Dec. 29, 1925. 1,567,709

E. J. CARROLL

DRIER

Filed June 14, 1922 3 Sheets-Sheet 1

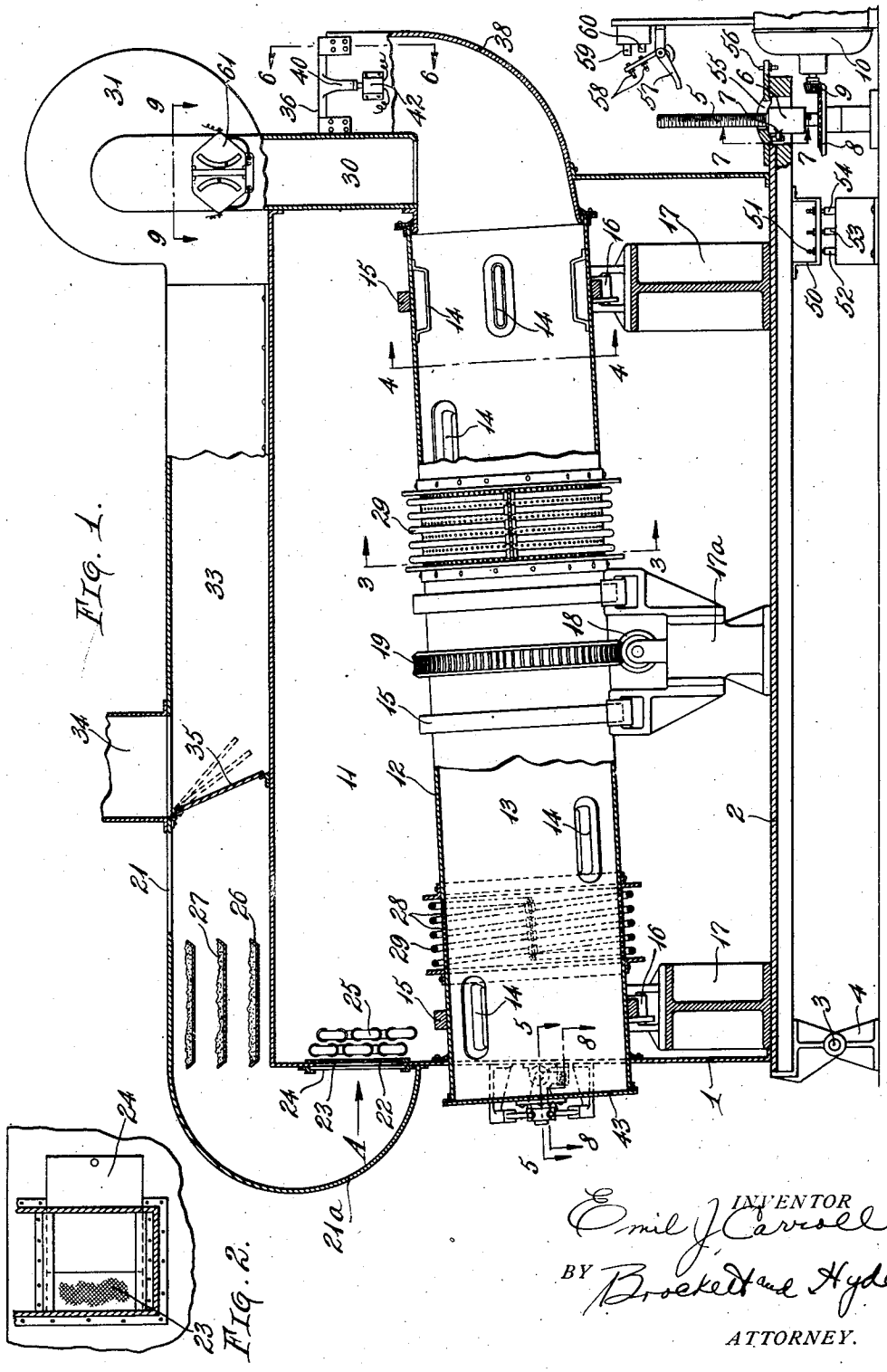

FIG. 1.

FIG. 2.

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FIG. 3.

