June 29, 1926. 1,590,273

D. S. BAKER

METHOD AND APPARATUS FOR CONDITIONING MATERIALS

Filed Jan. 17, 1923 2 Sheets-Sheet 1

Fig. 1.

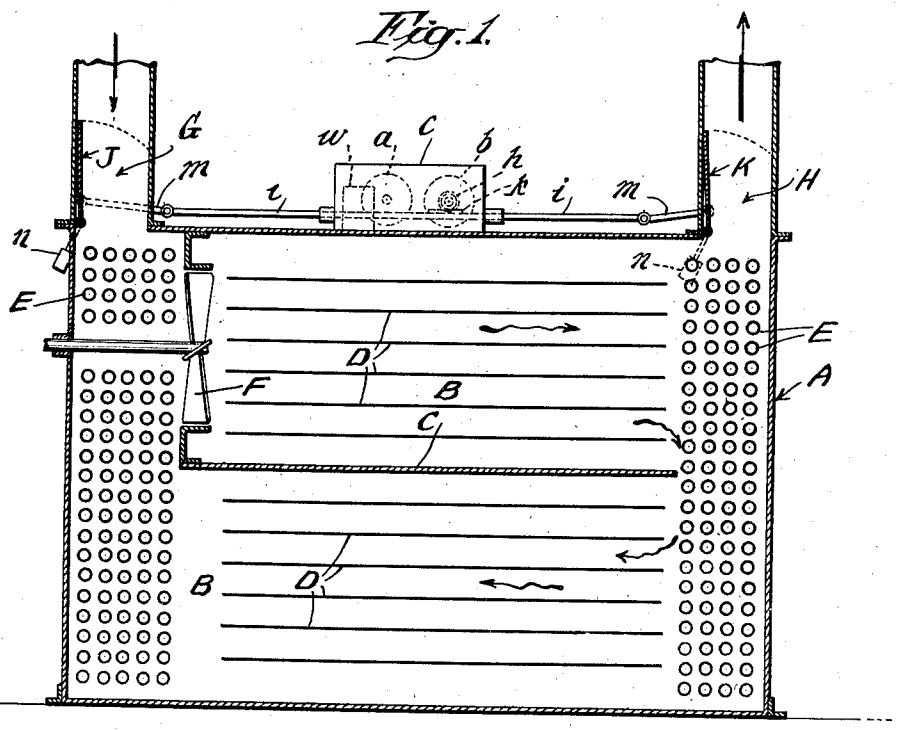
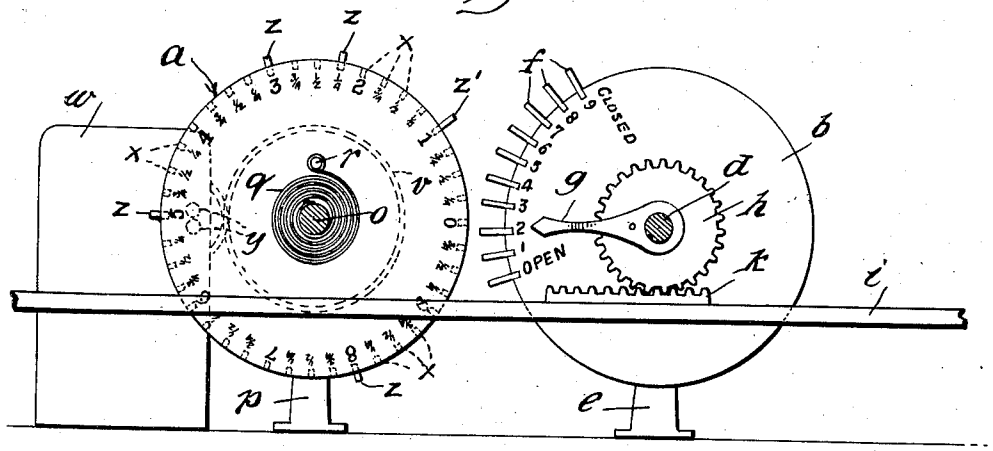


Fig. 2.



