

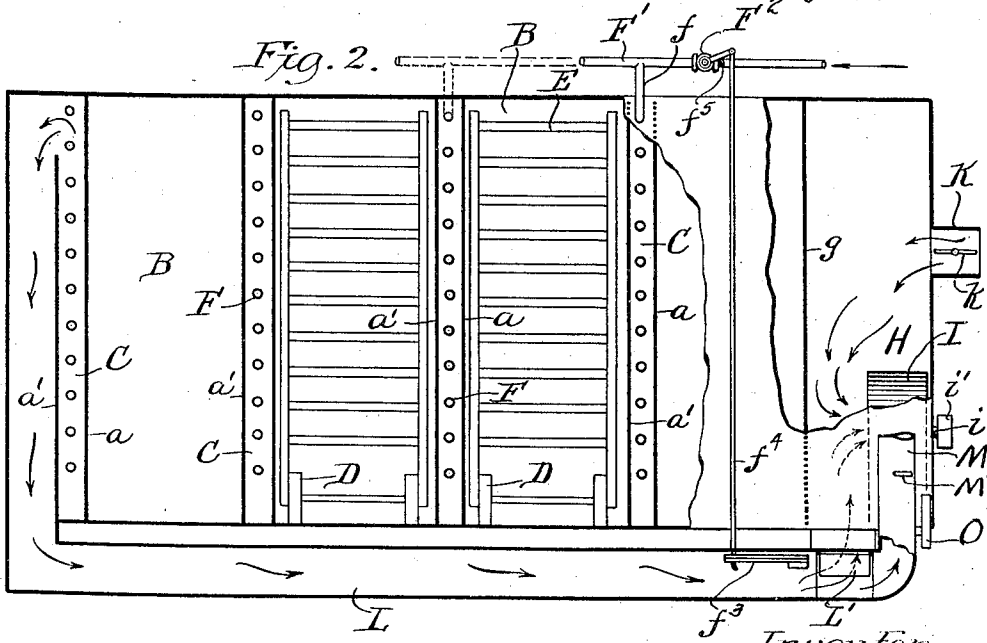
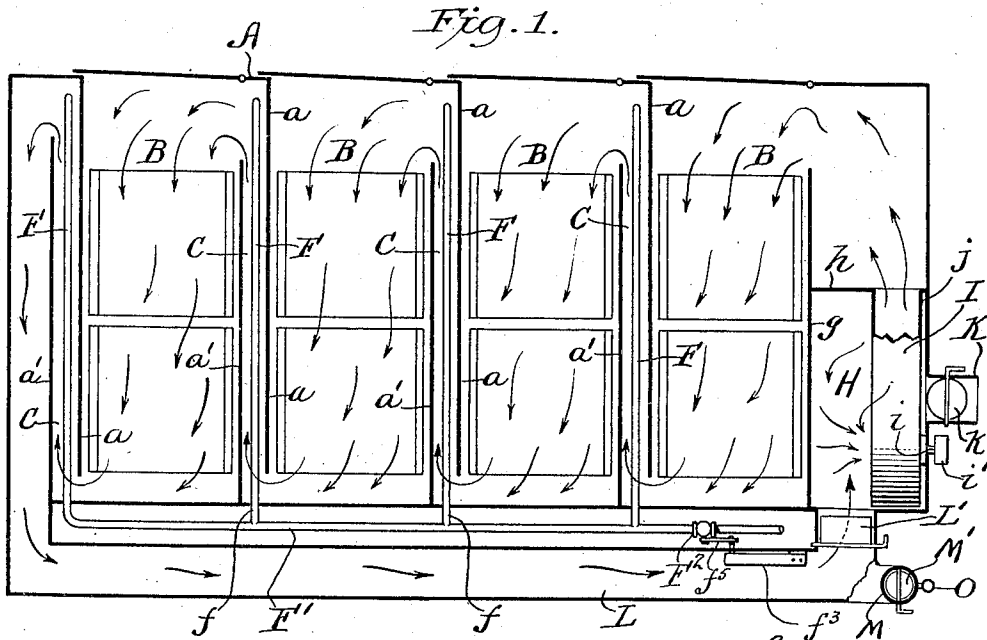
Nov. 2, 1926.