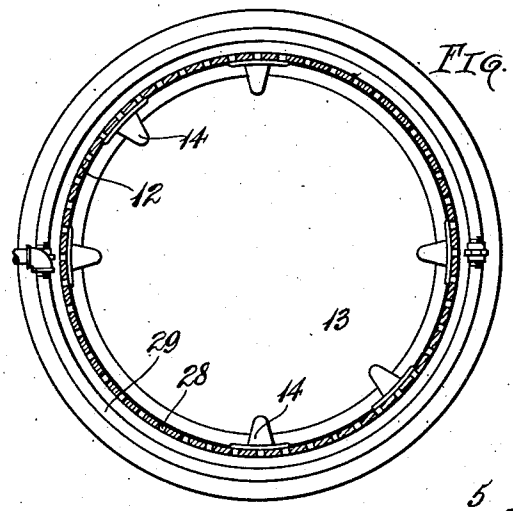


FIG. 4.

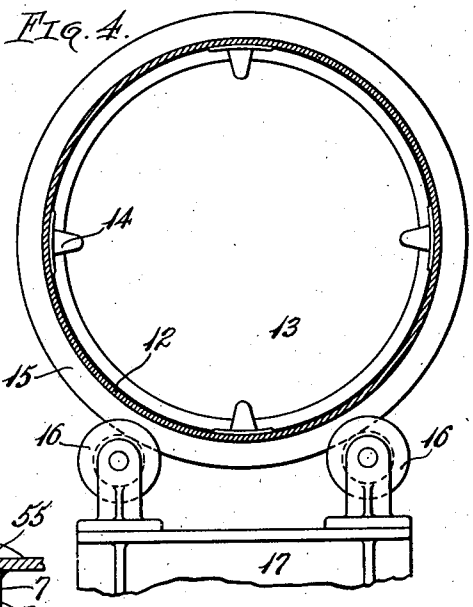


FIG. 5.

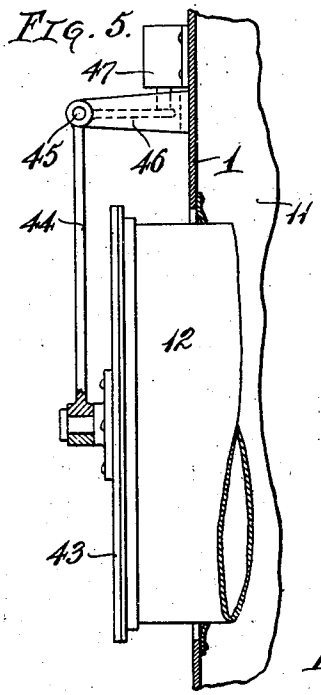


FIG. 7.

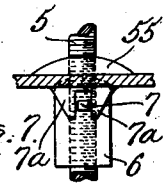


FIG. 6.

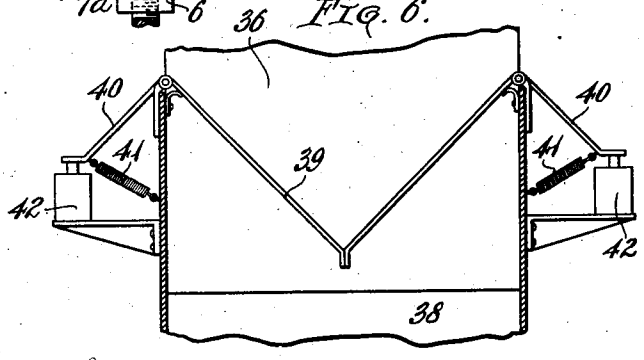


FIG. 9.

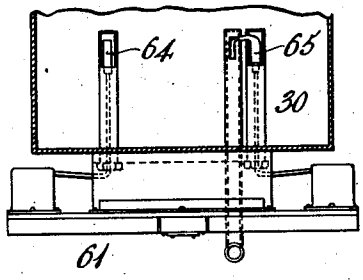
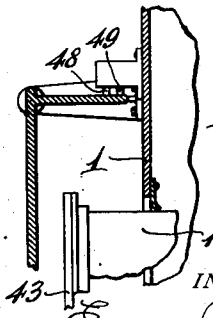


FIG. 8.



