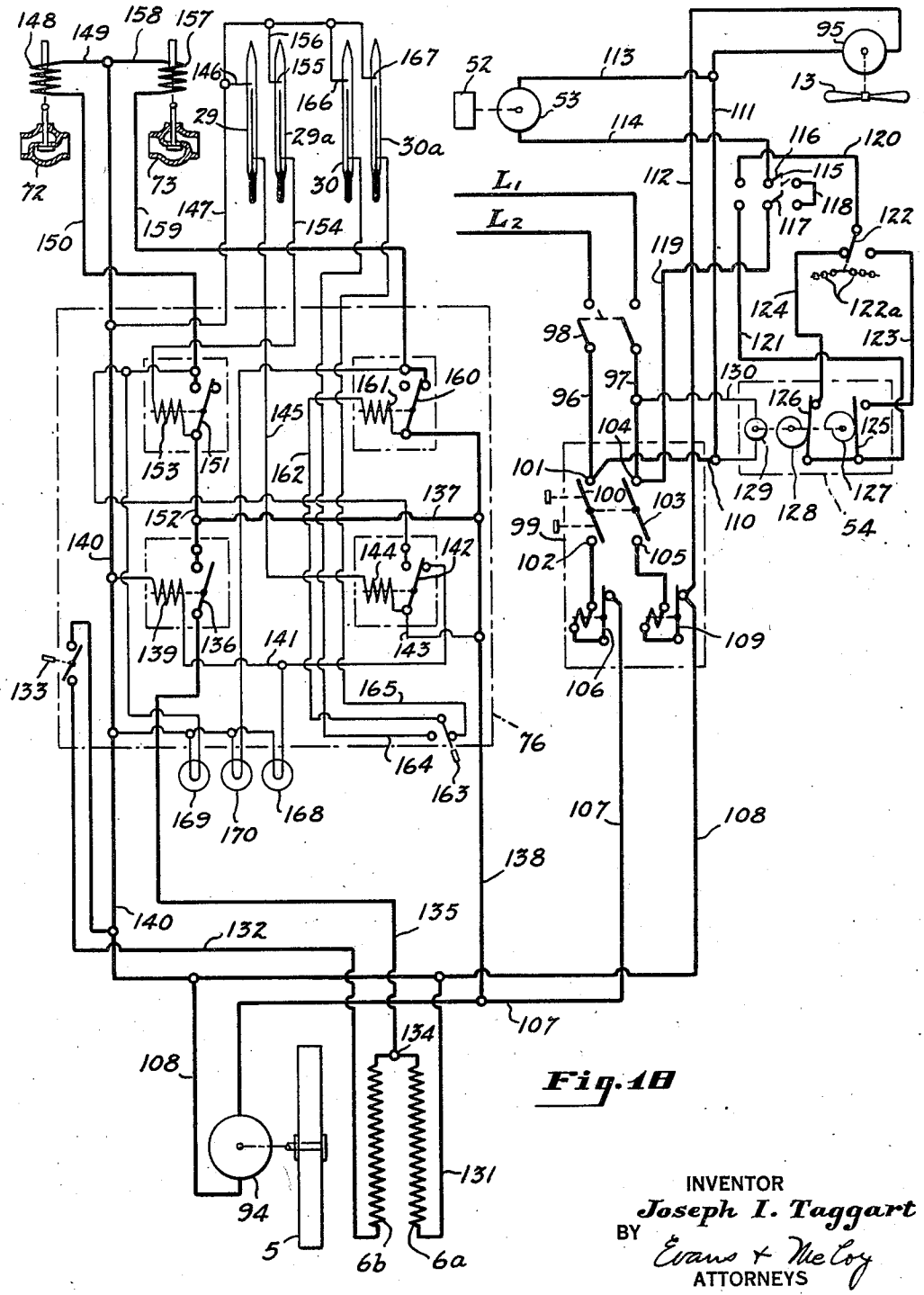


Fig. 18

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Patented Apr. 28, 1942 2,281,339

UNITED STATES PATENT OFFICE

2,281,339

INCUBATOR

Joseph I. Taggart, Cleveland, Ohio

Application August 2, 1940, Serial No. 349,478

18 Claims. (Cl. 119—37)

This invention relates to an incubator for hatching eggs of domestic fowls, and more particularly to incubators of the staged incubation type in which the egg tray racks may contain eggs in various stages of incubation.

The present invention provides an incubator so designed that the eggs may remain in the trays in which they are originally packed throughout the entire incubating process, in which incubating racks are provided for supporting the eggs throughout the major portion of the incubation period, and a single hatching rack is provided for supporting the trays of eggs during the final hatching period, the supporting racks being so constructed and arranged that the trays may be quickly and easily transferred from the incubating rack to the hatching rack.

One object of the present invention is to provide air circulating means of such a character that a comfortable and healthy atmosphere is provided for the chicks after they are hatched.

A further object of the invention is to provide means for completely and instantaneously removing from the air the down produced by the chicks during the hatching process.

A further object of the invention is to provide adequate space for the chicks in the hatching rack.

A further object is to provide improved means for accurately regulating the temperature and humidity of the air and for maintaining the temperature and humidity conditions uniform throughout the incubating chamber.

A further object of the invention is to so combine manual operable regulating devices with the automatic temperature and humidity controlling devices that a considerable saving in the consumption of electric current may be obtained.

With the above and other objects in view, the invention may be said to comprise the device as illustrated in the accompanying drawings hereinafter described and particularly set forth in the appended claims, together with such variations and modifications thereof as will be apparent to one skilled in the art to which the invention pertains.

