

Aug. 12, 1952

H. B. FOULDER ET AL

2,606,372

APPARATUS FOR CONDITIONING MATERIAL

Filed June 22, 1949

Fig. 1

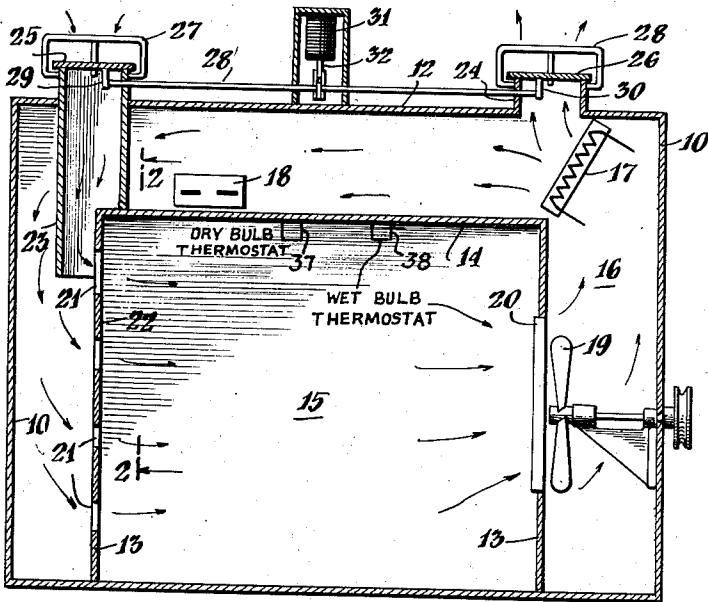


Fig. 2

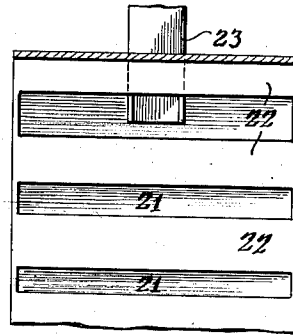
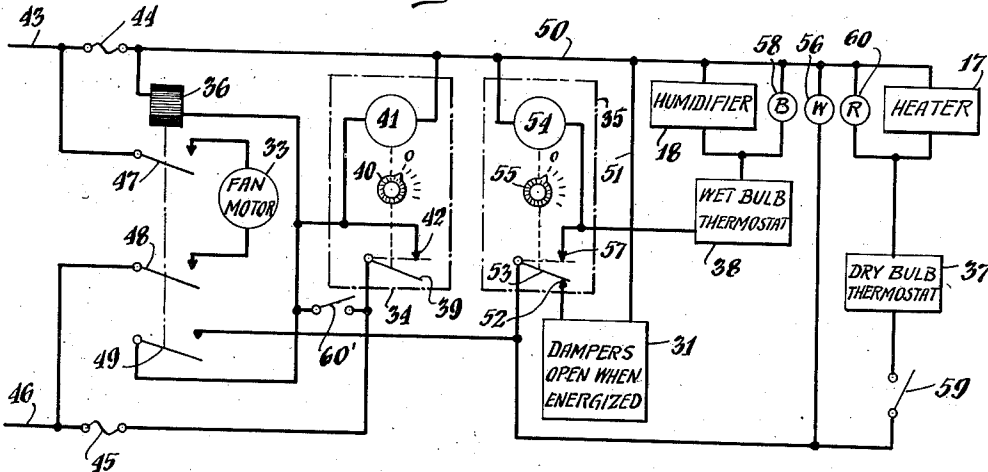


Fig. 3



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## UNITED STATES PATENT OFFICE

2,606,372

APPARATUS FOR CONDITIONING  
MATERIAL

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Application June 22, 1949, Serial No. 100,638

8 Claims. (Cl. 34—46)

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This invention relates to apparatus for conditioning material, and particularly to apparatus for conditioning material by the circulation of conditioned air over or through the material.

In many industries, it is desirable to subject certain material to a conditioning process, such as heating or humidifying. A typical process is the humidifying or twist setting of yarn, by which the yarn is prevented from kinking or tangling during subsequent operations such as knitting or weaving.

In such a conditioning process, it is common to place the material to be conditioned in a chamber, and to circulate through the chamber air which has been heated, humidified, or otherwise treated so as to give it some particular characteristic to be imparted to the material.

