Nov. 17, 1936. H. SUHR 2,061,259

METHOD OF AND APPARATUS FOR DRYING

Original Filed March 26, 1930 2 Sheets-Sheet 1

Fig. 1.

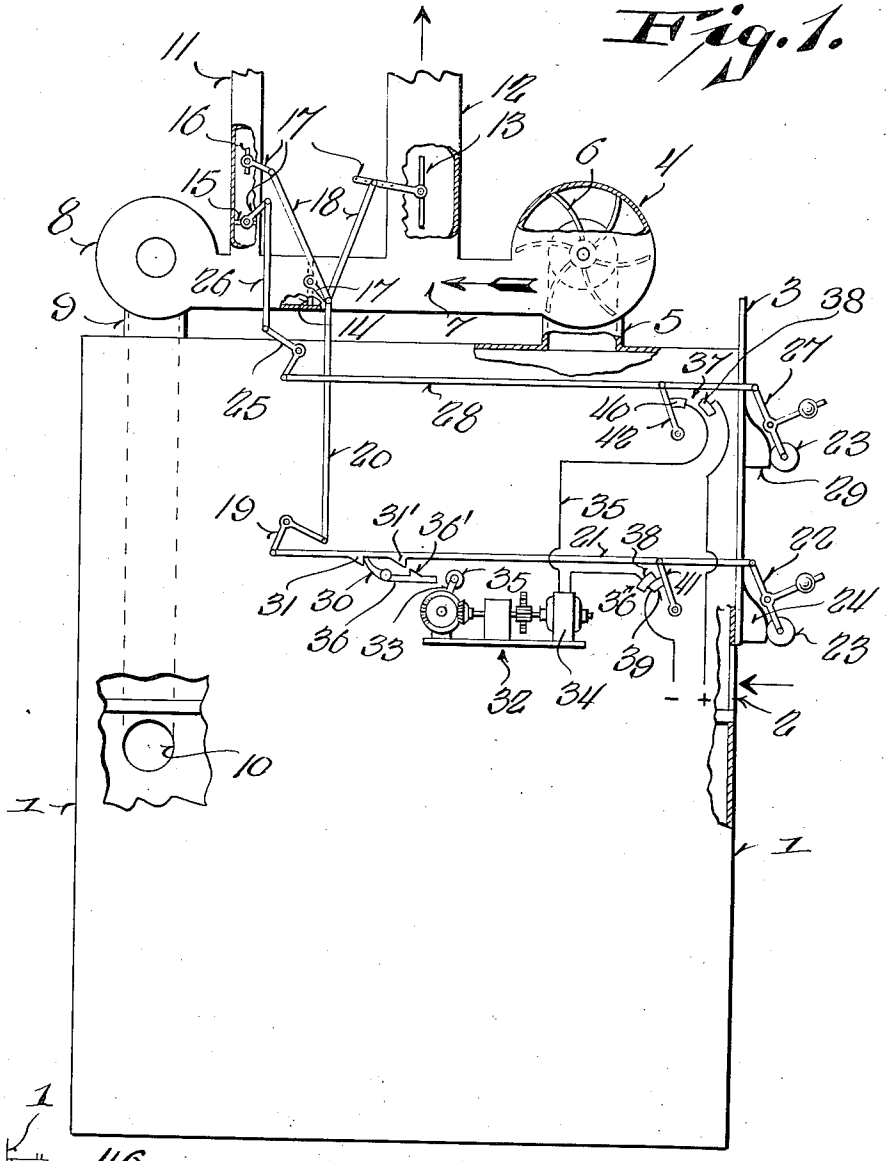
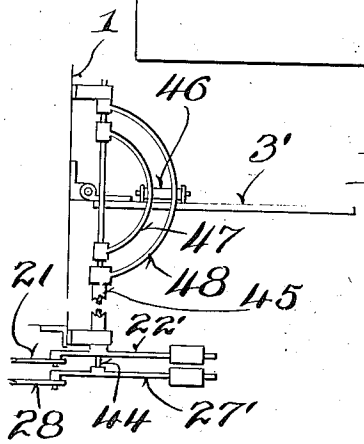


Fig. 4.



Inventor
H. Suhr
By
Attorneys

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Fig. 2.