Reference should be had to the accompanying drawings forming a part of this specification, in which:

Figure 1 is a front elevation of an incubator embodying the invention, with portions of the front wall broken away to show the incubating and hatching racks;

Fig. 2 is a diagrammatic plan view showing the manner in which the air is circulated through the incubator;

Fig. 3 is a longitudinal, vertical section showing the paths of air flow;

Fig. 4 is a section taken on the line indicated at 4—4 in Fig. 1;

Fig. 5 is a fragmentary plan view showing the tray tilting mechanism;

Fig. 6 is a fragmentary section on an enlarged scale taken on the line indicated at 6—6 in Fig. 5;

Fig. 7 is a fragmentary section on an enlarged scale taken on the line 7—7 in Fig. 5;

Fig. 8 is a fragmentary side elevation showing a portion of the tray rocking mechanism on an enlarged scale;

Fig. 9 is a top plan view of one of the rockable tray supports with an egg tray therein;

Fig. 10 is a section taken on the line indicated at 10—10 in Fig. 9;

Fig. 11 is a section taken on the line indicated at 11—11 in Fig. 9;

Fig. 12 is a top plan view of an egg tray with a chick guard placed thereon;

Fig. 13 is a section taken on the line indicated at 13—13 in Fig. 12;

Fig. 14 is a section taken on the line indicated at 14—14 in Fig. 12;

Fig. 15 is an end elevation looking toward the air conditioning chamber and showing the air cooling and humidifying device;

Fig. 16 is a transverse vertical section through the air conditioning chamber showing a modified form of humidifying device;

Fig. 17 is a section taken on the line 17—17 in Fig. 16; and

Fig. 18 is a wiring diagram showing the circuits controlling the fan and rack tilting motors and the heating, cooling and humidifying devices.

In the accompanying drawings there is shown an incubator cabinet 1 having a single main compartment or chamber 2 and a front wall having double doors 3, through which access may be had to the interior of the cabinet. The cabinet is provided with an air conditioning compartment or chamber 4 at one end thereof in which there is mounted a large centrifugal air fan 5. Within the chamber 4 a plurality of resistance heaters 6 are mounted, these heaters being in the form of elongated bars containing conductors in which heat is generated by resistance to the passage of an electric current. A cooling coil 7 is also mounted in the air conditioning chamber, this coil consisting of copper tubing through which water may be circulated to cool the air. The

inner wall of the air conditioning chamber 4 is formed by a diaphragm filter 8 which forms a partition between the main chamber 2 of the incubator and the air conditioning chamber, the filter 8 extending substantially the full height and width of the chamber 4 and thereby providing a filter of large capacity.

In the end of the compartment 2 adjacent the air conditioning chamber is mounted a hatching rack 9 which is constructed to provide a support for a series of superposed egg trays 10, the rack 9 being preferably a carriage mounted upon casters 11, so that it can be rolled out of the incubator cabinet to give access to the filter and other parts for cleaning. Within the compartment 2 and alongside the hatching rack 9 a plurality of incubating racks 12 are provided, each adapted to support the series of superposed trays 10. In the incubator illustrated in the accompanying drawings, the hatching rack 9 is adapted to support fifteen egg trays, and three incubating racks 12 are provided, each adapted to support fifteen trays. Eggs may be placed in the incubating racks at intervals and after a period of about nineteen days the eggs ready for hatching are transferred from the incubating racks to the hatching racks. In operating the incubator at full capacity fifteen trays of eggs would be placed in the incubating racks, preferably in every third support on each of the three racks to evenly distribute the eggs in the incubating racks. In about one week's time a second batch of fifteen trays would be placed in a similar manner in the incubating racks and after the lapse of a few days a third batch of fifteen trays is placed in the cabinet. After a period of about nineteen days after the first eggs were placed in the cabinet, the fifteen trays first placed in the cabinet are transferred to the hatching rack and the empty spaces in the incubating racks are filled with fresh eggs. After the two or three days required for hatching, the hatching rack can be wheeled out of the cabinet and the chicks removed.

Circulation of air through the incubating racks is effected by means of a fan 13 mounted in the upper portion of the chamber 2 at the end remote from the air conditioning chamber 4. The fan 13 creates a downward current of air from the top to the bottom of the chamber and this air flows back through and under the incubating racks and then upwardly to the ceiling where it is again drawn into the fan. The fan 5 at the end of the chamber creates a subatmospheric pressure in the air conditioning chamber 4 which draws some of the air from the body of air circulating in the chamber 2 through the hatching rack 9 and the filter 8. The fan 5 has a housing 14 which is provided with peripheral outlets 15 which discharge the air drawn from the air conditioning chamber 4 to the opposite sides of the chamber 2. Passages are provided along the front and back walls of the cabinet through which the air drawn from the circulating body of air within the chamber may be returned past the hatching rack 9 to the vertically circulating body of air in the chamber 2. The passages adjacent the walls of the cabinet are provided by partitions 16 and 16a along the front and back of the egg tray supporting racks. The partition 16a is in the form of a fabric curtain which permits ready access to the egg supporting racks. The suction created by the fan 5 will draw the curtain tightly against the ends of the egg trays 10. Additional air guiding means is provided by baffles 17 and 17a extending transversely across the chamber 2 adjacent the ceiling and floor immediately to the inner side of the hatching rack 9. These baffles serve to prevent passage of large volumes of air above or below the stack of egg trays in the hatching rack, so that air is drawn horizontally through the hatching rack and over and between the egg supporting trays. In order to properly direct the air currents produced by the fan 13 in the chamber 2, a horizontal baffle 18 is provided beneath the incubating racks 12, which serves to deflect the air stream upwardly through the egg trays supported by the incubating racks. A baffle 19 above the incubating racks and below the fan 13 controls the return of air to the fan 13. Two separate air circulating systems are thus provided, the fan 13 maintaining a constant circulation of the air vertically through the incubating racks and the fan 5 serving to draw a portion of the air from the body of air within the chamber 2 through the hatching rack and filter into the air conditioning chamber where it is heated, cooled or humidified as required and returned to the main chamber. If only the current created by the end fan 5 were used the eggs in the top trays would become too warm and the eggs in the bottom trays too cool. The current created by the ceiling fan 13 overcomes this tendency and insures a very uniform temperature throughout the egg racks.

Since some of the oxygen of the air is consumed by the eggs during the incubating process and carbon dioxide is given off by the eggs, it is desirable to revivify the air by replacing a portion thereof with fresh air from the atmosphere. The outer wall of the air conditioning chamber is provided adjacent the center of the fan with screened inlet apertures 20 controlled by slide valves 21. Immediately above the fan 5 there is a chamber 22 into which some of the air discharged peripherally by the fan passes, and this chamber has openings 23 through the top wall of the cabinet to the atmosphere, which openings may be regulated by slide valves 24. During operation of the fan 5, a certain amount of fresh air will be drawn through the inlet apertures 20 and air will also be discharged through the outlet openings 23. The rate at which air is drawn into and discharged from the cabinet may be regulated by adjusting the valves 21 and 24.