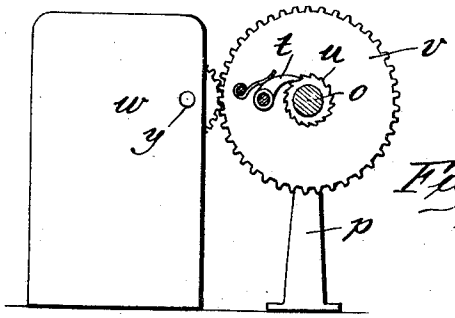


Fig. 3.

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Fig. 4.

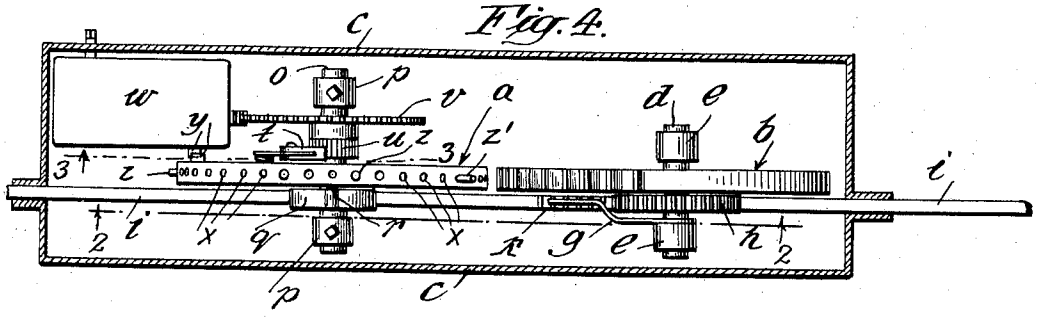
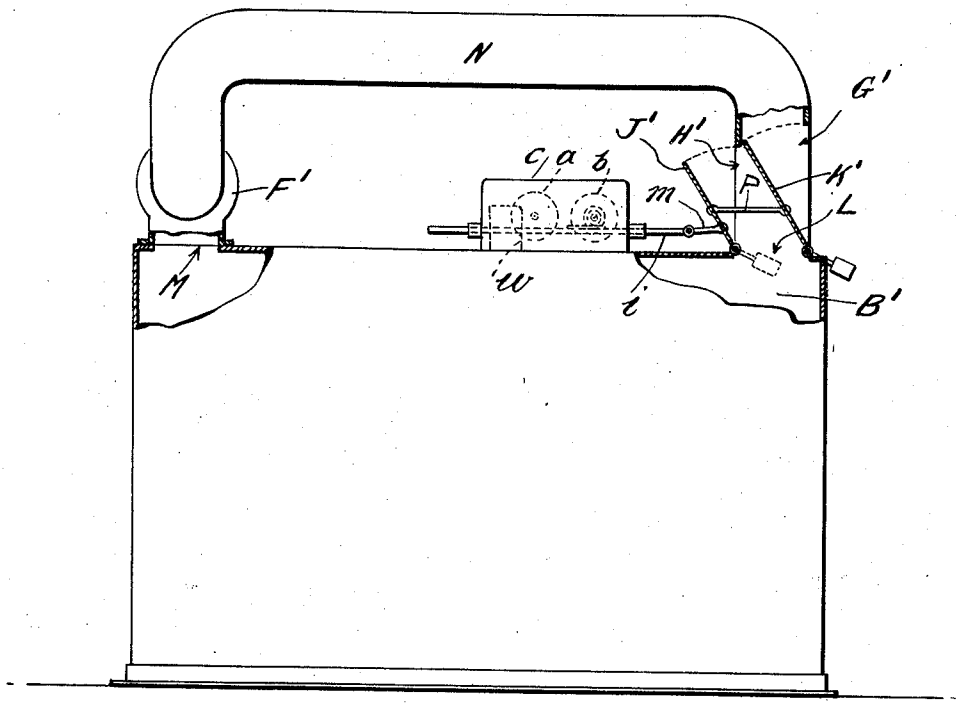


Fig. 5.



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UNITED STATES PATENT OFFICE.

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METHOD AND APPARATUS FOR CONDITIONING MATERIALS.

Application filed January 17, 1923. Serial No. 613,241.

This invention relates to a method and apparatus for conditioning materials, and aims to facilitate the drying or otherwise conditioning of materials by subjecting them to contact with a gaseous medium having predetermined moisture content throughout the treatment.