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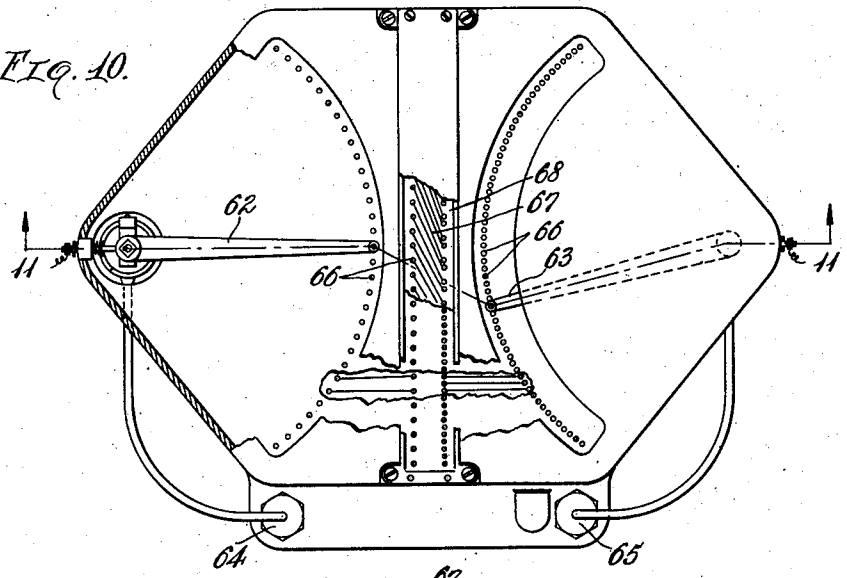
DRIER

Filed June 14, 1922 3 Sheets-Sheet 3

FIG. 10.



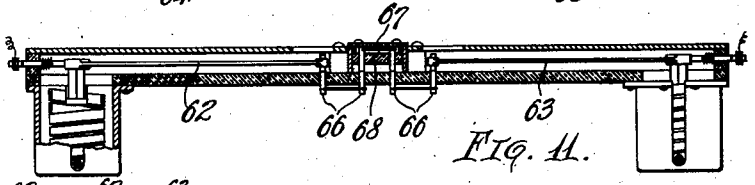


FIG. 11.

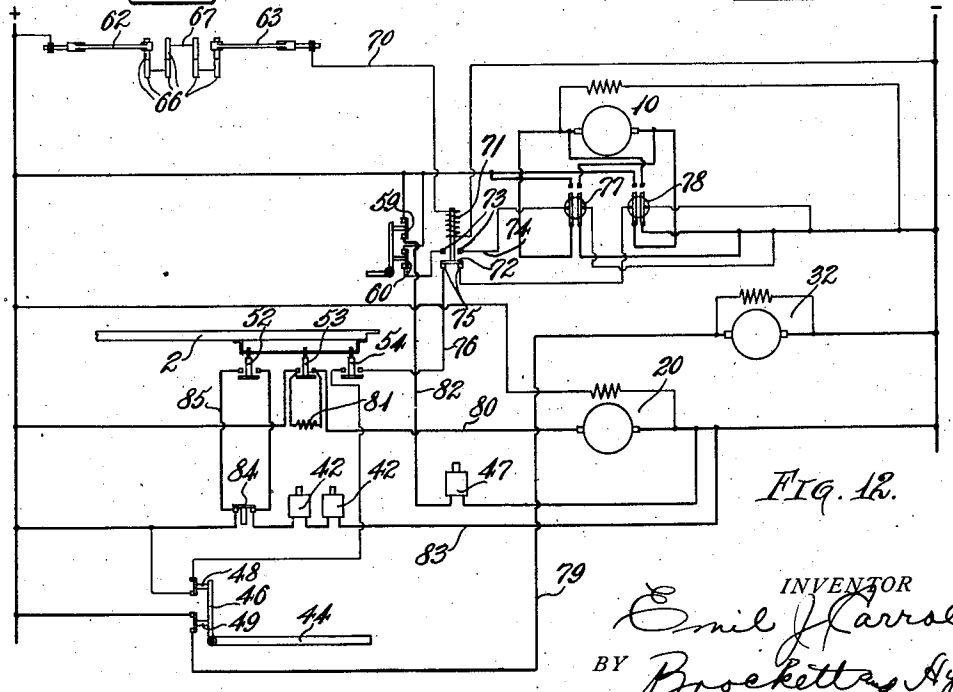


FIG. 12.