Since excessive evaporation of moisture from the eggs in undesirable, it is important that means be provided for maintaining a proper degree of humidity in the air circulating past the eggs in the incubator. Means is therefore provided for adding moisture to the air drawn through the fan 5. The humidifying device may be placed in a humidifying chamber 25 which forms a part of the air conditioning chamber. As herein shown, the humidifying chamber 25 is beyond the exterior of the end wall of the cabinet 1 and has apertures 26 and 27 opening to the chamber 4. The aperture 26 is adjacent the bottom of the chamber 4 and the aperture 27 is adjacent the center of the fan 5, so that the suction of the fan draws air through the inlet aperture 26 into the chamber 25 and through the outlet aperture 27 to the fan. The air moistening means within the chamber 25 consists of a spray nozzle 28 which is connected to a suitable source of water under pressure and delivers water in the form of a fine spray into the humidifying chamber.

The control of the heaters 6, the cooling coil

7, and the spray nozzle 28 is preferably automatic, flow of current to the heaters 6 being controlled by a thermostat 29 in the chamber 2, and the flow of water through the cooling coil 7 being controlled by a thermostat 29a in the chamber 2. The spray 28 may be controlled by either of two humidostats 30 and 30a in the chamber 2. The thermostats 29 and 29a and the humidostats 30 and 30a are preferably positioned on the end wall of the cabinet 1 beneath the fan 13 so that they are controlled wholly by the main body of air circulating through the incubating racks. By so placing the control elements they are bathed with the air that is drawn from the egg trays rather than air that has just come from the air conditioning chamber so that a very accurate control of the temperature and humidity of the air surrounding the eggs is obtained.

The air circulating device of the present invention maintains a continuous flow of air through the trays and between the eggs in the trays supported in the incubating racks, providing for effective transfer of heat from the air to the eggs in the initial stages of incubation and from the eggs to the air in later stages of incubation, thus maintaining the temperature of the eggs throughout the incubating racks at a substantially constant temperature. During the hatching period, the eggs can advantageously have a temperature slightly higher than during the incubating stages.

In the device of the present invention the circulation through the hatching rack is horizontal across the trays and there is less flow of air between the eggs in the trays than in the incubating racks but the flow is rapid enough to prevent the eggs from becoming too warm. The advantage of the slower circulation is in the effect it has on the chicks that are emerging from the shell. The slower air movement reduces the evaporation from the wet feathers which cover the chick, thus cooling it to a lesser degree. The air flowing horizontally between the superimposed trays in the hatching rack is, however, effective to cool the chicks to a proper temperature after they are hatched. In this stage their body temperature normally is one to three degrees higher than the incubator temperature.

When the baby chicks emerge from their shells each baby feather is covered with a horny sheath which sloughs off as the chick dries. Under a microscope these sheaths resemble crushed straws. They are light enough to be picked up by the air streams and this action of the air reduces them to powder. By the time they emerge from the shells and become thoroughly dry, a thousand chicks will shed more than a quart of this material, which is popularly referred to as "down."

This down has always been recognized as a nuisance and as a means of spreading disease among the chicks. While many attempts have been made to extract this down from the air, the problem has never been successfully solved prior to the present invention. By restricting the flow of air through the hatching rack to a flow in a horizontal direction directly from the chicks to the diaphragm filter 8, the down as it is shed by the chicks is picked up by the air stream and carried directly to the filter 8, which extends substantially the full height and width of the hatching rack and has a capacity sufficient to collect the down given off by the chicks when the hatching rack is filled to capacity. The collection of down upon the filter 8 has the effect of slowing the flow of air through the filter during the latter portion of the hatching stage, but it is not sufficient to entirely interrupt the flow of air over the chicks and the maintenance of a pure atmosphere in chick compartments. The slowing of the current through the end fan 5 extends the vertical circulation of air in the chamber 2 closer to the hatching racks but the retarding effect is not sufficient to cause the down to become mixed with the air circulated by the fan 13 or to interfere with the regulation of the temperature and humidity of the air. The down collected upon the filter 8 can be quickly and easily removed from the surface of the diaphragm filter 8 by means of a vacuum cleaner nozzle after the hatching rack has been removed from the cabinet. A sufficient space is preferably provided between the hatching rack and the filter to enable a vacuum cleaner nozzle to be run over the filter 8 without removing the hatching rack from the cabinet if it becomes desirable at any time to clear the filter before completion of the hatching operation.

Incubating racks

As shown in Figs. 1 and 5 to 8, inclusive, each incubating rack 12 has a rear supporting post 31 and a series of superposed tray supporting frames 32, each of rectangular form and composed of angle bars joined together at the corners of the frame. Each frame 32 has horizontal, inwardly projecting, tray supporting flanges 33 and vertical, retaining flanges 34. At the front end of each suporting frame a low, vertical flange 35 is provided which serves to hold the egg tray 10 in place, but which permits the egg tray to be easily inserted into or removed from the supporting frame. Each frame 32 has a central trunnion 36 at its rear end which is adapted to be inserted into one of a vertical row of keyhole slots 37 formed in each of the posts 31. Vertical supporting links 38 are connected to the front corners of the supporting frames 32 by means of pivots 39. The two parallel links 38 of each frame are pivoted at their upper ends to opposite ends of a rocking lever 42 which is connected midway between its ends by a pivot 43 to a horizontal supporting bar 44 attached to the front wall of the cabinet 1 above the doors 3. Each rocking lever 42 has a central, upwardly projecting arm 45 and the arms 45 of the levers are pivoted to a horizontal connecting bar 46. The bar 46 may be moved back and forth in an endwise direction by means of a crank 47 which has a connecting rod 48 extending therefrom to one of the lever arms 45. The crank 47 is driven through reduction gearing in a gear box 49 from a pulley 50, which is driven by a bell 51, which is driven through a second gear reduction in a box 52 by an electric motor 53. The reduction from the motor 53 to the crank 47 is such that the rocking movement of the incubating racks is quite slow. The rate of rotation of the crank 47 is preferably about 1 R. P. M. so that thirty seconds are required for a half revolution of the crank which will move the egg tray supports from one extreme inclined position, such as shown in Figure 1, to a corresponding opposite inclination. During operation, the egg tray supports are always stopped substantially in their positions of greatest inclination. The operation of the motor 53 is preferably controlled by an electric clock 54 which starts the motor 53 into operation at predetermined time intervals to im-

part a half revolution to the crank 47 and reverse the inclination of the tray supports.