An important object of the invention is to reduce the heat consumption in the drying of materials.

The invention provides an improvement in the method of conditioning materials in which a mass of the material is placed in a closed chamber through which a gaseous medium is circulated. In the apparatus heretofore used in carrying out this method, it has been customary to recirculate a part or all of the gaseous medium contained in the chamber. When only a part of the gaseous medium is recirculated, fresh gaseous medium is introduced into the chamber while a part of the medium which is passed over the material is withdrawn from the chamber. It has been customary to provide dampers for controlling the proportion of the gaseous medium which is recirculated.

The desirability of regulating the moisture content of the gaseous medium in the chamber throughout the treatment has long been recognized. The only practical method heretofore used for securing such regulation has been to introduce a hygrometer into the gaseous medium during each treatment and to regulate the proportion of new gaseous medium introduced throughout the treatment in accordance with the indications of the hygrometer. To accomplish such regulation manually has required constant attention on the part of a skilled operator. To accomplish such regulation by automatic means controlled by the hygrometer has necessitated the use of very elaborate and expensive mechanism.

The method which I have invented makes possible proper regulation of the moisture content of the gaseous medium throughout the treatment without the inconvenience or expense involved in the methods previously used.

In accordance with my invention, a sample of the material is first tested to ascertain the amount of moisture given off by the material during definite time intervals of the period required for conditioning the material. In the subsequent conditioning of other masses of the same material, the proportion of the gaseous medium recirculated is varied at definite time intervals, predetermined in accordance with the results and data obtained from the test so as to maintain the moisture content of the gaseous medium, throughout the treatment, at that required for most efficient treatment.

The invention includes also a simple and inexpensive automatic controlling mechanism for use in carrying out the new method.

In order that the invention may be clearly understood, I will describe in detail a specific method embodying it and also a specific apparatus for use in carrying out the method. This apparatus is illustrated in the accompanying drawings, in which:—

Fig. 1 is a diagrammatic sectional front elevation of a dryer provided with controlling mechanism embodying the invention;

Fig. 2 is an enlarged front elevation of the controlling mechanism sectioned on the line 2—2 of Fig. 4;

Fig. 3 is a vertical section on the line 3—3 of Fig. 4;

Fig. 4 is a top view of the controlling mechanism shown in Fig. 1; and

Fig. 5 is a front elevation of a different type of dryer provided with controlling mechanism embodying the invention.

As a specific method illustrative of my invention, I will describe the conditioning of a material, where the object sought is to dry the material completely with the least possible consumption of heat. The drying may be accomplished in a dryer of ordinary construction, such, for example, as that illustrated in Fig. 1.

The dryer shown in Fig. 1 consists of a casing A enclosing a drying chamber B subdivided into two flow passages by a partition C. Above and below the partition C are supports D for the material to be dried. At each end of the chamber B are steam pipes E for heating the drying medium, which is usually air. A mechanically driven blower F is provided for causing a circulation of the drying medium in the chamber.

At the top of the casing A are an inlet opening G and an outlet opening H. These openings are controlled by the dampers J and K, respectively. It is apparent that when both these dampers are closed, all the drying medium contained in the chamber B will be recirculated in the chamber by the action of the blower F. If, on the other hand, both these dampers are open, as shown

in Fig. 1, fresh drying medium will be drawn in through the opening G, while some of the drying medium which has already passed over the material will escape through the opening H.

When, therefore, the dampers J and K are in any position other than completely closed position, a part of the drying medium present in the chamber B at any given time is discharged through the opening H and replaced by fresh drying medium drawn in through the opening G; while the remainder of the drying medium present in the chamber at said time is recirculated in the chamber. The ratio of that part of the gaseous contents of the chamber which is not discharged from the chamber, but is re-used to the total gaseous content of the chamber will hereinafter be referred to as "the proportion of the drying medium recirculated". The proportion recirculated at any time is determined by the position of the dampers J and K.

In order to accomplish the object sought in the specific illustrative method, that is, to avoid the waste of heat, the proportion recirculated should at all times be made as large as possible, while on the other hand, sufficient fresh drying medium must always be added to keep the moisture content of the medium in the chamber low enough for effective drying.