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Patented Dec. 29, 1925. 1,567,709

UNITED STATES PATENT OFFICE.

EMIL J. CARROLL, OF CINCINNATI, OHIO, ASSIGNOR TO THE AMERICAN LAUNDRY MACHINERY COMPANY, OF CINCINNATI, OHIO, A CORPORATION OF OHIO.

DRIER.

Application filed June 14, 1922. Serial No. 568,257.

To all whom it may concern:

Be it known that I, EMIL J. CARROLL, a citizen of the United States, residing at Cincinnati, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Driers, of which the following is a specification.

This invention relates to apparatus for drying any moist materials, but more particularly cloth, textile fabrics or articles made therefrom which have been either washed or subjected to the effect of a liquid cleaning agent and from which it is desired to remove the final traces of moisture or liquid.

The object of the invention is to provide improved drying apparatus in which the material to be dried may be dried until the moisture contained therein has been reduced to a pre-determined definite amount as measured by the relative humidity of an air current passing over the material, following which the material may be automatically ejected from the machine, the driving and operating mechanism being so controlled as to leave the machine ready for another cycle of operations.

A further object of the invention is to improve the general construction of the drying machine to enable it to be controlled automatically in the manner before specified and to also improve the controlling devices and operating mechanism for said machine.

Further objects of the invention are in part obvious and in part will appear more in detail hereinafter.

The invention comprises the construction and arrangement of parts hereinafter described and claimed.

In the drawings, which represent one suitable embodiment of the invention, Fig. 1 is a longitudinal sectional view, parts being shown in elevation; Fig. 2 is a detail view of an air inlet, looking in the direction of the arrow A, Fig. 1; Figs. 3 and 4 are transverse sections on the lines 3—3 and 4—4, Fig. 1; Fig. 5 is a sectional plan view on the line 5—5, Fig. 1; Fig. 6 is a detail sectional elevation of the inlet doors on the line 6—6, Fig. 1; Fig. 7 is a detail section on the line 7—7, Fig. 1; Fig. 8 is a detail section on approximately the line 8—8, Fig. 1; Fig. 9 is a horizontal section on the line 9—9, Fig. 1; Fig. 10 is an elevation, partly broken out and in section, of the controlling psychrometer; Fig. 11 is an inverted sectional plan view on the line 11—11, Fig. 10; and Fig. 12 is a diagrammatic view of the electric circuits.

The apparatus shown in the drawings comprises a hollow frame or casing 1 of any suitable form having a floor 2 and pivoted at one end at the point 3 on a horizontal axis on supports 4. The entire frame or casing can be turned about said pivot to vary the inclination to the horizontal of the tube through which the work travels by any suitable means. The drawings show for this purpose a vertical screw 5 engaging a nut 6 provided with a projection 7 lying between ears 7^a for preventing rotation of said nut, and said screw being rotated by the bevel gear 8 actuated by bevel pinion 9 driven by motor 10.

Within the chamber 11 of the hollow casing is an elongated tube 12 having an inner chamber 13, said tube being provided at intervals on its inner surface with inwardly projecting ribs or baffles 14. The tube is normally slightly inclined in the casing when the latter is in horizontal position, as shown in Fig. 1, and is also mounted to rotate therein. For this purpose it is provided with a series of circumferentially extending tracks 15 resting upon flanged rollers 16 carried by supports 17 on the floor 2. One of said supports, marked 17^a, also serves to support a worm 18 engaging a worm wheel 19 on the tube for rotating the same at a relatively low speed. The worm 18 may be driven in any suitable manner such as by an electric motor, indicated conventionally at 20, Fig. 12, said motor being coupled to the worm shaft.