Controls have previously been applied to such processes to regulate the time during which the heat, humidity or other condition is maintained. With the controls of the prior art, the termination of a conditioning process of the type described has been accomplished by simply turning off the conditioner, for example, the heater or humidifier. After any such process which involves heat, it is necessary to cool the material after the process is terminated before the material can be conveniently handled. Such cooling has commonly been taken care of by opening the loading doors of the chamber. Such cooling operations have been unsatisfactory in certain respects. For example, after a humidifying process, the rush of steam and vapor through the doors when they are opened is objectionable. Furthermore, if the cooling operation does not succeed in sufficiently reducing the moisture in the machine, then there may be a considerable undesirable condensation of moisture on the next cold charge of material to be treated.

It is an object of the present invention to provide material conditioning apparatus of the type described including improved means for cooling the material upon termination of the conditioning process.

Another object is to provide apparatus of the type described including improved means for controlling the cooling of the material.

Another object is to provide improved cooling and control means for conditioning apparatus of the type described in which the objectionable outrush of steam through the doors is eliminated.

Another object is to provide improved cooling means in which the moisture remaining in the apparatus is substantially reduced during the

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cooling cycle, so as to reduce any tendency toward condensation on the next charge of fresh material.

Another object is to provide material conditioning apparatus including several conditioning devices such as a heater, a humidifier and air circulating means, and improved means for providing a flexible control of the several conditioning devices.

The foregoing, and other objects of the invention are attained in the apparatus described in detail below. The apparatus employs certain conventional elements including a material conditioning chamber, an air conditioning chamber, suitable air passages connecting the two chambers and providing a closed air circulation system, a fan for circulating air through the two chambers, a dry heater and a humidifying heater in the air conditioning chamber and dry bulb and wet bulb thermostats for controlling the dry heater and the humidifying heater, respectively.

In addition to the conventional elements, the apparatus includes an improved fresh air circulating system and improved means for controlling the fresh air circulation and other conditioning devices.

The improved fresh air circulating system includes a fresh air intake conduit opening into one side of the material conditioning chamber opposite the fan, which is arranged to draw air from the chamber. An exhaust conduit leads from the air conditioning chamber at a point near the exhaust side of the fan. Dampers in the intake and exhaust conduits are provided with a common operating mechanism so that they open and close simultaneously. When the two dampers are closed, all the air is recirculated and when both are open, fresh air is mixed with the recirculated air.

The improved control apparatus includes two timers. One timer controls the dampers and the humidifier, whereas the other timer, which is hereinafter referred to as the master timer, controls the fan, the heater and also determines whether the first-mentioned timer is in control of the humidifier and the dampers. This arrangement provides a very flexible control of all the conditioning devices, as described more completely below.

In the accompanying drawings, Fig. 1 is a somewhat diagrammatic cross-sectional view of one form of material conditioning apparatus embodying the present invention.

Fig. 2 is a detail view, taken along the line 2—2

of Fig. 1, looking in the direction of the arrows.

Fig. 3 is an electrical wiring diagram of the various conditioning devices shown in Fig. 1 and the electrical circuits by which they are controlled.

Referring to Fig. 1, there is shown a material conditioner including outer walls 10 supporting an outer roof 12, and the two inner walls 13 supporting an inner roof 14. The inner walls 13 and the roof 14 enclose a conditioning chamber 15, in which the material to be conditioned is inserted, for example, on racks or trays.

The space between the inner walls 13 and the outer walls 10, together with the space between the inner roof 14 and the outer roof 12, forms an air conditioning chamber, generally indicated by the reference numeral 16. The chamber 16 has mounted therein a dry heater 17 and a humidifier 18, which may be of any well known construction.

For example, the heater 17 may be a steam coil controlled by a suitable electrical valve. Humidifier 18 may be a similar steam coil submerged in a tank of water.

A fan 19 is located adjacent a central opening 20 in the right hand wall of chamber 15. The left hand wall of chamber 15 is provided with a series of horizontal openings 21 separated by baffles 22. When the fan 19 is operating, it draws air from the chamber 15 and forces it through the chamber 16, past the heater 17 and the humidifier 18, and back through the openings 21 between baffles 22 to the chamber 15.