1,605,634

A. F. WRIGHT

ART OF DRYING

Original Filed July 9, 1919



Inventor,
Archibald F. Wright,
By *N. J. Bernhard*
Attorney.

UNITED STATES PATENT OFFICE.

ARCHIBALD F. WRIGHT, OF STAMFORD, CONNECTICUT, ASSIGNOR TO THE INDUSTRIAL DRYER CORPORATION, OF STAMFORD, CONNECTICUT, A CORPORATION OF CONNECTICUT.

ART OF DRYING.

Original application filed July 9, 1919, Serial No. 309,705. Divided and this application filed April 19, 1926. Serial No. 102,827.

This invention pertains to the art of drying various materials or products of widely different characters.

The method or process which constitutes the subject-matter of this application is a division of another application for a drying apparatus filed by me on July 9, 1919, Serial No. 309,705, and which method or process was disclosed, in part, in a prior application filed July 9, 1919, Serial No. 309,706.

According to my method, a drying atmosphere conditioned as to both temperature and moisture content in definite proportions is circulated into contact with material to be treated, for effecting the exchange of heat for moisture, but leaving the material in a condition for the free exudation of moisture, i. e., without producing on the surface of such material a film or skin which is likely to interfere with the diffusion of moisture from the interior or body of the material. During the period of such circulation of the drying atmosphere it remains in a condition wherein its moisture content and its temperature are constant, or substantially constant, in their relative proportions, and this conditioning of such atmosphere is effected concurrently with its recirculation into contacts repeatedly with the material under treatment, such conditioning of the atmosphere being attained by a minimum loss of heat energy to the ultimate end that moisture is evaporated from the material with rapidity and by an economical expenditure of fuel.

The recirculation of the drying atmosphere into repeated contacts with the material for exchanging heat for moisture will result ultimately in a condition of moisture saturation, wherein the recirculated atmosphere tends to deposit moisture upon, rather than to pick up moisture from, the surface of such material. The presence of moisture in the drying atmosphere is beneficial, rather than detrimental, provided the percentage of moisture is not excessive, dependent upon the character of the material under treatment, but, obviously, such atmosphere is required to be at a determined temperature for the function of exchanging heat for moisture. Obviously, the practice of passing a drying atmosphere once into

contact with the material, and thence discharging such atmosphere from the presence of the material is uneconomical, involving a substantial loss of heat energy for the reason that heat units supplied to and present in the discharged atmosphere are wasted.

It has been proposed to recirculate a drying atmosphere into contact repeatedly with the material to be treated, but such recirculation has been performed under conditions which tend to deposit moisture upon the material rather than to evaporate moisture from the same. This may be attributable to the lack of provision for the maintenance of the drying atmosphere in a condition wherein the moisture content and the temperature are in definite proportions, to the end that the heat units present in the atmosphere are exchanged for moisture on the surface of the material while leaving such surface in a condition for the free transudation of that moisture contained within the body or mass of the material under treatment. For conditioning the drying atmosphere in the cycles of its recirculation, my invention includes a procedure, wherein the atmosphere is revitalized by discharging a part of the operating air and by replenishing with fresh air the volume of which is equal substantially to the operating air so discharged, and the mixed air is further conditioned by radiating heat units thereinto for the maintenance of the definite temperature required.

In the treatment of material in accordance with my invention, a drying atmosphere at a determined temperature and with a determined moisture content is recirculated into contacts repeatedly with the material under treatment. Such recirculation effects the exchange of heat for moisture with the result that after an appreciable lapse of time, more or less, the atmosphere indicates a condition where it is or may be charged with a too high moisture content and there is brought about a decrease in the temperature of such atmosphere due to such exchange of heat for moisture. At such stage, the atmosphere is conditioned both as to humidity and temperature to the end that the relative proportions of moisture content and heat unit may remain constant,

or substantially so, during the cycles of recirculation of the atmosphere. To these ends, my procedure involves the discharge from the circulatory path of a given volume of the moist operating air, the replacement of such discharged air with a substantially equal volume of fresh atmospheric air supplied from a source separate from the circulatory path, whereby to condition the operating air with respect to its moisture content and to revitalize the operating air, and, further, the fresh air so mixed with the returning operating air is further conditioned by radiating heat units thereto, whereby to restore the circulating atmosphere to the required temperature.