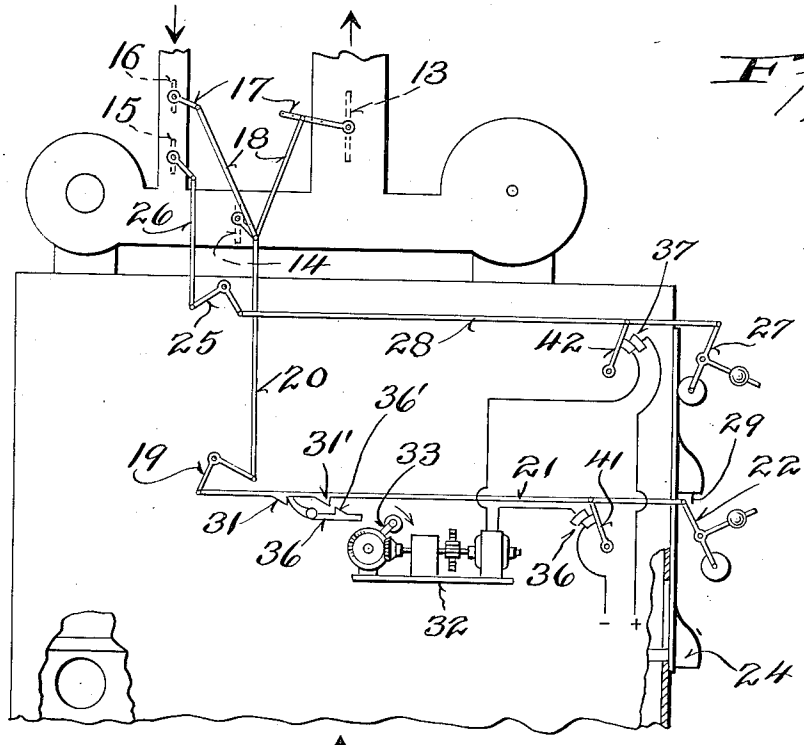
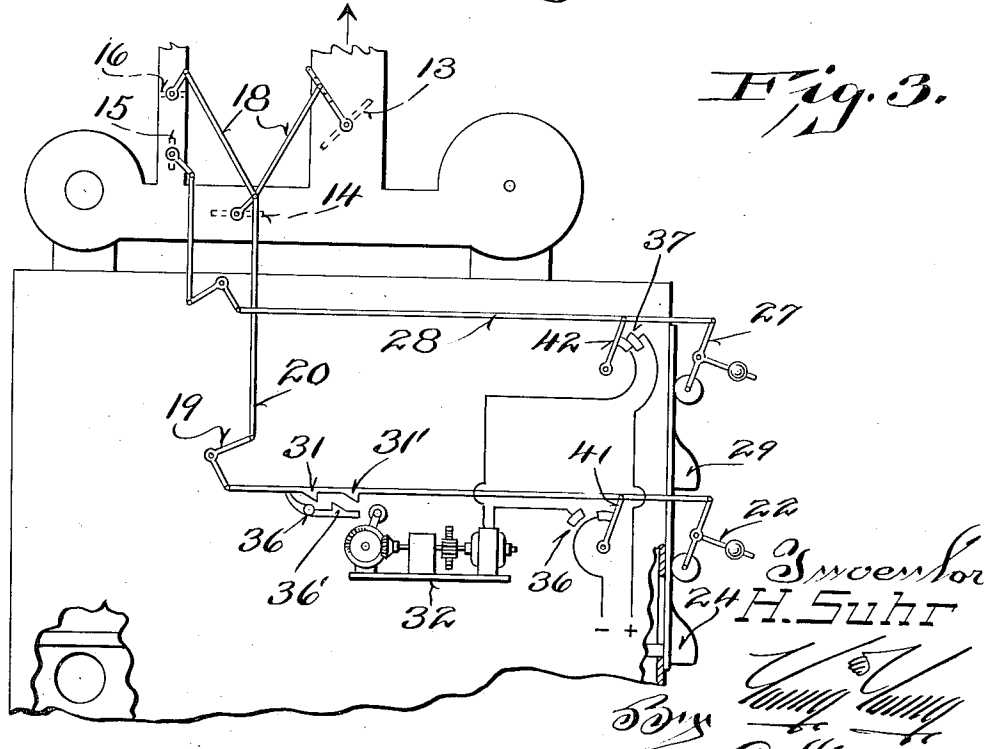


Fig. 3.