Suitable means are provided for circulating drying air through the chambers 11 and 13. For this purpose the casing is provided with an air supply conduit 21^a having an inlet 21 open to the atmosphere, said conduit communicating with an inlet 22 to the chamber 11. The latter inlet is provided with a suitable screen 23 and a slidable regulating door 24 to more or less open or close the inlet. Adjacent the inlet 22 are a series of heating coils 25 through which any suitable heating medium, such as steam, may be circulated. The air supplied to the chamber 11 is preferably also de-hydrated in any suitable manner, such as by placing within the air supply conduit a series of trays 26 con-

taining suitable de-hydrating material, such as a deliquescent salt, for example, calcium chloride, as indicated at 27. The air admitted to chamber 11 enters the chamber 13 in the rotating tube through a series of perforations 28 at suitable points in the tube. These perforations are shown as distributed in two annular zones beneath two series of heating coils 29 encircling the tube and which may be heated by the same medium circulated through the pipes 25, these coils 29 additionally heating the air current at the zones where it enters the chamber 13. At its upper or inlet end the chamber in the inclined tube communicates with a channel 30 leading to the suction side of a suitable fan or blower 31 operated by a motor 32 shown conventionally in Fig. 12. The outlet from the fan 31 communicates with a passage 33 open to the atmosphere at the outlet 34. Adjacent said outlet is a hinged door 35, which, in the position shown in full lines, Fig. 1, cuts off communication between the outlet and inlet air channels but which may be adjusted to various positions, as indicated by the dotted lines, to more or less open communication between these two channels. This arrangement enables a part of the air which otherwise would be discharged through the outlet to be admitted to the air inlet channel and again circulated through the machine, whenever such method of operation is found advisable.

The rotating tube 12 is provided at its upper end with suitable means for permitting the material to be dried to be introduced thereinto. For this purpose the inlet end of the tube, by a rotating or swivel joint, communicates with a chute 36 the opening to which is normally closed by the pair of inclined hinged abutting doors 39 (Fig. 6). Each of said doors is hinged to the stationary frame and is provided with an arm 40 to which is connected a tension spring 41, said springs tending to hold the doors closed, but enabling them to be pushed apart when the machine is to be loaded. The inclined doors also serve as a hopper or receptacle to receive and support a load of material while it is waiting to be introduced into the machine. With each door, or with the arm 40 thereof, cooperates an electromagnet 42, which, when energized, holds the door in closed position.

The outlet from the tube 12 is closed by a door 43 carried by an arm 44 hinged at 45 to the stationary frame, said arm having an extension 46 beyond its pivot which cooperates with an electromagnet 47, energization of which holds the door closed. Arm 46, when the door is closed, also engages the buttons of two switches, marked 48, 49, normally holding them closed, but permitting them to be opened by their springs whenever the door opens.

Adjacent the inlet end of the machine which rises and falls, the frame or casing is provided with a bracket 50 carrying adjustable screws or other devices 51 adapted to engage the buttons of three switches 52, 53, 54, the purpose of which will appear hereafter. Also, the cap plate 55 which carries the ears 7^a, is provided with an adjustable screw 56 adapted when the casing reaches its highest point of elevation to engage the arm 57 of a bell crank lever carrying adjustable screws 58 to operate the buttons of two normally closed switches 59, 60. When the casing is in its lowest position, shown in Fig. 1, switches 52, 53, 54 are open, but said switches all close when the casing is elevated. Likewise, when the casing is in its lower position, switches 59, 60 are closed but said switches are opened when the casing reaches its highest position and are held open until it is again moved downwardly, whereupon lever 57 drops and said switches are again closed.

The entire apparatus so far described is automatically controlled, so far as the drying effect is concerned, by a suitable instrument sensitive to the humidity of the air current flowing out from the machine. This instrument, known as a psychrometer, may be of any suitable form adapted not only to be subject to humidity of the air current but to also produce a controlling effect upon the other parts of the apparatus. The instrument itself is of the general form illustrated, described and claimed in a co-pending application for psychrometer, filed June 14, 1922, Serial No. 568,240, by myself and George W. Johnson to which reference may be had for a more complete description if desired. Again, the instrument shown in the drawings is identical with that form of instrument shown in my co-pending application for control system for drying apparatus, filed June 30, 1922, Serial No. 571,865, so that full description of all of the details of said instrument is here unnecessary. It is sufficient to state that this controlling psychrometer, indicated generally at 61, Fig. 1, and in detail in Figs. 10 and 11, comprises two switch arms 62, 63, one subject to the influence of a dry bulb thermometer 64 and the other to the influence of a wet bulb thermometer 65, which thermometers, as shown in Fig. 9, are located in the passage 30 leading from the chamber 13 to the fan or blower 31. With said switch arms cooperate several series of contacts 66 interconnected by conducting wires 67, two of said sets of contacts 66 and their cross coupling wires 67 being carried by a detachable plate 68, it being understood that the instrument may be provided with interchangeable plates of this character having the sets of contacts thereon cross coupled or connected to represent various percentages of

relative humidity, as in the instrument shown in the co-pending applications before referred to.