My procedure of conditioning the drying atmosphere in the cycles of its recirculation utilizes to a certain extent the heat units theretofore supplied to the operating air, for the reason that a part only of such operating air is discharged from the circulatory path, and the remainder of the warm and moist operating air is returned to the circulatory path and is utilized by conditioning such remainder of the operating air by the addition thereto, and the admixture therewith, of fresh atmospheric air the volume of which is equal substantially to the operating air so discharged. I am thus able to condition the operating air economically, for the reason that the returning air is in a more or less warm condition, having been previously heated to the required operating temperature, but it is to be noted that the returning operating air is conditioned not only as to its moisture content by the admixture of fresh atmospheric air therewith, but such mixture of fresh atmospheric air with the returning operating air is further conditioned by radiating heat units into the resulting atmosphere for the maintenance of such atmosphere at the desired temperature.

For controlling the conditioning of the drying atmosphere, both as to its moisture content and as to its temperature, provision is made for ascertaining the moisture content of such atmosphere, and for conditioning such atmosphere as to its moisture content by discharging through a controllable outlet from the circulatory path a definite volume of warm humid operating air, and by replenishing such drying atmosphere with a similar volume of fresh atmospheric air supplied through a controllable inlet to the circulatory path. Furthermore, provision is made for the control of the radiator by which heat units are supplied to the drying atmosphere, to the end that the temperature may remain constant, or substantially constant.

The steps of conditioning the drying atmosphere as to its moisture content by the admixture of fresh air therewith, and of reheating the drying atmosphere, take place

concurrently with the recirculation of such atmosphere within an operating chamber within which the material is exposed to the action of such recirculated atmosphere; but it is to be noted that the drop in temperature in the operating air due to the exchange of heat for moisture, and the tendency of such operating air to become charged with excess moisture, are compensated for by revitalizing the air to maintain the moisture content and the temperature in relative proportions to each other during the period of recirculating the drying atmosphere.

An apparatus suitable for carrying my invention into practice is disclosed in the accompanying drawings, wherein—

Figure 1 is a sectional plan view, and

Figure 2 is a diagrammatic view partly in vertical section taken longitudinally through the apparatus substantially centrally thereof.

A is an appropriate housing, divided internally by a plurality of partitions *a, a', g, h*, to result in a plurality of material chambers, B, a plurality of radiator chambers, C, and a fan chamber, H. The radiator chambers C are in alternate relation to material chambers B, and in the apparatus shown the intakes to, and the exits from, the chambers C are so arranged that a drying atmosphere, circulated by a blower or exhaustor, I, flows from the chamber H to and within chambers B, C, successively, i. e., the atmosphere flows out of chamber H into and within one chamber B, thence it flows into and within one radiator chamber C next to B, thence it flows into and within the next chamber B, and so on successively within chambers B, C, alternately until at the end of the series of chambers B, C, as indicated by the arrows denoting the circulation in Figure 1.

The material to be treated is supported by any suitable means within chambers B. As shown, the material is in a separated or divided condition on trays E, carried by wheeled trucks D, the latter being insertable into and removable from chambers B through appropriate doors.

Within chambers C are radiators or heaters, F, adapted to be supplied with an appropriate heating medium, such as steam, hot air, furnace gases, etc. The radiators are shown as steam coils, suitably positioned within chambers C, provision being made for supplying steam through branch pipes *f* from a main *F'*.

For controlling the heat radiated from heaters F, a valve *F²* is provided in the steam main *F'*, said valve being operable as and when required. As shown, the valve is operated automatically by a drop in temperature of the drying atmosphere below the required limit, and in order that said steam valve may respond to the temperature condition of said atmosphere, I have provided

a thermostat f^3 in the line of flow of the atmosphere within the return duct L, said thermostat being operatively connected through a link f^4 with a crank f^5 on the

5 steam valve.