The egg trays 10 are of sufficiently rigid construction to resist deflection of the walls thereof by the weight of the eggs during the shifting of the center of gravity of the loaded trays while they are being rocked. The rigidity of the egg trays 10 prevents cracking of eggs in the incubator racks. The trays 10 are preferably in the form of sheet metal pans of a size and shape to fit within the vertical flanges of the supporting frames 32, and these trays have perforations 55 throughout the bottoms thereof to permit flow of air through the trays and between the eggs therein. The top edges of the side walls of the trays are stiffened by rolled beads 56. The eggs are packed closely in the trays 10 with their little ends down so that the eggs are held against movement in the trays during the tilting movements of the trays.

The hatching rack

The hatching rack 9 is in the form of a carriage mounted on the supporting caster wheels 11, being provided with a base member 57 and upright corner posts 58 which are connected by suitable cross braces 59. The posts 58 at opposite sides of the hatching rack are spaced apart a distance considerably greater than the width of the egg trays 10 and the egg trays are supported centrally between the posts 58 by means of wide, horizontal, supporting bars 60 attached to the inner sides of the posts 58 and provided with tray receiving ledges 61 along their inner edges.

It is desirable that the hatched chicks have more room to move about in that is provided by the trays 10 themselves. For this reason, each tray 10 when it is placed in the hatching rack 9 is provided with an extension chick guard 62, which is wider than the tray 10. The chick guard 62 is in the form of a sheet metal pan which has a rectangular aperture 63 in its bottom, which is of a size to receive the upper portion of one of the trays 10. Angle bars 64 are attached to the interior of the end walls of the chick guard, which are adapted to rest upon the upper edges of the end walls of the trays 10. The bottom of the chick guard on opposite sides of each tray 10 provides runways for the chicks. The chick guard has perforated side walls 65 projecting above the tops of the trays 10. Chick guards 62 provide a sufficient space for chicks hatched from a tray full of eggs so that it is unnecessary to remove any eggs from the trays or to rearrange the eggs when they are transferred to the hatching rack. If desired, however, some of the eggs can be transferred from the tray 10 to the runways at the sides of the tray provided by the chick guard.

Air cooling and humidifying devices

The cooling coils 7 in the air conditioning compartment receive water from a supply line 67 connected to a lower header 68 which is connected by a series of vertical copper tubes 69 to an upper header 70. Cooling of the air is accomplished by permitting water to flow from the supply line 67 through the cooling coil. The water for the spray nozzle 28 in the humidifying chamber is preferably supplied from the coil 7, so that the spray delivered by the nozzle 28 is warm water which has less chilling effect upon the air and which is more effective for humidifying the air. The upper header 70 is connected to a T-fitting 71, the branches through which water is discharged being controlled by solenoid operated valves 72 and 73.

The valves 72 and 73 are controlled electrically by means of circuits which will be hereinafter described, the operating solenoids being controlled by circuits leading through a terminal box 74 and a conduit 75 to a main control box 76. A small tube 77 is connected to the branch of the T-fitting 71, which is controlled by the valve 72. The lower end of the tube 77 is positioned above a vertical pipe 78 of larger diameter so that the rate of flow of water through the tube 77 can be observed. A manually operated valve 79 is provided for controlling the rate of flow of water through the tube 77. By noting the rate of discharge of water through the lower end of the tube 77, the operator by adjusting the valve 79 can adjust the rate of flow of water through the cooling coil 7 during the periods while the valve 72 is open. The pipe 78 discharges into the bottom of the humidifying chamber 25 which is connected to a drain pipe 80. A drainage tray 81 is positioned beneath the coil 7 to catch any water condensing and dripping from the pipes 69, and this drain tray is also connected to the drain pipe 80 to discharge any water collecting therein.

The operation of the valve 72 is controlled by the thermostat 29*a* and the valve is opened when the temperature within the incubator exceeds a predetermined degree.

The branch of the T-fitting 71, controlled by the valve 73, is connected by a tube 82 to a filter 83, from which the water is discharged through a pipe 84 to the spray nozzle 28. A manual valve 85 may be provided to shut off the supply of water to the nozzle 28 so that the nozzle may be removed for cleaning. The valve 72 is controlled by one or the other of the humidostats 30 or 30*a* to deliver warm water to the spray nozzle 28 whenever the humidity of the air within the cabinet falls below a predetermined degree. Since a higher humidity is desirable during the hatching stage, it is advantageous to provide two controlling humidostats, either of which may be connected in the humidifier valve controlling circuit, as desired.

In some installations, a water supply, delivering water under sufficient pressure for satisfactory operation of the spray type of humidifier, is not available. For such installations a modified form of humidifier, such as illustrated in Figs. 16 and 17 of the drawings, may be provided. Instead of employing a spray nozzle, one or more strips of open mesh fabric 87, through which air may pass readily, may be mounted on the cooling coil in the air conditioning chamber. These strips of fabric may be secured to the upper header 70 by means of clips 88 and to the lower header 68 by means of anchoring cords 89. A tube 90 is attached to the branch of the T-fitting 71, controlled by the valve 73, and this tube is connected to a manifold 91 which delivers into tubes 92, one for each of the strips 87. The tubes 92 are positioned with their discharge ends adjacent the upper ends of the strips 87 to discharge water upon the fabric strips. The water discharged upon the fabric strips is drawn by capillary attraction into the meshes of the fabric and the flow of air through the fabric to the fan 5 causes moisture to be absorbed by the air.

Electrical control devices

The wiring for the control of the fans, the tray rocking motor, the electric heaters, the cool-

ing coil and the humidifier is shown in Fig. 18 of the drawings.