As shown in Fig. 12, the controlling psychrometer, including its dry and wet bulb thermometer controlled switch arms 62, 63 and its contacts 66 and conducting wire 67 is in a circuit 70 including a coil 71, the core of which actuates a switch 72 co-operating with two sets of contacts, to wit, contacts 73 in a circuit 74 and contacts 75 in a circuit 76. Circuit 74 includes the switch 60 before referred to and the coil of a magnetic contactor 77, the contacts of which close a circuit through the motor 10. Circuit 76 includes the coil of another magnetic contactor 78, the contacts of which close another circuit through the motor 10 but with the armature circuit reversed, as will be readily apparent. This circuit 76 also includes switches 54 and 48 before referred to. The circuit for the fan motor 32, indicated at 79, includes the switch 49 before referred to. The circuit for the driving motor 20, which rotates the tube, includes in its armature branch 80 and added resistance 81 adapted to be short circuited by closing the switch 53. Switch 59 is in a circuit 82 which includes the electro-magnet 47, while circuit 83, which includes the two electromagnets 42, also includes a starting button 84 adapted to be short circuited by a branch circuit 85 including the switch 52.

The operation is as follows:

Let us assume that it is desired to dry the clothing or other material until the relative humidity of the air current is reduced to thirty per cent. The particular plate 68 inserted in the controlling psychrometer will therefore be the one having its contacts and cross coupling conductors arranged to make the psychrometer close its controlled circuit when thirty per cent relative humidity is reached.

Let us assume also that the parts are in the position shown in Fig. 1 with a load of moist material in the rotating cylinder and that both the fan motor 32 and driving motor 20 are operating. The air entering the inlet 24 is de-hydrated and is heated by the coils 25 and 29, so that hot dry air enters chamber 13 along two or more zones through the openings 28. All other air inlets than the inlet 21 are closed, so that the traveling hot dry air absorbs moisture from the material in the chamber 13 and carries it to the outlet. The slowly rotating tube, by its baffles 14, turns the material over and over slowly advances it through chamber 13. At the beginning of the operation the relative humidity, of course, is quite high and is usually considerably above thirty per cent, the selected minimum. Therefore, the circuit 70 through the controlling psychrometer is open and coil 71 is de-energized. Coils 42 are energized holding the inlet door closed and coil 47 is energized holding the outlet door closed. Switches 48, 49 and 59, 60 are closed and switches 52, 53, 54 are open, while switch 72 closes circuit 76, which, however, is open at switch 54. The coils of both of the magnetic contactors 77, 78 are de-energized.

The drying operation goes on by the absorption of more and more moisture from the clothes by the hot dry air passed thereover and the first high relative humidity of the air current gradually falls until finally the selected minimum, say thirty per cent, is reached. At this point the two switch arms 62, 63 of the psychrometer reach contacts at opposite ends of a single cross coupling conductor 67 and close the psychrometer controlled circuit 70, thereby energizing coil 71. The effect of this coil is to open circuit 76 at contacts 75 and close circuit 74 at contacts 73. Circuit 74 energizes the coil of contactor 77 and closes a direct circuit through the elevating motor 10, so that said motor immediately begins to operate and turns the screw 5 in the direction to elevate the inlet end of the casing. Promptly the screws 51 leave the buttons of their switches 52, 53, 54, one of the first effects being to short circuit the resistance 81 and speed up the driving motor 20, so that the tube 12 is rotated with increased speed. Also switch 52 closes so that the starting button 84 is short circuited and ineffective and it is impossible to de-energize coils 42 which hold the inlet doors closed. This arrangement prevents the possibility of attempting to introduce another load of material into the machine until it has been emptied and brought back to proper starting conditions, as will appear. Switch 54 closes, but the circuit 76 including said switch is still open at the contact 75.