Inventor
H. Suhr
By
Attorneys

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2,061,259

METHOD OF AND APPARATUS FOR DRYING

Herman Suhr, Milwaukee, Wis., assignor to Acme Sheet Metal Works, Milwaukee, Wis., a corporation of Wisconsin

Continuation of application Serial No. 439,067, March 26, 1930. This application October 9, 1931, Serial No. 567,953

12 Claims. (Cl. 34—19)

This invention relates to a method of and an apparatus for drying.

One of the principal objects of the present invention is to control the circulation of air in the dryer in a simple, positive and efficient manner during the various stages of the drying operation and more particularly to exhaust or withdraw air or the drying medium from the dryer during the charging or loading of articles into the dryer, to circulate fresh heated air through the dryer for a predetermined period subsequent to the charging of the same to remove the greater portion of the combustible gases or vapors given off by the article being dried and thereafter to recirculate air or the greater part of the heated air during the subsequent drying stages.

The present application is a continuation of and a substitute for my application for Apparatus for controlling the circulation of air in drying ovens and the like, filed March 26, 1930, Serial No. 439,067.

While the present invention may be applied to various types of drying ovens with advantageous results, it is particularly, although not necessarily, designed for use in connection with japanning and drying ovens in which it is desired to recirculate heated air through the oven during the drying operation. In such instances, it is a well-known fact that the fumes given off from the japanned or enameled articles, contain approximately 70% explosive gases, and therefore where it is desired to effect economy of operation by the recirculation of the heated air within the dryer, great hazard is encountered and frequent explosions result, as the gases must necessarily pass through the heater. Further, in the operation of a dryer of this type, particularly during the loading period when the doors are open, it is essential to prevent the escape of fumes from the oven as the same are dangerous and highly injurious to workmen and others coming in contact with them.

It is, therefore, a more specific object of the present invention to provide a method of and an apparatus for automatically controlling the circulation of air to cause the withdrawal of gases from the oven during the loading or discharging operation, and the entrance of fresh air through the loading or discharging door, whereby the escape of fumes is prevented; to cause the circulation of fresh air through the oven for a predetermined period subsequent to initial charging for removing the greater portion of explosive fumes; and thereafter effect recirculation of heated air through the oven to facilitate rapid drying with minimum consumption of fuel.

A further object resides in the provision of an apparatus of the foregoing character utilizing dampers for controlling the circulation of air within the oven, and the provision of automatically actuated means for correlating the operation of said dampers to effect the desired circulation within the oven.

In its broader aspects, the method involved in the present invention consists in circulating fresh heated air during the initial drying stages to carry off the explosive gases or vapors given off by the articles being dried, and thereafter recirculating the greater part or all of the air or drying medium to facilitate and enhance drying action. This fundamental method may be and preferably is modified or augmented during the loading or charging phases of the operation by the step of withdrawing air from the oven when the charging door is open, thereby preventing the escape into the building or room in which the drying is located of the gases, heated air or vapors that are or may be in the oven. This step is followed by the circulation of fresh heated air for a predetermined period and then the final recirculation of heated air. By reason of the fact that the heavy vapors are at the very beginning of the drying operation removed from the oven, the articles being dried have a better finish and less time is required for the drying. Since less time is required the fuel consumption is lowered. These advantages are in addition to the advantages of preventing explosions and thereby rendering the drying safe in operation.

With the above and other objects in view, which will appear as the description proceeds, the invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the herein disclosed invention may be made as come within the scope of the claims.

In the accompanying drawings is shown one illustrative example of a physical embodiment of the apparatus of the present invention devised for the practical application of the principles and the carrying out of the method of the invention.

In the drawings, which are more or less diagrammatical in character, Figure 1 is an elevation of an oven equipped with the present invention, parts being broken away and in section to more clearly illustrate structural features, the

various parts being shown in relative position for loading or charging of the oven;

Figure 2 is a similar view illustrating the relative position of the various parts immediately subsequent to charging of the oven;

Figure 3 is a similar view illustrating the position of the various parts during the subsequent drying operation; and

Figure 4 is a fragmentary plan view of a modified structure in which a swinging oven door is utilized in place of a sliding door.