A fresh air intake duct 23 extends downwardly from above the roof 12 through the air conditioning chamber 16 and its lower end opens at the side of the chamber 15 opposite the fan 19, between the two uppermost baffles 22. An exhaust duct 24 extends upwardly from the roof 12. The intake and exhaust ducts 23 and 24 are provided with dampers 25 and 26, respectively. These dampers are illustrated as disks resting on the upper ends of the ducts 23 and 24. Movement of these disks is restricted by cages 27 and 29 attached to the ducts.

The exhaust duct 24 is shown as terminating in the room just above the material conditioning unit. If the discharge of steam and vapor into the room is found objectionable, the exhaust duct may be readily extended to the outside of the building.

A shaft 28 extends between the ducts 23 and 24 and has its ends projecting inside the ducts. The shaft 28 is provided at its opposite ends with arms 29 and 30 which are effective upon rotation of shaft 28 to lift the disks 25 and 26, thereby opening the intake and exhaust ducts. The shaft 28 may be rotated by any suitable operating mechanism, illustrated somewhat diagrammatically as a solenoid 31 connected by a link 32 to a suitable arm on the shaft 28.

When the dampers are opened, fresh air can flow freely through the intake duct 23 and the chamber 15. Some of the air then flowing through chamber 15 is discharged through the exhaust duct 24 and some is recirculated through the conditioning chamber 16.

The intake duct structure shown subjects the outlet end of that duct to the direct suction of the fan 19 and thereby insures that when the dampers are open, a substantial proportion of the air circulated through the chamber 15 is fresh air. The discharge end of the intake duct is not subject to any turbulent flow of recirculated air. The proportion of fresh air and re-

circulated air is determined by the structures of the several air passages. With the structure shown, all the air entering the intake duct 23 is guided to and through the material conditioning chamber 15. There is no short-circuiting of the fresh air to the exhaust duct 24 due to turbulence in the air passages.

Referring now to Fig. 3, there are shown diagrammatically the several conditioning devices including the heater 17, and the humidifier 18, the damper operator 31 and a motor 33 for driving the fan 19. Fig. 3 also shows several electrical control elements and circuits controlled by those elements for energizing the several conditioning devices. These electrical control elements include a master timer 34, another timer 35, a relay 36, a dry-bulb thermostat 37 and a wet-bulb thermostat 38. The thermostat 37 and the wet-bulb thermostat 38 include temperature sensitive elements located in the material conditioning chamber 15 or at any other suitable point where they are in contact with the air being circulated through that chamber.

The master timer 34 includes a movable contact 39, an operating knob 40 and an electric motor 41. Its construction is such that when the knob 40 is in the normal or zero position, as shown in the drawing, the contact 39 is in its open position, shown in full lines in the drawing. When the knob 40 is moved away from its zero position, contact 39 is moved into its dotted line position, where it engages a stationary contact 42. This completes a circuit for the timer motor 41, which may be traced from one electrical energy supply line 43 through a fuse 44, motor 41, stationary contact 42, movable contact 39 and thence through another fuse 45 to the other supply line 46. Timer motor 41 drives the knob 40 back towards its zero position at a fixed rate of speed. In the usual arrangement, the electrical energy supply is alternating current and the motor 41 is synchronous, so that it drives the knob 40 at a speed determined by the frequency of the alternating current. When the knob 40 reaches its zero position, the contact 39 is again moved away from stationary contact 42.

Hence, the timer 34 causes the contacts 39-42 to remain closed for a length of time depending upon the distance through which the knob 40 is moved away from its zero position.

When contact 39 engages contact 42, it also completes a circuit for the winding of relay 36, which is connected in parallel with the timer motor 41. Relay 36 thereupon closes its contacts 47, 48 and 49. Contacts 47 and 48 complete an obvious energizing circuit for fan motor 33.

Contact 49 in closing completes a circuit for the damper operator 31. This circuit may be traced from line 43 through fuse 44, wires 50 and 51, damper operator 31, contacts 52 and 53 of timer 35, contact 49 of relay 36, contacts 42 and 39 of timer 34 and thence through fuse 45 to the other supply line 46. The damper operator 31 is so constructed that the dampers are opened when the operator is energized.

Contact 49 in closing also completes an energizing circuit for a white signal lamp 56, which indicates to the operator that the fan is running. This circuit may be traced from supply line 43 through fuse 44, wire 50, signal lamp 56, contact 49, contacts 42 and 39 and thence through fuse 45 to the opposite supply line 46.