The end fan 5 is driven by an electric motor 94 and the fan 13 is driven by an electric motor 95, motors 94 and 95 being connected for simultaneous operation. The operation of these motors is continuous, while that of the rack actuating motor 53 is intermittent. Current for operating all of the electric motors and the various control devices is supplied from main line wires 96 and 97 through a master switch 98. Current for the fan motors and the control devices is controlled by a starting and stopping switch 99. The motor circuits are so arranged that the movement of the switch 99 to open position stops the motors 94 and 95 but permits independent operation of the motor 53. The temperature and humidity control devices are also rendered ineffective by opening of the switch 99.

It is desirable to stop the air circulating fans and to render the heating, cooling and humidifying means inoperative when the cabinet is opened for charging the incubating racks or for transferring trays to the hatching rack, and this may be done by opening the switch 99. It is desirable that the motor 53 be independently operable by means of a manual switch to enable the tray supporting frames to be moved to a horizontal position for convenient loading of the incubator racks.

The switch 99 has a blade 100 which connects a terminal 101 to which the line wire 96 is connected to a terminal 102. A second blade 103 connects a terminal 104 to which the line 97 is connected to a terminal 105. The terminal 102 is connected through an overload release switch 106 to a wire 107 which extends to one terminal of the motor 94. The opposite terminal of the motor 94 is connected by a wire 108 through an overload release switch 109 and through the blade 103 of the switch 99 to the line 97. The terminal 101 of the line 96 is connected by wires 110 and 111 to one terminal of the motor 95 and the other terminal of the motor 95 is connected through a wire 112 through the overload release switch 109 and the switch blade 103 to the line 97. Upon closure of the switch 99 the circuits of both the motors 94 and 95 are closed to continuously operate the fans 5 and 13. One terminal of the motor 53 is connected through a wire 113 through the wires 111 and 110 to the line 96. The other terminal of the motor 53 is connected through a wire 114 to a manually operable switch 115 which has two blades 116 and 117, which in one position of the switch 115 are bridged by a conductor 118 to establish a connection with the line 97 through a wire 119. By moving the switch 115 into and out of engagement with the bridging conductor 118, the operation of the motor 53 may be controlled manually to shift the egg tray receiving supports 32 to horizontal position for the insertion or removal of trays.

During normal operation of the incubator, the motor 53 is preferably controlled by the clock 54. The blade 116 of the switch 115 is adapted in one position of the switch to connect a wire 120 of the clock controlled circuit to the wire 114 connected to one terminal of the motor 53. The blade 117 of the switch 115 is adapted to connect a wire 121 of the clock controlled circuit to the wire 119 which is connected to the line 97. When the switch 115 is in position to connect the wires 114 and 120, and the wires 119 and 121, current flowing between the motor 53 and the line 97 is deflected through the clock controlled circuit. In order to vary the timing of the rack tilting operations of the motor 53, the clock 54 preferably operates a plurality of switches which may be selectively connected into the motor circuit. The wire 120 extends to an automatic snap switch 122 through which the wire 120 may be connected to either of two wires 123 and 124. The wires 123 and 124 are alternately connected to the wire 121 by movable switch members 125 and 126 operated by cams 127 and 128 which are simultaneously driven at a definite rate of speed by the clock 54. The clock 54 is preferably an electric clock having a motor 129, one terminal of which is connected to the line 96 through the wire 110, and the other terminal of which is connected to the line 97 by a wire 130. The clock motor 129 operates continuously and one of the cams 127 or 128 causes a closing of the circuit through the motor 53 at predetermined time intervals, the cams being so formed and so positioned with respect to the movable switch member that it operates that either cam will hold its switch in closed position for a period of time sufficient to impart a one-half revolution to the crank 47 so as to insure movement of the tray supports 32 from one extreme inclined position to the opposite extreme inclined position.

The switch 122 is operated by chains 122*a* which are attached to lever arms 45 of the incubating racks so that the switch 122 is shifted from one of its engaging positions to the other when the racks reach either extreme tilted position. The cams 127 and 128 are positioned with the lobe of one displaced 180° with respect to the lobe of the other. When the cam 127 closes the switch 125, the motor 54 is started and continues to operate until the switch 122 is shifted to break the motor circuit, which remains open until the cam 128 closes the switch 126.

When the doors 3 are opened for the purpose of charging the incubating racks or for transferring trays from the incubating racks to the hatching racks, the switch 115 is moved into engagement with the bridging conductor 118 to operate the motor 53 to shift the tray supports 32 into horizontal position.

When the trays have reached the desired position, the movement is stopped by shifting the switch 115 to the center or neutral position, thus stopping the motor 53 and rendering it inoperative. Upon completion of the loading or transferring operation, the switch 115 is returned into engagement with 118 and the motor 53 operated until the trays have reached their normal incubating angle. When this is accomplished, the switch 115 is returned to the clock controlled circuit engaging position.

The heaters 6 are provided with coils 6*a* and 6*b*. One end of the coil 6*a* is connected through a wire 131 to the wire 108 and through the switch blade 103 to the line 97. One end of the coil 6*b* is connected to the wire 108 through a wire 132 and a manually operated switch 133. By opening the switch 133 the coil 6*b* may be disconnected. It is desirable to vary the capacity of the heater since under certain conditions of operation less heating of the air is required. Temperature and humidity of the outside atmosphere may be such that a single heating coil will produce ample temperature regulation. Under other conditions a more rapid heating of the air may be desirable.

The ends of the coils 6*a* and 6*b* opposite the ends connected to the wire 108 are connected by a bridging conductor 134 which is connected by

a wire 135 to a normally open switch 136. When the switch 136 is in closed position, the circuit to one or both of the heating coils is completed through wires 137 and 138 to the wire 107 and through the switch blade 100 to the line 96. The switch 136 is actuated by a solenoid 139, one end of the solenoid coil being connected by a wire 140 through the wire 108 and through the switch blade 103 to the line 97. The other end of the coil of the solenoid 139 is connected by a wire 141 through a normally closed relay switch 142 and through a wire 143 to the wire 138 which is connected through the wire 107 to the line 96. The switch 142 is operated by a solenoid 144, one end of the solenoid coil being connected to the wire 143 and the other end being connected through a wire 145 to the thermostat 29. The thermostat 29 is preferably of the contact thermometer type and the wire 145 is permanently connected with the mercury column thereof. A contact member 146 is positioned in the path of the mercury column to be engaged by the mercury when a predetermined temperature is reached. The contact member 146 is connected by a wire 147 to the wire 140 which is connected through the wire 108 to the line 96. Whenever the mercury column of the thermostat 29 reaches the contact member 146, the switch 142 is actuated to break the connection between the wires 143 and 141 and interrupt the current through the solenoid 139, permitting the switch 136 to open and break the circuit through the heater coils. One or both of the heaters 6 are energized so long as the temperature within the incubator is below a predetermined temperature. Whenever the temperature rises to the point where the mercury column engages the contact member 146, the heater circuit is opened.