The elevating motor continues to operate until the screw 56 abuts arm 57 and opens the two switches 59, 60. Opening of switch 60 de-energizes the coil of magnetic contactor 77, so that the elevating motor stops. Opening of switch 59 de-energizes coil 47 so that the outlet door 43 is no longer held closed, but said door promptly opens by gravity and swings outwardly allowing the material in the now steeply inclined cylinder to slide out by gravity into a receptacle, conveyor or chute for delivering it to any suitable point. When the door 43 opens, switches 48, 49 also open, the latter switch 49 breaking the circuit to the fan motor 32 and stopping it, while the former switch 48 breaks the circuit at contacts 72. Opening of switch 48 prevents the circuit 76 being completed, even though switch 72 drops, until after the outlet door is closed, so that it is impossible to actuate the magnetic contactor 78 to connect up motor 10 and pro-

duce lowering motion of the apparatus until the outlet door is closed.

As soon as the outlet door opens atmospheric air rushes freely into chamber 13 and affects the thermometers of the controlling psychrometer, moving its switch parts to new positions because the relative humidity of the atmosphere is usually different from the selected minimum relative humidity. Therefore, opening the outlet door to discharge the material also has the effect of opening circuit 70 and de-energizing coil 71, thereby allowing switch 72 to drop ready for subsequent actuation or control by the psychrometer at the conclusion of another drying operation.

Door 43 may now be closed by hand, which closes switch 48 and completes circuit 76, whereupon magnetic contactor 78 completes a circuit to motor 10, but with the direction of current through the armature reversed so that screw 5 is rotated in the opposite direction and the casing is lowered to its normal position shown in Fig. 1. The first effect of the lowering movement is to allow lever 57 to drop, thereby permitting switches 59, 60 to close. Closing of switch 60 produces no effect because the relay is open at contacts 73, but the closing of switch 59, which occurs fairly promptly after lowering movement begins, energizes coil 47 and holds door 43 closed. Closing of switch 49 starts the fan motor 32. When the casing reaches its lower or normal position, switches 52, 53, 54 are all opened. Opening of switch 54 breaks the circuit to the magnetic contactor 78 which in turn opens the circuit to the elevating motor 10. Opening of switch 53 inserts the added resistance 81 in the armature circuit of motor 20 and reduces its speed of rotation, while opening of the switch 52 renders the start button 84 effective. Another load of material to be dried having been deposited in the hopper formed by the closed doors 39 at the inlet of the machine, start button 84 is pressed, which de-energizes coils 42 and permits the doors 39 to open by gravity and allow the material to slide into the machine, after which the doors 39 are closed by spring 41. The start button 84 is released and coils 42 are again effective to hold the inlet doors closed.

The cycle is again repeated.

It has been found from experience that from the beginning to the end of a drying operation the relative humidity of the air current at the psychrometer increases rapidly to a maximum and then gradually falls until finally the selected minimum per cent is reached. Also, experience has shown that on the average any batch of material is properly dried when the selected minimum relative humidity is made approximately one-half of the maximum relative humidity in the early stages of the drying operation. This law does not seem to be founded upon any special ground but is a law of experience enabling the proper one of the interchangeable psychrometer plates 68 to be readily selected under any given conditions of relative humidity in the atmosphere, heating effect of the heating coils, atmospheric temperature etc. It is only necessary to run one batch of material through and observe the maximum relative humidity as indicated upon an indicating psychrometer such as described in my copending applications above referred to and select a plate 68 representing one-half of the observed maximum relative humidity.

The invention described enables the drying operation to be carried out automatically. Materials to be dried may be delivered in proper quantity into the receiving hopper directly from a chute or conveyor and the attention of the operator is only required for closing the door 43 and pressing the start button to allow the material to slide into the machine.

Having described my invention, I claim:

1. Drying apparatus, comprising a receptacle within which the material to be dried is placed, means for circulating air around the material to absorb moisture therefrom, and means sensitive to the humidity of the moisture laden air for causing ejection of the material from said receptacle when the relative humidity reaches a predetermined minimum.