It may therefore be seen that the operation of the master timer 34 away from its zero position causes the fan motor 33 to drive the fan

19 and the damper operator 31 to open the intake and exhaust dampers, and also lights the signal lamp 56.

The timer 35 includes a timer motor 54 and a knob 55, which corresponds generally to the motor 41 and knob 40 in the timer 34. The motor 54 and knob 55 control contact 53 in a manner similar to the control of contact 39 in timer 34, which was previously described.

When knob 40 of timer 34 is away from its normal position and knob 55 of timer 35 is moved away from its normal position, contact 53 is moved away from its normal position in engagement with contact 52 to a position shown in dotted lines in the drawing, where it engages contact 57. This interrupts the circuit for damper operator 31, so that the dampers close. At the same time, a circuit is completed for the timer motor 54 and a circuit is completed for humidifier 18, which places it under the control of wet-bulb thermostat 38. This latter circuit may be traced from supply line 43 through fuse 44, wire 50, humidifier 18, wet-bulb thermostat 38, contacts 57 and 53, contact 49, contacts 42 and 39 and thence through fuse 45 to supply line 46. The wet-bulb thermostat 38 controls the humidifier 18 so that the latter is operated whenever the wet-bulb temperature of the air is less than the value for which the thermostat 38 is set. A blue signal lamp 58 is connected in parallel with the humidifier 18 and when illuminated, indicates to the operator that the humidifier is operating.

The circuit for the heater 17 may be traced from supply line 43 through fuse 44, wire 50, heater 17, thermostat 37 and a manually operable switch 59, contact 49 of relay 26, contacts 42 and 39, and thence through fuse 45 to the opposite supply line 46.

When the switch 59 is closed and knob 40 of timer 34 is moved away from its zero position, then heater 17 is placed under the control of thermostat 37. When switch 59 is open, heater 17 does not operate. A red signal lamp 60 is connected in parallel with heater 17 to indicate when it is operating.

A manual switch 60' is provided to shunt contacts 39 and 42, so that the several conditioning devices may be operated independently of the timer 34, if desired.

The control system described is capable of many different modes of operation. For example, the fan 19 may be operated without turning on either the humidifier 18 or the heater 17. This may be done by opening the switch 59 and leaving knob 55 of timer 35 on its zero position, while moving knob 40 of timer 34 away from its zero position.

The fan 19 and the humidifier 18 may be operated without the heater 17 by opening the switch 59 and turning on both timers 34 and 35. If it is desired to have a humidifying period followed by a drying period, then timer 35 is set for the length of the humidifying period and timer 34 is set for the sum of the humidifying period and drying period.

At the end of the humidifying period, contact 53 of timer 35 moves away from stationary contact 57 to terminate operation of humidifier 18, and engages stationary contact 52 to energize the damper operator 31 and start the fresh air cooling phase of the operation.

Heater 17, humidifier 18 and fan 19 may all be used by closing the switch 59 and turning on both timers. Other modes of operation are also possible.

While the specific terms "wet-bulb thermostat" and "dry-bulb thermostat" have been used herein, it should be understood that these terms are used in a broad sense and are intended to describe any apparatus for closing an electric circuit, or performing any similar control function, in response to wet-bulb temperature and dry-bulb temperature, respectively.

We claim:

1. Apparatus for conditioning material, comprising a first chamber for material to be conditioned, a second chamber, means in said second chamber for varying a condition of the air therein, means providing an enclosed continuously open path for recirculating air through said chambers, a fan located at one side of said first chamber for drawing air therefrom and discharging it into said second chamber, a fresh air intake conduit terminating at the side of said first chamber opposite said fan, said path including an aperture in said opposite side of said first chamber adjacent the end of said intake conduit, a discharge conduit leading from said path adjacent the circulating means at the discharge side of the fan to the outside of said enclosed path, dampers in said intake and discharge conduits, means located in said enclosed path and responsive to said condition of the air therein, common operating means for opening and closing said dampers simultaneously, a control element operatively connected to said damper operating means and said condition varying means for controlling the same, said element being movable between a normal position in which said dampers are open and said condition varying means is ineffective and an active position in which said dampers are closed and said condition responsive means controls said condition varying means to establish a predetermined value of said condition, and means including a timer for operating said element, said timer being effective after movement of said element to its active position to return said element to its normal position upon expiration of a pre-selected time.
2. Apparatus for conditioning material, comprising a first chamber for material to be conditioned, a second chamber, means in said second chamber for varying a condition of the air therein, means providing an enclosed continuously open path for recirculating air through said chambers, a fan located at one side of said first chamber for drawing air therefrom and discharging it into said second chamber, a fresh air intake conduit terminating at the side of said first chamber opposite said fan, said path including an aperture in said opposite side of said first chamber adjacent the end of said intake conduit, a discharge conduit leading from said path adjacent the discharge side of the fan to the outside of said enclosed path, dampers in said intake and discharge conduits, means located in said enclosed path and responsive to said condition of the air therein, common operating means for opening and closing said dampers simultaneously, a first control element operatively connected to said damper operating means and said condition varying means for controlling the same, said element being movable between a normal position in which said dampers are open and said condition varying means is ineffective and an active position in which said dampers are closed and said condition responsive means controls said condition varying means to establish a predetermined value of said condition, and means includ-

ing a timer for operating said element, said timer being effective after movement of said element to its active position to return said element to its normal position upon expiration of a preselected time, a master control element operatively connected to said fan, said damper operating means, said first control element and said condition varying means, said master control element being movable between a normal position in which said fan, said first control element and said condition varying means are ineffective and said dampers are closed and an active position in which said fan is operating and said first control element is in control of said damper operating means and said condition varying means, and means including a second timer for operating said master control element, said second timer being effective after movement of said master control element to its active position to return said master control element to its normal position upon expiration of a preselected time.

3. Apparatus for conditioning material, comprising a first chamber for material to be conditioned, a second chamber, means in said second chamber for varying a condition of the air therein, means providing an enclosed continuously open path for recirculating air through said chambers, a fan for propelling air along said path, a fresh air intake conduit emptying into said first chamber, a discharge conduit leading from said second chamber to a point outside said chambers and said enclosed path, dampers in said intake and discharge conduits, means located in said enclosed path and responsive to said condition of the air, common operating means for opening and closing said dampers simultaneously, a control element operatively connected to said damper operating means and said condition varying means, said element being movable between a normal position in which said dampers are open and said condition varying means is ineffective and an active position in which said dampers are closed and said condition responsive means controls said condition varying means to establish a predetermined value of said condition, and means including a timer for operating said element, said timer being effective after movement of said element to its active position to return the element to its normal position upon expiration of a preselected time.

4. Apparatus for conditioning material, comprising a first chamber for material to be conditioned, a second chamber, means in said second chamber for varying a condition of the air therein, means providing an enclosed continuously open path for recirculating air through said chambers, a fan for propelling air along said path, a fresh air intake conduit emptying into said first chamber, a discharge conduit leading from said second chamber to a point outside said chambers and said enclosed path, dampers in said intake and discharge conduits, means located in said enclosed path and responsive to said condition of the air, common operating means for opening and closing said dampers simultaneously, a first control element operatively connected to said damper operating means and said condition varying means, said first control element being movable between a normal position in which said dampers are open and said condition varying means is ineffective and an active position in which said dampers are closed and said condition responsive means controls said condition varying means to establish a predetermined value of said condition, means including a first timer for

operating said first control element, said timer being effective after movement of said control element to its active position to return said control element to its normal position upon expiration of a preselected time, a master control element operatively connected to said fan, said damper operating means, said first control element and said condition varying means, said master control element being movable between a normal position in which said fan, said first control element and said condition varying means are ineffective and said dampers are closed and an active position in which said fan is operating and said first control element is in control of said damper operating means and said condition varying means, and means including a second timer for operating said master control element, said second timer being effective after movement of said master control element to its active position to return it to its normal position upon expiration of a preselected time.

5. Apparatus for conditioning material, comprising a first chamber for material to be conditioned, a second chamber, means in said second chamber for humidifying the air therein, means providing an enclosed continuously open path for recirculating air through said chambers, a fan for propelling air along said path, a fresh air intake conduit emptying into said first chamber, a discharge conduit leading from said second chamber to a point outside said chambers and said enclosed path, dampers in said intake and discharge conduits, a wet-bulb thermostat located in said air path and responsive to the wet-bulb temperature of the air being circulated, common operating means for opening and closing said dampers simultaneously, a control element operatively connected to said damper operating means and said humidifying means, said control element being movable between a normal position in which said dampers are open and said humidifying means is ineffective and an active position in which said dampers are closed and said wet-bulb thermostat controls said humidifying means to establish a predetermined wet-bulb temperature of the circulated air, and means including a timer for operating said control element, said timer being effective after movement of said control element to its active position to return it to its normal position upon expiration of a preselected time.