The first step of the method consists in drying a sample mass of the material and determining, for example, by means of a hygrometer, the amount of moisture given off by the material during definite time intervals of the drying period. It will, ordinarily, be found that moisture is given off much more rapidly at the beginning of the period than near the end. From the data so obtained, it is then determined how large a proportion of the drying medium may be recirculated during each such time interval of the drying, without making the moisture content of the drying medium in the chamber too high for effective drying.

The next step consists in utilizing the data so obtained in drying other masses of the same material. This step is carried out by placing such other masses successively in the drying chamber B, and during each treatment varying the proportion of the drying medium recirculated at definite time intervals, so predetermined in accordance with the data obtained in the first step of the method, that during each time interval of the treatment the proportion of recirculation is as large as it can be without making the moisture content of the drying medium in the chamber too high for effective drying. By such intermittent variation of the proporion of recirculation at predetermined time intervals, the moisture content of the drying medium in the chamber may be retained approximately uniform throughout the treatment.

It will be understood that the method may be applied to the conditioning of materials in other ways than by drying, and that the method may be carried out so as to obtain any desired variation of the moisture content of the medium in the chamber during the treatment.

The second step of the method may be carried out with the aid of the automatic controlling mechanism which is shown in the drawings. The controlling mechanism may be used in connection with the type of dryer shown in Fig. 1, and arranged to vary the position of the dampers J and K at predetermined time intervals.

The controlling mechanism shown in Fig. 1 is mounted on the casing A of the dryer which has already been described. This mechanism comprises a time member *a* which is moved at a uniform, predetermined rate, and an actuating member *b*, which is connected with the dampers J and K. The time member and the actuating member are provided with cooperating engaging members, by means of which the time member moves the actuating member. The engaging members of the time member are removable so that the predetermined times at which the actuating member is moved and the amount of each movement thereof may be changed in accordance with the nature of the material to be treated.

In the form illustrated, the time member *a* and the actuating member *b* have the form of discs which are mounted side by side in a casing or box *c* which is secured to the top of the casing A of the dryer.

The actuating disc *b* is fixed on a short stub shaft *d* rotatably mounted on brackets *e* secured to the bottom of the box *c*. On the periphery of the actuating disc *b* are a number of equally spaced projections or teeth *f*. These teeth are individually identified by the word "Closed" and figures from "1" to "9" stamped on the face of the disc *b*. At a distance from the figure "9" equal to the distance between adjacent teeth, the word "Open" is stamped on the disc. A pointer *g* is fixed to one of the brackets *e* and directed horizontally toward the time disc *a*. The actuating disc *b* is connected to the dampers J, K in such manner that the dampers are both completely open when the disc is turned so as to bring the word "Open" in front of the pointer *g*, and are both completely closed when the word "Closed" is brought in front of the pointer *g*. The connection between the disc *b* and the dampers, which is illustrated in the drawing, consists of a pinion *h* fixed on the stub shaft *d*, a slide bar *i* bearing a rack *k* engaging the pinion *h* and connected to the dampers J, K by means of hinged connecting rods *m*. The dampers J

and K are counterbalanced by weights *n*, *n*. These counter-weights and the friction in the connecting mechanism between the dampers in the actuating disc *b* cause the dampers and the actuating disc *b* to remain in any position in which they may be placed until some force is applied to move them.

The time disc *a*, as illustrated in the drawing, is rotatably mounted on a stub shaft *o* fixed on brackets *p* secured to the bottom of the box *c*. On one side of the time disc *a* is a coiled spring *p* having its ends fixed, respectively, to the stub shaft *o* and to a pin *r* on the disc *a*, and wound in such direction that it tends to turn the time disc *a* in a clockwise direction. On the other side of the time disc *a* is fixed a pawl *t* which cooperates with a ratchet *u* secured to a gear *v* which is rotatably mounted on the stub shaft *o*. The rate of turning of the time disc in a clockwise direction is determined by clock mechanism contained in a casing *w* and providing an escapement and a train of gears, one of which meshes with the gear *v*. As this clock mechanism is of ordinary construction, it is not illustrated or described in detail herein. The clock mechanism is so regulated that when the spring *q* is wound up the time disc *a* turns at the rate of one revolution in ten hours. The spring *q* may be wound up by turning the time disc *a* in an anti-clockwise direction, as during such turning the pawl *t* slips over the teeth of the ratchet *u*.