The blower or fan I is positioned within chamber H, the intake to the blower having communication freely with said chamber. As shown, the shaft i of the fan extends through the housing A for receiving a driving pulley i' . The outlet from blower I is a wind trunk j , which extends to, and through, partition h , for delivering a current of air into a chamber within the housing, whence the air circulates within chambers B, C, in succession.

A drying atmosphere, usually air conditioned as to its humidity and temperature, flows within a closed circulatory path constituted, in part, by chambers B C, and in part by return flue L, the latter leading the moist warm air current from the last chamber B or C of the series back to the blower chamber H, whence the air, or at least a larger proportion of such air, is drawn into the intake of the blower, whereby the atmosphere is adapted for recirculation into contacts repeatedly with the material present in chambers B. Usually, the return flue L extends at the lower rear side of the housing, one end portion of said flue L being connected with the last chamber B or C for receiving warm moist air therefrom, whereas the other end portion of said flue L is in communication with an exit stack or uptake M, and is in communication, also, with blower chamber H, as shown. The flow of moist warm air from return flue L into the stack or uptake M is controllable by the adjustment of a damper M' , shown as extending crosswise of the stack, whereas the flow of some of the operating air from return flue L to the blower chamber H is in like manner controllable by a damper L' .

It is important in the control of the operation for the attendant to ascertain the moisture content of the circulating air, in order that the volume of moist air to be discharged may be determined, and to this end a hygrodeik O, (wet and dry bulb thermometer), is provided at a suitable place convenient for inspection, usually in the stack M, see Figure 2.

Provision is made for supplying fresh atmospheric air to the circulatory path for the drying atmosphere and from a source independent of the atmosphere flowing within said path. To this end, I provide a fresh air inlet K having direct communication with the blower chamber, said inlet K being equipped with a damper k for regulating the flow of a volume of fresh air to the circulatory path within which flows said drying atmosphere.

65 The dampers k , L' , M' , are adapted for

operation in a suitable way or by appropriate means, the means provided being adapted for manual operation. These dampers are adjusted for conditioning the drying atmosphere as to the moisture content thereof. Should the indication afforded by the hygrodeik O show an excess of moisture in the drying atmosphere, damper M' is opened, more or less, for discharging a determined volume of moist air from the circulatory path, and concurrently with the manipulation of said damper control for the discharge of moist air, the damper L' is closed, more or less, for cutting down the volume of moist warm air drawn into chamber H by the action of the blower, and, further, damper k is opened, more or less, for admitting fresh atmospheric air to said blower chamber. A determined volume of moist warm air is thus admitted by flue L to the blower chamber, and a determined volume of fresh air through inlet K is likewise supplied to the blower chamber, such warm moist air and the fresh air being mixed and being drawn into the blower, whence the mixed air is recirculated within chambers B, C, into contacts repeatedly with the material, and into contacts with the radiators F, the latter supplying the heat units to the atmosphere for the maintenance of the required temperature.

The atmosphere is thus recirculated for carrying heat units and moisture to the material under treatment, and during the cycles of its recirculation, such atmosphere is conditioned by the admixture of fresh air therewith and it is reheated, whereby the humidity and temperature are maintained in definite proportions relatively to each other during the cycles of recirculation of such atmosphere. It follows that the drying atmosphere is maintained both as to temperature and humidity in a condition efficient for the exchange of heat for moisture, and such procedure in conditioning the atmosphere is effected without cessation of the drying operation, and it is attained by utilizing to an appreciable extent some of the warm moist operating air, thus attaining economy.