6. Apparatus for conditioning material, comprising a first chamber for material to be conditioned, a second chamber, a humidifier in said second chamber, a heater in said second chamber, means providing an enclosed continuously open path for recirculating air through said chambers, a fan for propelling air along said path, a fresh air intake conduit emptying into said first chamber, a discharge conduit leading from said second chamber to a point outside said chambers and said enclosed path, dampers in said intake and discharge conduits, a wet-bulb thermostat located in said enclosed path and responsive to the wet-bulb temperature of the circulated air, a dry-bulb thermostat located in said enclosed path and responsive to the dry-bulb temperature of the circulated air, common operating means for opening and closing said dampers simultaneously, a first control element operatively connected to said damper operating means and said humidifier, said first control element being movable between a normal position in which said dampers are open and said humidifier is ineffective and an active position in which said

dampers are closed and said wet-bulb thermostat controls said humidifier to establish a predetermined wet-bulb temperature of the circulated air, means including a first timer for operating said control element, said first timer being effective after movement of said first element to its active position to return it to its normal position upon expiration of a preselected time, a master control element operatively connected to said fan, said damper operating means, said first control element, said humidifier and said heater, said master control element being movable between a normal position in which said fan, said first control element, said humidifier and said heater are ineffective and said dampers are closed and an active position in which said fan is operating, said dry-bulb thermostat is in control of said heater and said first control element is in control of said damper operating means and said humidifier, and means including a second timer for operating said master control element, said timer being effective after movement of said master control element to its active position to return it to its normal position upon expiration of a preselected time.

7. Apparatus for conditioning material, comprising a first chamber for material to be conditioned, a second chamber, means in said second chamber for varying a condition of the air therein, means providing an enclosed continuously open path for circulating air through said chambers, a fan for propelling air along said path, a fresh air intake conduit emptying into said first chamber, a discharge conduit leading from said second chamber to a point outside said chambers and said enclosed path, dampers in said intake and discharge conduits, means located in said enclosed path and responsive to said condition of the air, common electric operating means for opening and closing said dampers simultaneously, a movable electric contact operatively connected to said damper operating means and said condition varying means, said contact being movable between a normal position in which said dampers are open and said condition varying means is ineffective and an active position in which said dampers are closed and said condition responsive means controls said condition varying means to establish a predetermined value of said condition, manually operable means for moving said contact from its normal position to its active position, and a timer operatively connected to said contact and effective after movement of the contact to its active position to return it to its normal position upon expiration of a preselected time.

8. Apparatus for conditioning material, comprising a first chamber for material to be conditioned, a second chamber, means in said second chamber for varying a condition of the air there-

in, means providing an enclosed continuously open path for circulating air through said chambers, a fan for propelling air along said path, a fresh air intake conduit emptying into said first chamber, a discharge conduit leading from said second chamber to a point outside said chambers and said enclosed path, dampers in said intake and discharge conduits, means located in said enclosed path and responsive to said condition of the air, common electric operating means for opening and closing said dampers simultaneously, a first movable electric contact operatively connected to said damper operating means and said condition varying means, said first contact being movable between a normal position in which said dampers are open and said condition varying means is ineffective and an active position in which said dampers are closed and said condition responsive means controls said condition varying means to establish a predetermined value of said condition, means including a first timer for operating said first contact, said timer being effective after movement of the contact to its active position to return the contact to its normal position upon expiration of a preselected time, an electric motor for driving said fan, a master electric contact operatively connected to said fan motor, said first contact and said condition varying means, said master contact being movable between a normal position in which the fan motor is deenergized, said first contact and said condition varying means are ineffective, and said dampers are closed and an active position in which said fan motor is energized and said first contact is in control of said damper operating means and said condition varying means, and means including a second timer for operating said master contact, said second timer being effective after movement of said master contact to its active position to return it to its normal position upon expiration of a preselected time.

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