The valve 72, which controls flow of water through the cooling coil 7, is operated by a solenoid 148, one end of the solenoid coil being connected by a wire 149 to the wire 140 and through the wire 108 to the line 96, the other end of the solenoid coil being connected by a wire 150 to a switch 151, which when closed connects the wire 150 through a wire 152 to the wire 137 and through the wires 138 and 107 to the line 96. The switch 151 is operated by a solenoid 153, one end of the solenoid coil being connected to the wire 152, and the other end being connected through a wire 154 to the thermostat 29*a*. The thermostat 29*a* is also preferably of the contact thermometer type, and the wire 154 is permanently connected to the mercury column thereof. A contact member 155 is positioned in the path of the mercury column of the thermostat 29*a* to be engaged by the mercury column at a predetermined temperature. The contact member 155 is connected by a wire 156 to the wire 147 and through the wires 140 and 108 to the line 97. Upon closure of the circuit through the thermostat 29*a*, the solenoid 153 is energized to close the switch 151 which completes the circuit through the solenoid 148 to open the valve 73. The contact member 155 is set for engagement with the mercury column at a temperature slightly higher than the contact 146. The heaters 6 are operated continuously until the mercury column of the thermostat 29 engages the contact member 146 whereupon the heating coils are disconnected. If the temperature rises above the predetermined temperature at which the heaters are disconnected the mercury column in the thermostat 29*a* engages the contact member 155, closing the circuit through the solenoid 153 and operating the switch 151 to energize the solenoid 148 to open the valve 73, which drains water from the cooling coil, which is replaced by cold water from the water supply line. The contacts 146 and 155 of the thermostats are set to approximately the high and low limits between which it is desired to maintain the temperature of the air in the incubator. For example, the contact member 146 may be set for a temperature of 99¼° F. while the contact member 155 may be set for a temperature of 99¾° F. By operation of the heaters 6 and the cooling coil 7 under the control of thermostats 29 and 29*a*, temperature within the incubator cabinet may be maintained between very close limits.

The valve 73 controlling the flow of water to the humidifier is operated by a solenoid 157, one end of the solenoid coil being connected by a wire 158 through the wires 140 and 108 to the line 97; the other end of the solenoid coil is connected by a wire 159 to a normally closed switch 160 which connects the wire 159 through the wires 138 and 107 to the line 96. The switch 160 is operated by a solenoid 161, one end of which is connected to the wire 138 and the other end of which is connected through a wire 162 to a manually operable switch 163. The switch 163 serves to connect the wire 162 to either of two wires 164 or 165. The wire 164 extends to the humidostat 30 and the wire 165 extends to the humidostat 30*a*. The switch 163 is provided for the purpose of shifting the control from the humidostat 30 to the humidostat 30*a*, or vice versa. The two humidostats are set to control the operation of a solenoid 157 at different degrees of humidity and the two controls are desirable because of the fact that during the hatching operation a higher degree of humidity in the incubator is desirable. The humidostats 30 and 30*a* are preferably of the wet bulb contact thermometer type and each has a column of mercury. The wire 164 is connected permanently to the mercury column of the humidostat 30; the wire 165 is permanently connected to the mercury column of the humidostat 30*a*. Contact members 166 and 167 are provided on the humidostats in the path of the mercury column, the contact member 167 being set higher than the contact member 166. The contact members 166 and 167 are connected through wires 140 and 108 to the line 97 so that when one of the contacts 166 or 167 is engaged by the mercury column of the humidostats 30 or 30*a*, the circuit is completed through solenoid 161 to break the circuit of the solenoid 157 and permit closure of the valve 73.

Signal lights may be provided to indicate operation of the heating means, cooling means and the humidifier. As herein shown, a light 168 is connected to the wires 141 and 140 so that current will be supplied to the light while current is flowing through the heater. A light 169 is connected to wires 140 and 150 across the circuit of the valve operated solenoid 148 and is lighted when the valve 72 is opened to create a flow of water in the cooling coil. A light 170 is connected to the wires 140 and 159 across the circuit of the valve operating solenoid 157 and is lighted while the valve 73 is being held in open position by the solenoid 157.

The control circuits for the heating, cooling and humidifying devices are connected through the fan motor circuit so that all of these devices are rendered inoperative when the switch 99 is moved to open position.

Cabinet construction

The cabinet 1 is preferably constructed of material that is not readily affected by moisture and which is a poor conductor of heat. The cabinet is preferably constructed in six sections, comprising four side walls 171, a ceiling 172, and a floor 173. Each of the side walls and the ceiling is in the form of a panel built upon a rectangular wood frame 174. The frame 174 is covered with waterproofed inner and outer layers of plywood 175 and 176. The space within the frame 174 and between the plywood layers is preferably filled with an insulating material 177, such as rock wool or the like. The inside surfaces of the walls, ceiling and floor are covered with a copper foil 178 that is cemented to the plywood and then lacquered to prevent penetration of moisture from the interior of the cabinet. The outside surfaces of the walls are covered with a linoleum 179, the linoleum being cemented to the plywood with waterproof cement. The wall sections are so designed that they fit around the floor and ceiling edges with only space for a gasket 180 of cork or rubber between the joints. The sections are held together with bolts 181, which pass through holes in one section and engage blind nuts 182 that are built into the adjoining section. When the sections are drawn together by the bolts 181 against the gaskets 180, airtight joints are provided along the corners of the structure. The floor 173 may be formed of an upper layer of plywood 183 covered with copper foil and a lower layer of insulation board 184.