2. Drying apparatus, comprising a receptacle for holding material to be dried and provided with an outlet door through which the material is discharged therefrom, means for circulating air around the material to absorb moisture therefrom, and means sensitive to the humidity of the moisture laden air for opening said door when the relative humidity reaches a predetermined minimum.

3. Drying apparatus, comprising a receptacle for containing material to be dried and provided with an outlet door, said receptacle being adapted to have its bottom tilted to an inclined position to cause the material therein to flow to and through the outlet, means for circulating air around the material for absorbing moisture therefrom, and means sensitive to the humidity of the moisture laden air for opening said door and causing inclination of the bottom of said receptacle to eject the material through said opening when the relative humidity reaches a predetermined minimum.

4. Drying apparatus, comprising a receptacle for material to be dried, means for tilting said receptacle to eject material therefrom, means for circulating air through said receptacle for absorbing moisture from the material to be dried, and means sensitive to the humidity of the moisture laden air for controlling said tilting means.

5. Drying apparatus, comprising a rotary cylinder for containing material to be dried, means for rotating said cylinder, means for producing a flow of air through said cylinder for absorbing moisture from the material, and means sensitive to the humidity of the moisture laden air for controlling the speed of rotation of said cylinder.

6. Drying apparatus, comprising a rotatable drum for containing material to be dried, means for rotating said drum, means for producing flow of air through said drum to absorb moisture from the material therein, and means sensitive to the humidity of the moisture laden air for increasing the speed of rotation of said drum when the relative humidity reaches a predetermined minimum.

7. Drying apparatus, comprising a drum rotatable about its own axis and adapted to contain material to be dried, said drum being mounted to turn about a transverse axis to produce increasing inclination of its own axis to the horizontal for causing material therein to slide to an outlet, means for producing flow of air through said drum to absorb moisture from the material therein, and means sensitive to the humidity of the moisture laden air for increasing the speed of rotation of said drum and for also tilting the drum about said transverse axis to produce increasing inclination of the drum axis to the horizontal.

8. Drying apparatus, comprising a receptacle for material to be dried, means for circulating air around said material to absorb moisture therefrom, and means sensitive to the humidity of the moisture laden air for ejecting material from receptacle and stopping operation of said air circulating means.

9. Drying apparatus, comprising a receptacle mounted to tilt for ejection of material to be dried therefrom, means for circulating air around said material for absorbing moisture therefrom, and means sensitive to the humidity of the moisture laden air for tilting said receptacle and stopping operation of the air circulating means.

10. Drying apparatus, comprising a rotatable drum mounted to tilt about a horizontal axis for ejecting material to be dried therefrom, means for rotating said drum, means for increasing the tilt or inclination of said drum, and means controlled thereby for increasing the speed of rotation of the drum.

11. Drying apparatus, comprising a drum rotatable about its own axis and adapted to contain material to be dried, said drum being provided with an inlet door, means for turning said drum to increase the inclination of its axis to the horizontal, and means adapted when said drum is so tilted to prevent opening movement of said inlet door.

12. Drying apparatus, comprising a casing containing a rotary drum for holding material to be dried, means for raising one end of said casing to more steeply incline the drum axis, and means actuated when said casing is raised for preventing reverse operation of said casing raising means.

13. Drying apparatus, comprising a rotatable drum mounted for up or down movement at one end to increase or decrease the inclination of its axis to the horizontal, the opposite end of said drum being provided with an outlet door, means normally holding said door closed, and means controlled by tilting movement of the drum for rendering said door holding means ineffective.

14. Drying apparatus, comprising a receptacle for material to be dried provided with an outlet through which material is ejected therefrom, a door for said outlet, means for circulating air around said material to absorb moisture therefrom, and means controlled by said door for regulating the operation of said air circulating means.

15. Drying apparatus, comprising a drum mounted to rotate about its own axis and adapted to contain material to be dried, means for rotating said drum, said drum being also mounted to tilt about a transverse axis to vary the inclination of its own axis to the horizontal, and means controlled by tilting movement of said drum about said transverse axis for controlling the speed of rotation of said drum.

In testimony whereof I hereby affix my signature.

EMIL J. CARROLL.