Referring now more particularly to the accompanying drawings the numeral 1 designates a diagrammatic showing of a conventional japanning or drying oven, provided with a charging opening 2, normally closed by a sliding door 3, it being understood in practice that the oven may be charged or loaded by any suitable mechanism, and the closure door automatically operated in cooperation with the charging. Also, while the invention is illustrated and disclosed in connection with a sliding oven door, it will be obvious that the same may be applied to any type of oven, utilizing either sliding or swinging doors, without affecting the operation or purpose of the present invention.

Mounted upon the oven is a conventional fan or blower casing 4 provided with an intake pipe 5 communicating with the interior of the oven 1. The usual suction fan 6 is mounted within the casing 4, which casing is also provided with a discharge pipe 7, which communicates with a conventional heating drum or combustion chamber 8, heat for which is supplied by any type of burner (not shown). The combustion chamber is in turn provided with a discharge pipe 9 which also communicates with the interior of the oven 1 through the opening 10. Thus, it will be seen that in the normal operation of the oven, air will be withdrawn from the same into the fan casing and discharged through the heater 8 back to the interior of the oven, which operation permits continuous recirculation of heated air through the oven, thus maintaining the desired temperature within the oven, with a minimum consumption of fuel.

The discharge pipe 7, forming a communication between the fan casing 4 and the heater or combustion chamber 8, is provided with a fresh air intake pipe 11, and an exhaust pipe 12, communicating with a suitable flue (not shown), or outside atmosphere. A damper 13, pivotally mounted within the exhaust pipe 12, serves to control the exhaust of fumes from the oven, as will be hereinafter explained, while a damper 14, mounted within the discharge pipe 7, between the intake 11 and the exhaust 12, controls the recirculation of air through the oven. Pivotally mounted within the fresh air intake 11 are a pair of dampers 15 and 16 positioned above each other and equipped for independent operation, as will be hereinafter described.

As set forth in the preceding objects, one of the purposes of the present invention is to effect, when desired, automatic control of the circulation of air within the oven, and this may be accomplished by eliminating manual control of the dampers heretofore described, and providing mechanical means, actuation of which is controlled by operation of the loading or charging door.

As shown in the drawings, the dampers 13, 14, 15 and 16 are provided with suitable actuating arms 17, the arms of the dampers 13 and 16 being connected to the arm of the damper 14 by links 18. In turn the arm of the damper 14 is connected to a bell crank 19 through a link 20. Thus, upon oscillation of the bell crank 19, the dampers 13, 14 and 16 are simultaneously actuated. The bell crank 19 is in turn connected to a latch bar 21 having its outer end connected to a weighted lever 22, provided with a roller 23, which is operatively engaged by the cam 24 carried by the oven door 3. The damper 15, which is operated independently of the damper 16, is connected to a bell crank 25 by the link 26, and the bell crank is connected in turn to a second weighted cam lever 27, through the link 28.

The cam lever 27 is also actuated by a cam 29 carried by the oven door 3. Thus, it will be seen that as the oven door 3 is shifted vertically, the cams 24 and 29, engaging the rollers 23 on levers 22 and 27, will automatically effect actuation of the dampers 13, 14, 15 and 16, to obtain the desired circulation of air within the oven, as will be described in connection with the operation of the apparatus.

Subsequent to the closing of the oven door 3, it is desired to maintain the relative position of the dampers 13, 14 and 16, assumed upon opening the oven door, and therefore a pivotal dog 30 is provided to engage the nose 31 provided on the latch bar 21, which prevents shifting of the latch bar by the weighted lever 22, when the cam 24 leaves the roller 23, thus maintaining the relative position of the dampers 13, 14 and 16, until the dog 13 is subsequently tripped after a predetermined period by the tripping mechanism 32. This mechanism comprises a rotatable arm 33, which, through suitable reduction gearing, is rotated by a motor 34. The outer end of the arm 33 carries a roller 35, which, upon rotation of the arm 33, engages the tail 36 of the dog 30, causing the nose 31 to be released, permitting the weighted lever 22 to shift the latch bar 21 to its normal position, which operation results in returning the dampers 13, 14 and 16 to their original position.