In the periphery of the time disc *a* are forty equally spaced holes *x*. These holes are identified by figures "0", "¼", "½", "¾", "1", etc., stamped on the face of the time disc *a*. On the clock casing *w* and the time disc *a* are fixed cooperating stops *y* which arrest anti-clockwise turning of the time disc when a figure "0" is opposite the pointer *g*.

A plurality of engaging members or pegs *z*, *z'* are provided for insertion in any of the holes *x* of the time disc *a*. The pegs *z'* are longer than the pegs *z*. When one of the pegs *z'* is inserted in one of the holes *x*, it projects such a distance that when, during a turning of the time disc *a*, it encounters one of the teeth *f* of the actuating disc *b*, it turns the actuating disc *b* through an arc equal to twice the angular distance between adjacent teeth of the actuating disc. The pegs *z* are of such length that when one of them is inserted in one of the holes *x* and engages one of the teeth *f* of the actuating disc *b*, the disc *b* is turned through an arc equal to the angular distance between adjacent teeth.

The operation of the device described and the proper positioning of the pegs *z*, *z'* may best be understood from a specific example. As an example, it may be assumed that it has been determined by a test that in order to maintain the moisture content of the drying medium at a desired value, the dampers J and K must be regulated in accordance with this schedule:

At start_____Dampers closed two-tenths.
At one hour____Dampers closed four-tenths.
At 2¼ hours____Dampers closed five-tenths.
At three hours___Dampers closed six-tenths.
At five hours__Dampers closed seven-tenths.
At eight hours_Dampers closed eight-tenths.

In order to adapt the device to regulate the dampers in accordance with this schedule, a long peg *z'* is placed in the hole *x*, which is identified by the figure "1", a short peg *z* is placed in the hole *x* identified by the figure "¼", which is adjacent to the figure "2", and other small pegs *z* are placed in the holes *x* identified by the figures "3", "5", and "8", respectively. The time disc *a* is turned in an anti-clockwise direction until its turning is arrested by the stops *y*, so that the symbol "0" on the time disc is placed opposite the pointer *g*. The actuating disc *b* is set with the figure "2" opposite the pointer *g*. The material to be dried is placed in the chamber B, steam is admitted to the heating pipes E and the blower F is placed in operation.

During the first hour of the treatment, the dampers J, K are two-tenths closed because of the setting of the actuating disc *b* with the symbol "2" opposite the pointer *g*. At the end of the first hour the peg *z'* in the hole *x* identified by the figure "1" comes into contact with a tooth *f*, and turns the disc *b* through the arc twice as great as that which separates the teeth of the disc *b*, so that the figure "4" of the disc *b* is brought in line with the pointer *g*, and the position of the dampers J, K is changed to a corresponding extent. At the end of two hours and a quarter from the beginning of the treatment, the peg *z* in the hole *x* identified by the figure "¼" adjacent to the figure "2" comes into contact with a tooth *f* and turns the disc *b* through an arc equal to that which separates the teeth of the disc so that the figure "5" of the disc *b* is brought in line with the pointer *g*. As the operation proceeds, the pegs *z* in the holes *x* identified by the figures "3", "5" and "8" are brought successively into contact with the teeth *f*. It will be evident that this has the effect of varying the position of the dampers J and K in accordance with the schedule previously given.

It is apparent from Fig. 1 that the construction of the dryer therein shown is such that a considerable proportion of the drying medium in the chamber B is recirculated even when the dampers J and K are completely opened. This type of dryer is, therefore, not satisfactory for handling materials which give off moisture very rapidly at any stage of the treatment. Such mate-

rials may be treated in the dryer illustrated in Fig. 5. In the dryer shown in that figure, an opening L near one end of the chamber B′ is connected to an opening M near the other end of the chamber by means of a conduit N in which the blower F′ is introduced. In the conduit N are two openings G′ and H′, which are opposite each other. The openings G′ and H′ are, respectively, the intake and the outlet openings of the chamber B′, although, in this type of dryer, they are not formed directly in the walls of the chamber. Hinged dampers J′, K′ are provided for controlling the inlet and outlet openings. These dampers are connected by a link P. It is apparent that when the two dampers are moved to open position, shown in Fig. 6, the damper J′ blocks circulation through the conduit so that all the drying medium in the chamber passes out through the discharge opening H′ and is replaced by fresh drying medium drawn in through the opening G′.