When the exterior humidifying chamber 25 is provided, it is constructed of sheet metal with a covering of linoleum, like the side walls, and suitable means is provided for obtaining access to the interior, such as a removable front wall 185. Also, to prevent the passage of drops of water through the opening 27 into the air conditioning chamber, a vertical partition 186 is preferably provided between the spray nozzle 28 and the aperture 27.

Operation

During operation, the switches 98 and 99 remain in closed position and the fans 5 and 13 operate continuously, creating two distinct air currents; one in a vertical circuit through the fan 13 and the incubating racks 12, and the other in a horizontal circuit through the hatching rack 9, the filter 8, the air conditioning chamber 4 and the fan 5 to the passages at the front and rear sides of the chamber through which the air is returned to the body of air being circulated by the fan 13. The heating, cooling and humidifying devices controlled by the thermostats 29 and 29*a*, and the humidostats 30 and 30*a*, keep the temperature and humidity substantially constant, and by reason of the manner in which air is circulated the condition of the air is very uniform throughout the interior of the cabinet.

The motor 53 under the control of the clock 54 operates at predetermined time intervals to alter the position of the eggs in the incubating racks. When additional eggs are to be placed in the incubating racks, the switch 99 is preferably opened to stop the fan motors and disconnect the automatic temperature and humidity control devices from the source of current. By operation of the hand switch 115, the motor 53 is operated to bring the egg tray supports 32 to horizontal position, and the previously loaded trays 10 are placed in the empty tray supports 32. As soon as this operation is completed, the normal operation is resumed after closing the doors 3 by closing the switch 99. The switch 99 is preferably opened whenever the doors 3 are opened for transfer of egg trays to the hatching rack and removal of the hatching rack with the hatched chicks therein.

The constant flow of air in a single direction through the hatching rack 9 and the filter 8 to the fan 5 prevents contamination of the air by the down shed by the chicks and maintains a comfortable and healthy atmosphere for the chicks. By adjusting the air inlet and outlet valves 21 and 24, respectively, the required amount of fresh air may be introduced into the cabinet to supply oxygen sufficient for chicks being hatched.

By proper adjustment of the manually operated valve 79 to regulate the operation of the automatically controlled cooling device, the switch 133 to regulate the heating devices, and the valves 21 and 24 to regulate the air supply, a considerable saving may be effected in the consumption of electric current, ample power being available at all times for quickly altering temperature or humidity when desirable.

It is to be understood that variations and modifications of the specific devices herein shown and described for purposes of illustration may be made without departing from the spirit of the invention.

What I claim is:

1. An incubator comprising an enclosed elongated main chamber, an air conditioning chamber at one end of said main chamber, a hatching rack having means for supporting superposed egg trays and positioned in said main chamber at the end adjacent the air conditioning chamber, a plurality of incubating racks positioned side by side in said main chamber, each adapted to support superposed egg trays, an air filter interposed between said main chamber and said air conditioning chamber, means for continuously withdrawing air from said air conditioning chamber to cause air to be drawn from the main chamber horizontally through the hatching rack and filter, means for conducting the air drawn from the air conditioning chamber and circulating the same in the portion of the main chamber occupied by the incubating racks in a direction transverse to the direction of movement through the hatching rack, and means for controlling the temperature and humidity of the circulating air.

2. An incubator comprising an enclosed elongated main chamber, an air conditioning chamber at one end of said main chamber, a hatching rack having means for supporting superposed egg trays and positioned in said main chamber at the end adjacent the air conditioning chamber, a plurality of incubating racks positioned side by side in said main chamber, each adapted to support superposed egg trays, an air filter interposed between said main chamber and said air conditioning chamber, means creating an air current in a portion of the main chamber in an endless circuit with downward movement at the end of the chamber opposite the air conditioning chamber and upward movement through the incubating racks, means for withdrawing a portion of the air from the upwardly moving portion of said air current horizontally through the hatching rack and filter to the air conditioning chamber, and means for varying the temperature and humidity of the air so withdrawn and returning the same to the main chamber.

3. An incubator comprising an enclosed elongated main chamber, an air conditioning chamber at one end of said main chamber, a hatching rack having means for supporting superposed egg trays and positioned in said main chamber at the end adjacent the air conditioning chamber, a plurality of incubating racks positioned side by side in said main chamber, each adapted to support superposed egg trays, an air filter interposed between said main chamber and said air conditioning chamber, means creating an air current in a portion of the main chamber in an endless circuit with downward movement at the end of the chamber opposite the air conditioning chamber and upward movement through the incubating racks, means for withdrawing a portion of the air from the upwardly moving portion of said air current horizontally through the hatching rack and filter to the air conditioning chamber, means for returning air from the conditioning chamber to the main chamber, means for heating, means for cooling and means for humidifying the air passing through the air conditioning chamber, and means responsive to variations in temperature and humidity in the main chamber for controlling said heating, cooling and humidifying means.

4. An incubator comprising an elongated chamber, a hatching rack at one end of said chamber, a plurality of incubating racks arranged side by side between the hatching rack and the opposite end of the chamber, means for controlling the temperature and humidity of the air in said chamber, a fan in the end portion of the chamber remote from the hatching rack for maintaining a vertically circulating current of air through the incubating racks, and a fan in the end of the chamber occupied by the hatching rack for drawing a portion of the air from the vertically circulating current and causing the same to pass horizontally through the hatching rack.

5. An incubator comprising an elongated chamber, a hatching rack at one end of said chamber, a plurality of incubating racks arranged side by side between the hatching rack and the opposite end of the chamber, means for controlling the temperature and humidity of the air in said chamber, a fan in the end portion of the chamber remote from the hatching rack for maintaining a vertically circulating current of air through the incubating racks, a fan in the end of the chamber occupied by the hatching rack for drawing a portion of the air from the vertically circulating current and causing the same to pass horizontally through the hatching rack, and an air filter interposed between the last mentioned fan and the hatching rack.

6. An incubator comprising an elongated chamber, a hatching rack at one end of said chamber, a plurality of incubating racks arranged side by side between the hatching rack and the opposite end of the chamber, means for controlling the temperature and humidity of the air in said chamber, a fan in the end portion of the chamber remote from the hatching rack for maintaining a vertically circulating current of air through the incubating racks, a centrifugal fan mounted in the end of the chamber at the outer side of the hatching rack for drawing a portion of the vertically circulating air current horizontally through the hatching rack, passages for returning air from said centrifugal fan horizontally past the hatching rack to the vertically circulating air current, and an air filtering diaphragm extending substantially the full width and height of the hatching rack and interposed between said hatching rack and centrifugal fan.