In order to properly control the tripping mechanism 32, the motor circuit 35 is provided with switches 36 and 37, respectively, both of which comprise stationary contacts 38 and movable contacts 39 and 40. The contact 39, cooperating with the stationary contact 38 of the switch 36, is carried by a pivotal arm 41, connected to and oscillated by the shiftable latch bar 21. The contact 40 is carried by a similar arm 42, connected to and actuated by the link 28.

Taking up the operation of the present invention, particular reference will be had to Figure 1, in which the dampers are shown in their relative position for loading or charging of the oven. During this operation, the oven door 3 has been raised, and the cams 24 and 29 have rocked the cam levers 22 and 27, respectively, to shift the dampers to the positions illustrated, in which position the damper 13 has completely opened the exhaust 12, while the damper 14 has closed the discharge pipe 7 and cut off communication between the fan and the heater. Also, although the damper 16 has been shifted to open position, it will be noted that the damper 15 has been closed, thus shutting off the fresh air intake 11. Obviously, in this position of the dampers, air will be withdrawn from the oven by means of the blower, and discharged through the exhaust 12 to a flue or outside atmosphere. Inasmuch as the fresh air inlet 11 has been cut off, and communication between the heater and blower closed, naturally air will be drawn into the oven

through the opening 2, to replace the exhausted air. Thus, during the loading or charging of the oven, when the door is open, escape of fumes or gases through the opening 2 is prevented.

Upon completion of the loading or charging operation, the door 3 is closed, as shown in Figure 2, which operation permits the weighted cam lever 27 to rock to its normal position, opening the damper 15 in the fresh air intake 11. However, it will be noted that the dog 30, engaging the latch bar 21, has prevented shifting of the dampers 14, 13 and 16. Therefore, as the blower continues to exhaust air from the oven, fresh air is admitted through the intake 11, as both dampers 15 and 16 are opened. The fresh air thus admitted passes through the heater 8 and circulates through the oven, which operation is maintained for a predetermined period, sufficient to carry off and exhaust the greater portion of combustible gases given off by the freshly japanned or enameled articles contained within the oven.

The period of exhausting combustible fumes and gases from the oven is timed by the tripping mechanism 32, operation of which is initiated upon closing the door 3. As shown in Figure 2, in this position of the latch bar 21 and the link 23, both switches 36 and 37 are closed, thus completing the motor circuit, and causing the trip arm 33 to be rotated, until the same engages the tail 36 of the dog 30 to effect tripping of the latch bar 21, which is then shifted to its normal position by the weighted cam lever 22, which operation opens the switch 36, thus breaking the motor circuit and stopping operation of the tripping mechanism.

Here it will be noted that the tail 36 of the dog 31, is provided with a nose 36', which, upon tripping of the tail by the roller 35, engages an auxiliary tooth 31' carried by the latch bar 21, thus preventing shifting of the latch bar until the arm 31 has passed from under the tail 36, which then allows the dog 30 to assume its normal position for latching.

After exhausting of the greater portion of combustible gases from the oven, and completion of operation of the timed tripping mechanism, the latch bar 21 is shifted to its normal position, as shown in Figure 3, which shifting movement oscillates the bell crank 19 and shifts the dampers 13, 14 and 16 to the position illustrated in Figure 3, in which position the communication between the blower and the heater, through the discharge pipe 7, is again obtained, but the fresh air intake 11 is completely closed by the valve 16 and the exhaust 12 partially closed by the damper 13. In this position of the dampers, obviously, the greater portion of air drawn from the oven will be recirculated through the heater and oven, thus maintaining the desired temperature within the oven, with a minimum consumption of fuel, which not only effects economy of operation, but also materially reduces the time required for drying.

During the drying operation, it will be noted that the exhaust 12 is not completely closed by the damper 13 due to the fact that a certain amount of air for combustion must enter the heater 8, and naturally a sufficient volume of air must be exhausted from the system to allow its admission. This continuous exhausting of a small portion of air during the drying operation, has the further advantage of carrying off combustible gases, which must be continually given off during drying of the articles within the oven.