The dryer shown in Fig. 5 is provided with controlling mechanism identical with that which has been described in connection with the other views, except that only one connecting rod *m* is necessary to connect the slide bar *i* to the dampers because of the fact that the dampers are secured together by the link P. It is apparent that the controlling mechanism, when applied to this dryer, may be used to vary the position of the dampers J′, K′ from an open position, in which no part of the drying medium in the chamber is recirculated, to a closed position, in which all the drying medium in the chamber B is recirculated.

While the controlling mechanism which has been described has been found adequate to control the moisture content with such accuracy as is required in the efficient treatment of most materials, it is apparent that the controlling mechanism may be arranged so as to vary the position of the dampers at as small or large intervals of time as may be required and to cause each movement of the dampers to be as small or large as may be required.

I wish it clearly understood that the apparatus features of my invention are by no means limited to the construction and arrangement of the specific apparatus which has been illustrated and described, as many changes may be made in this specific apparatus without departing from my invention. Thus, the form and position of both the time member and the actuating member may be changed, and connecting means other than the pegs illustrated may be used to cause the time member to effect movements of the actuating member at predetermined time intervals.

What is claimed is:

1. The method of conditioning material by treatment with a gaseous medium, which comprises circulating the gaseous medium over the material and recirculating a portion of the medium, while varying the proportion recirculated at definite time intervals so predetermined in accordance with data previously obtained from another mass of the same material as to maintain the moisture content of the medium in contact with the material at desired values throughout the treatment.

2. The combination with conditioning apparatus providing a treatment chamber and means for circulating gaseous medium therethrough and for recirculating a portion of the medium, of a time member, means for moving said time member at a predetermined rate, and means automatically actuated by the time member at predetermined time intervals to vary the proportion of the gaseous medium recirculated.

3. The combination with a chamber having inlet and outlet openings, a damper in each of said openings and means for causing a circulation of gaseous medium in the chamber and through said openings, of a time member, means for moving said time member at a predetermined rate, and means connected with both said dampers and automatically actuated by the time member to vary the position of the dampers at predetermined time intervals.

4. A device for controlling the position of the dampers of a treatment chamber, comprising an actuating member connected with said dampers, a time member, means for moving said time member at a predetermined rate, and means connecting the time member with the actuating member in such manner that the time member effects movements of the actuating member through predetermined distances at predetermined time intervals.

5. A device for controlling the position of the dampers of a treatment chamber, comprising an actuating member connected with said dampers, a time member, means for moving said time member at a predetermined rate, and engaging means on each of said members positioned to cause the time member to move the actuating member at predetermined time intervals.

6. A device for controlling the position of the dampers of a treatment chamber, comprising an actuating member connected with said dampers, a time member, means for moving said time member at a predetermined rate, and engaging means on said members adapted to cause the time member to move the actuating member through predetermined distances at predetermined time intervals, said engaging means being adjustable to vary said distances and said intervals.

7. A device for controlling the position of the dampers of a treatment chamber, comprising an actuating member connected with said dampers, a time member adjacent to said actuating member, means for moving said time member at a predetermined rate, and removable engaging means adapted to be mounted on the time member in various different predetermined positions and when so mounted to engage the actuating member at predetermined time intervals.

8. A device for controlling the position of the dampers of a treatment chamber, comprising an actuating member connected with said dampers, a time wheel adjacent to said actuating member and containing a plurality of spaced holes, means for rotating said time wheel at a predetermined rate, and removable pins each adapted to be inserted in any of the holes in the time wheel and when so inserted to engage the actuating member at a predetermined time and to impart thereto the movement of the time member at the time of such engagement.

9. A device for controlling the position of the dampers of a treatment chamber, comprising an actuating wheel connected with the dampers, a time wheel adjacent to the actuating wheel and containing a plurality of spaced holes, means for rotating the time wheel at a predetermined rate, and pins each adapted to be inserted in any hole of the time wheel and when so inserted to engage and partially rotate the actuating wheel at a predetermined time.

In testimony whereof I have hereunto set my hand.

DAVID S. BAKER.