The operation will be understood from the description taken in connection with the drawings. The trays containing the material are loaded on the trucks, and said trucks are run into the chambers B. Dampers k , L' , M' are adjusted, steam is supplied to radiators F, and blower I is set into operation for recirculating air within the closed circulatory path. The air is heated by the action of the radiators, and such air flows into contacts repeatedly with the material, thus exchanging heat for moisture. The air flows from the last chamber of the series into flue L by which it is conducted partly to the blower chamber H and partly

to stack M, but the volume returned to the circulatory path is controlled by the adjustment of damper L' and the volume discharged through stack M is controlled by the adjustment of chamber M'. Damper k in the fresh air inlet K being open, more or less, fresh air is drawn by the blower into chamber H, and thus moist warm air from flue L and fresh air admitted by inlet K are mixed within chamber H so as to be drawn into the intake of the blower, the latter acting to recirculate the mixed air within the chambers.

The apparatus herein disclosed constitutes the subject-matter of a separate application filed by me on July 9, 1919, Serial No. 309,705.

Having thus fully described the invention, what I claim as new and desire to secure by Letters Patent is:

1. In the art of drying, the process which consists in circulating a drying atmosphere, the moisture content and temperature of which are in constant proportions, into contacts repeatedly with the material to be dried, and conditioning such atmosphere for the maintenance of the moisture content and temperature in the required constant proportions during the cycles of its recirculation by mixing fresh atmospheric air with such atmosphere and reheating the atmosphere.

2. In the art of drying, the process which consists in circulating a drying atmosphere, the moisture content and temperature of which are in constant proportions, into contacts repeatedly with the material to be dried, conditioning such atmosphere as to its moisture content by discharging some of the moist atmosphere and mixing fresh atmospheric air with the remainder of the moist atmosphere to be recirculated, and reheating the conditioned atmosphere composed in part of fresh atmospheric air and in part of the moist air to be recirculated sufficient to maintain said proportions constant.

3. In the art of drying, the process which consists in circulating a drying atmosphere, the moisture content and temperature of which are in constant proportions to each other, into contacts repeatedly with the material to be dried, and during the cycles of its recirculation conditioning said drying atmosphere both as to its moisture content and as to its temperature for the maintenance during such recirculation of the humidity and temperature in constant proportions.

4. In the art of drying, the process which consists in circulating a drying atmosphere, the moisture content and temperature of which are in constant proportions to each other, into contacts repeatedly with the ma-

terial to be dried, and during the cycles of recirculation of such drying atmosphere conditioning the said atmosphere by discharging a definite volume of moist air from the recirculatory path, by admitting to and mixing with the remainder of such atmosphere a definite volume of fresh atmospheric air, and by radiating heat units into the mixed air undergoing recirculation sufficient to maintain said proportions constant.

5. In the art of drying, the process which consists in circulating within a closed circulatory path a drying atmosphere the moisture content and temperature of which are in constant proportions, conditioning such atmosphere as to its moisture content during such recirculation by discharging from the circulatory path a definite volume of moist air and feeding to such circulatory path a definite volume of fresh air for admixture with the remaining atmosphere during the recirculation thereof, and reheating the drying atmosphere during such recirculation thereof, whereby the constant proportions of temperature and moisture content are maintained in the atmosphere during its recirculation.

6. In the art of drying, the process which consists in circulating within a closed circulatory path a drying atmosphere the humidity and temperature of which are in constant proportions, conditioning such atmosphere as to its moisture content by discharging from the circulatory path a controllable volume of moist atmosphere and feeding to such circulatory path a controllable volume of fresh atmospheric air, whereby the moisture content of the atmosphere is kept in the constant proportion during such recirculation, and reheating the atmosphere for keeping the temperature at the constant proportion during such recirculation.

7. In the art of drying, the process which consists in circulating within a closed circulatory path a drying atmosphere the humidity and temperature of which are in constant proportions, conditioning such atmosphere as to humidity by discharging from the circulatory path a controllable volume of moist atmosphere and feeding to such circulatory path a controllable volume of fresh atmospheric air, whereby the fresh air is mixed with the remainder of the atmosphere and is recirculated therewith, and reheating the drying atmosphere mixed with fresh air, whereby the humidity and the temperature are kept in the constant proportions during the recirculation of the drying atmosphere.

In testimony whereof I have signed my name this 13th day of April, 1926.

ARCHIBALD F. WRIGHT.