As heretofore explained, it is contemplated that the present invention may be applied to ovens utilizing swinging doors as well as the sliding door illustrated. In this connection, attention is directed to the modification illustrated in Figure 4, in which the weighted levers 22' and 27' are mounted upon the shaft 44 and the sleeve 45, respectively. In this form of the invention the swinging door 3' is provided with a roller 46, which engages the arcuate cams 47 and 48 carried by the shaft 44 and sleeve 45, respectively. Upon swinging of the door 3, the levers 22' and 27 will be rocked by the cams 47 and 48, in the same manner as described in connection with the levers 22 and 27, to effect desired operation of the dampers, in accordance with the foregoing explanation.

From the preceding description taken in connection with the drawings, it will be apparent that a comparatively simple and positive mechanism has been provided for automatically controlling circulation of air within a drying oven, whereby maximum efficiency is obtained and danger of explosion reduced to a minimum. In fact, actual tests of the present invention have demonstrated that during the recirculation of heated air within the oven, the explosive contents of the fumes is reduced from approximately 70% to 30%, which is considered sufficiently below the danger point to effect a material reduction in insurance rates. This is accomplished by exhausting air from the oven during loading or charging of the same, to admit air through the loading opening to prevent the escape of injurious flames, and thereafter drawing off and exhausting a greater portion of the explosive gases during an initial predetermined period prior to recirculation of heated air for the major portion of the drying period.

It is obvious that the apparatus described above is adapted for carrying out the method involved in the present invention and which consists, as pointed out above, in circulating fresh heated air through the drying oven for a predetermined period or for the initial drying stages so as to carry off the explosive gases or vapors given off by the articles being dried. As a result of this step of the method, the apparatus is not only rendered safe in that explosions are prevented but that the articles being dried have a better finish. Furthermore, this step shortens the entire drying period which means a saving in fuel consumption. Following the first step the supply of fresh heated air is cut off or is largely cut off and instead of discharging heated air from the oven into a stack or flue the heated air is recirculated through the oven until the drying is completed. During the time when the oven is being charged with the articles to be dried air is withdrawn from the oven but no heated air is supplied thereto and the air supply of the oven during such interval is dependent upon the air flowing through the charging door. To summarize the complete method, that is, the method with the step which has the advantage of preventing escape of gases or vapors into the room or place in which the oven is located, it will be seen that the method consists in exhausting air and gases directly from the oven to cause a partial vacuum therein when the door is closed carrying off the exhausted air and gases when the oven is being loaded, supplying fresh heated air under the influence of said partial vacuum and carrying off the exhausted air and gases during the early drying stage and recirculating through

the oven the greater part of the heated air during the final drying stage.

The invention claimed is:

1. In a drying oven having a loading door, a fan connected to said oven for drawing air therefrom, a heater having a communication with said fan, a connection between said heater and the interior of said oven, an exhaust outlet in the communication between said fan and heater, a fresh air intake positioned in said communication between said heater and exhaust, dampers controlling said intake and exhaust, a damper in the communication and located between said intake and exhaust, and means for actuating all of said dampers upon the opening of said oven door to progressively effect exhaust of air from the oven and including means actuated by the closing of the door for actuating one of said dampers to create a circulation of fresh air through the heater and oven for a predetermined period subsequent to loading of the oven and means for actuating the other dampers to recirculate heated air through the oven.

2. A drying oven having a loading door, a fan connected to said oven for drawing air therefrom, a heater having communication with said fan, a communication between said heater and the interior of said oven, an exhaust outlet positioned in the communication between said fan and heater, a fresh air intake in connection with said heater, dampers positioned in said exhaust outlet and fresh air intake, a damper positioned in said communication between said intake and said exhaust outlet, and means for actuating all of said dampers to open said exhaust outlet and close the fresh air intake and the communication between said fan and heater when the oven door is opened and including means to retard opening of the damper in the communication between said fan and heater and a timed mechanism for tripping said retarding mechanism at the expiration of a predetermined period subsequent to the closing of the oven door whereby the damper controlling the communication between the fan and heater is opened, and the fresh air intake is closed to effect recirculation of heated air through the oven.

3. In a drying oven having a loading door, means for admitting fresh air to said drier, means for exhausting air from the drier, means for recirculating air through said drier, dampers for controlling all of said means, means for actuating said dampers upon the opening of said doors to exhaust air from the oven during loading of the same, means actuated by the closing of said door for actuating one of said dampers to provide for a circulation of fresh air through the oven, means for actuating the other dampers to provide for the recirculation of air through the oven after the expiration of a predetermined period, and means for heating the air circulated through the oven.