7. An incubator comprising a main chamber, a hatching rack at one end of said chamber, means for maintaining a vertically circulating current of air in said main chamber, and means for drawing a portion of the air from the vertically circulating current horizontally through the hatching rack and for returning the air so withdrawn past the hatching rack to the vertically circulating current.

8. An incubator comprising a main chamber, a hatching rack at one end of said chamber, means for maintaining a vertically circulating current of air in said main chamber, means for drawing a portion of the air from the vertically circulating current horizontally through the hatching rack and for returning the air so withdrawn past the hatching rack to the vertically circulating current, means for heating, means for cooling and means for humidifying air withdrawn through the hatching rack, and means responsive to variations in the temperature and humidity of the vertically circulating air in said chamber for controlling the heating, cooling and humidifying means.

9. An incubator comprising an elongated chamber, a hatching rack in said chamber at one end thereof, a series of superposed egg trays supported in horizontal position in said hatching rack, a plurality of incubating racks arranged side by side in said chamber, each rack having a series of superposed egg tray supporting members mounted for lateral rocking movements, means for rocking said tray supporting members, means for creating a vertically moving current of air through said incubating racks, and means for by-passing a portion of the air from the vertically moving current horizontally through the hatching rack and returning the same past the hatching rack to the vertically moving current.

10. An incubator comprising an elongated chamber, a hatching rack in said chamber at one end thereof, a series of superposed egg trays supported in horizontal position in said hatching rack, a plurality of incubating racks arranged side by side in said chamber, each rack having a series of superposed egg tray supporting members mounted for lateral rocking movements, means for rocking said tray supporting members, means for creating a vertically moving current of air through said incubating racks, means for by-passing a portion of the air from the vertically moving current horizontally through the hatching rack and returning the same past the hatching rack to the vertically moving current, means for filtering the air passed through the hatching rack, and means controlled by variations in the temperature of the air circulating through the incubating racks for heating or cooling the by-passed air.

11. An incubator comprising an elongated chamber, a hatching rack in said chamber at one end thereof, a series of superposed egg trays supported in horizontal position in said hatching rack, a plurality of incubating racks arranged side by side in said chamber, each rack having a series of superposed egg tray supporting members mounted for lateral rocking movements, means for rocking said tray supporting members, means for creating a vertically moving current of air through said incubating racks, means for by-passing a portion of the air from the vertically moving current horizontally

through the hatching rack and returning the same past the hatching rack to the vertically moving current, means for filtering the air passed through the hatching rack, means controlled by variations in the temperature of the air circulating through the incubating racks for heating or cooling the by-passed air, air humidifying means, and means responsive to variations in the humidity of air in said chamber for controlling the operation of said humidifying means.

12. An incubator comprising an elongated main chamber, an air conditioning chamber at one end of said main chamber, a plurality of incubating racks positioned side by side in said main chamber, said racks being spaced from the end of the chamber at which the air conditioning chamber is located, each rack having superposed members for supporting egg trays in laterally inclined positions, a carriage adapted to be run into the space between the incubating racks and the air conditioning chamber, a hatching rack on the carriage adapted to support superposed egg trays in horizontal position, means in the main chamber for circulating air through the incubating racks, means in the air conditioning chamber for drawing a portion of the air horizontally through the hatching rack, and passages for returning air from the conditioning chamber to the main chamber.

13. An incubator comprising a main chamber, an air conditioning chamber alongside the main chamber, a hatching rack in the main chamber adjacent the air conditioning chamber, an air filter interposed between the air conditioning chamber and the main chamber, means for circulating air in a vertical direction in said main chamber, means for continuously drawing air from said main chamber horizontally through said hatching rack and filter to the air conditioning chamber and for returning the air from the air conditioning chamber to the vertically circulating body of air in the main chamber, and means for controlling the temperature and humidity of the air in the main chamber.

14. An incubator comprising a main chamber, an air conditioning chamber alongside the main chamber, an air filtering diaphragm forming a partition between said chambers, a hatching rack in the main chamber adjacent said diaphragm, a fan in the main chamber for creating a vertical circulation of air therein, a fan in the air conditioning chamber for creating a subatmospheric pressure therein to draw a portion of the air horizontally from the vertically circulating body of air in the main chamber through the hatching rack and filtering diaphragm, passages for returning air from the last mentioned fan to the vertically circulating body of air in the main chamber, and means for controlling the temperature and humidity of the air in said main chamber.

15. An incubator comprising an elongated chamber, a plurality of racks in said chamber, each adapted to support a series of superposed egg trays, means for creating a vertically moving current of air through certain of said racks, means for by-passing a portion of the air from the vertically moving current, horizontally through another of said racks, and returning the same past the last mentioned rack to the vertically moving current, means for filtering the by-passed air, and means controlled by variations in the temperature of the vertically circulating air for heating or cooling the by-passed air.

16. In an incubator, an egg tray, a rack for supporting said tray having a tray receiving portion of greater width than the tray, and a chick guard attached to the tray and providing a chick runway alongside the tray.

17. In an incubator, an egg tray, a rack for supporting said tray having a tray receiving portion of greater width than the tray, and a chick guard of greater width than the tray and having an opening in its bottom to receive the upper portion of the egg tray, said chick guard being attached to the tray with its bottom below the top of the tray, the portions of the guard bottom on opposite sides of the tray forming chick runways.

18. An incubator comprising a main chamber, egg supporting racks in said chamber, means for circulating air in said chamber, air cooling means comprising a coil connected at one end to a water supply line, a discharge pipe connected to the opposite end of said coil, said discharge pipe having a plurality of outlets, a valve controlling each of said outlets, an air humidifying device receiving water from one of said outlets, means for operating said valves, means including a humidostat in the main chamber for controlling the operation of the valve controlling the outlet leading to the humidifying device, and means including a thermostat in the main chamber for controlling the operation of the valve controlling another of said outlets.

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