4. A drying oven having an exhaust fan connected to said oven producing a partial vacuum therein, a heater through which air is drawn into said oven, a duct from said fan to said heater, an exhaust outlet in said duct between said fan and heater and on the outlet or pressure side of said fan, an air inlet opening in said duct between said exhaust outlet and said heater, dampers for said inlet and exhaust openings, a damper in said duct between said inlet and exhaust openings, interlocking mechanism to operate said dampers in predetermined order, and means for actuating said interlocking mechanism whereby to effect progressive circulation of fresh air through said oven without re-circulation, recirculation of heated air through said oven together with a supply of fresh air and stoppage of fresh air entry through said inlet and simultaneous exhaust of air from said oven while loading same.

5. A drying oven having an exhaust fan connected to said oven producing a partial vacuum therein, a heater through which air is drawn into said oven, a duct from said fan to said heater, an exhaust outlet in said duct between said fan and heater and on the outlet or pressure side of said fan, an air inlet opening in said duct between said exhaust outlet and said heater, dampers for said inlet and exhaust openings, a damper in said duct between said inlet and exhaust openings, interlocking mechanism to operate said dampers in predetermined order, and automatic means for actuating said interlocking mechanism after a predetermined time interval, during which fresh air is circulated through said oven, and means effecting recirculation of heated air through said oven.

6. In a drying oven having a loading door, means for admitting fresh air to said drying oven, means for exhausting air from said drying oven, means for recirculating air through said drying oven, dampers for controlling all of said means, means for actuating said dampers upon opening of said door to exhaust air from the oven during loading of same, means actuated by the closing of said door for actuating one of said dampers to provide for a circulation of fresh air through said oven.

7. In a drying oven, a fan connected to said oven for drawing air therefrom, causing a partial vacuum therein, a heater having a communication with said fan, a connection between said heater and the interior of said oven, an exhaust outlet in the communication between said fan and heater, a fresh air intake positioned in said communication between said heater and said exhaust outlet, a pair of dampers in said fresh air intake, a damper in said exhaust outlet, interlocking means for operating one of said intake dampers and the exhaust damper and independent means for operating the other intake damper.

8. In a drying oven having a loading door, means for heating and recirculating the heated air through the oven, means for interrupting the recirculation of heated air, means for supplying fresh heated air to the drying oven, means operated by the movement of said door for regulating the supply of fresh heated air to the drying oven independently of the action of said recirculating means, means for exhausting air from the oven, and means for regulating the action of said air exhausting means.

9. In an oven for baking materials giving off combustible gases, in combination, an outlet pipe for withdrawing gases from said oven, an inlet pipe connected with said outlet pipe for returning said gases to said oven, damper means for alternately connecting said outlet pipe with the atmosphere and with said inlet pipe, and means for causing said damper means to connect said outlet pipe completely with the atmosphere for a predetermined period at the beginning of the bake.

10. In an oven for baking materials giving off combustible gases, in combination, an outlet pipe for withdrawing gases from said oven, an inlet pipe connected with said outlet pipe for returning said gases to said oven, damper means for alternately connecting said outlet pipe with the atmosphere and with said inlet pipe, means for causing

said damper means to connect said outlet pipe completely with the atmosphere for a predetermined period at the beginning of the bake, and means for automatically moving said damper means at the end of said predetermined period.

11. In an oven for baking materials giving off combustible gases, in combination, an outlet pipe for withdrawing gases from said oven, an inlet pipe connected with said outlet pipe for returning said gases to said oven, damper means for alternately connecting said outlet pipe with the atmosphere and with said inlet pipe, means for causing said damper means to connect said outlet pipe completely with the atmosphere for a predetermined period at the beginning of the bake, means for automatically moving said damper means at the end of said predetermined period, and means for regulating the movement of said damper means.

12. The method of circulating air in a drying oven having a loading door, exhaust outlet and intake opening, consisting of exhausting air from the oven through said outlet while preventnig air from entering said opening when the door is open, exhausting air from the oven through said outlet and admitting fresh air through said opening for a predetermined period after said door is closed and thereafter recirculating air through said oven without admission of fresh air through said opening until said door is reopened.

HERMAN SUHR.