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MOLD DRYING METHOD AND APPARATUS

Original Filed July 22, 1936

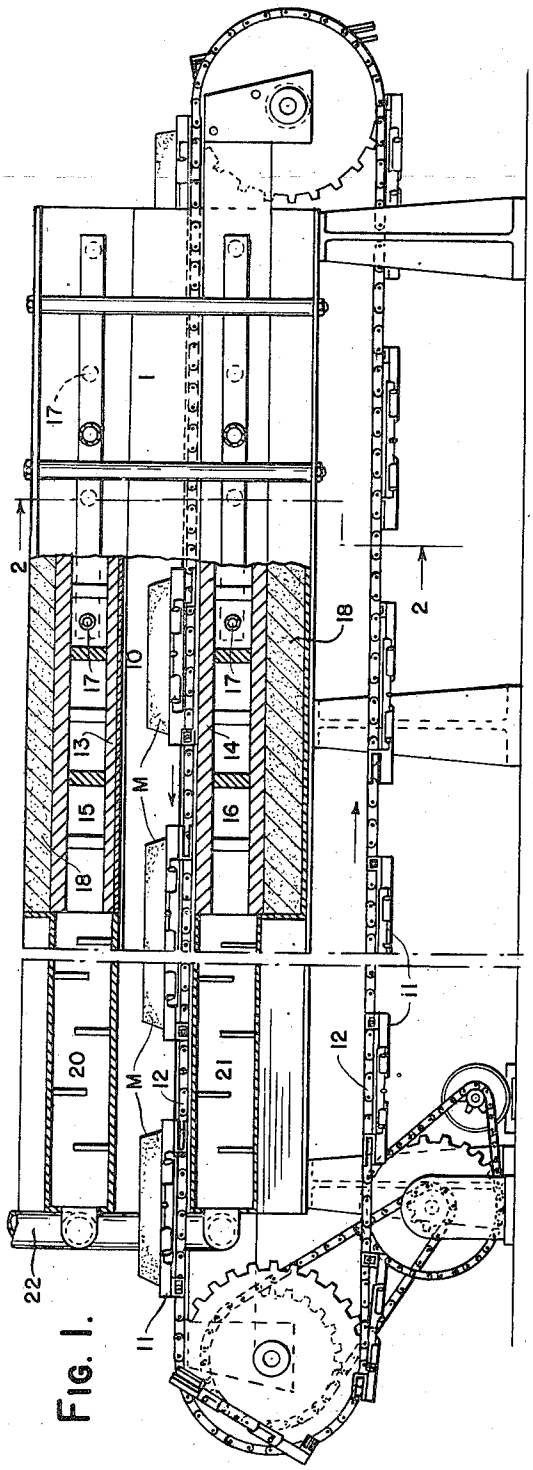


FIG. 1.

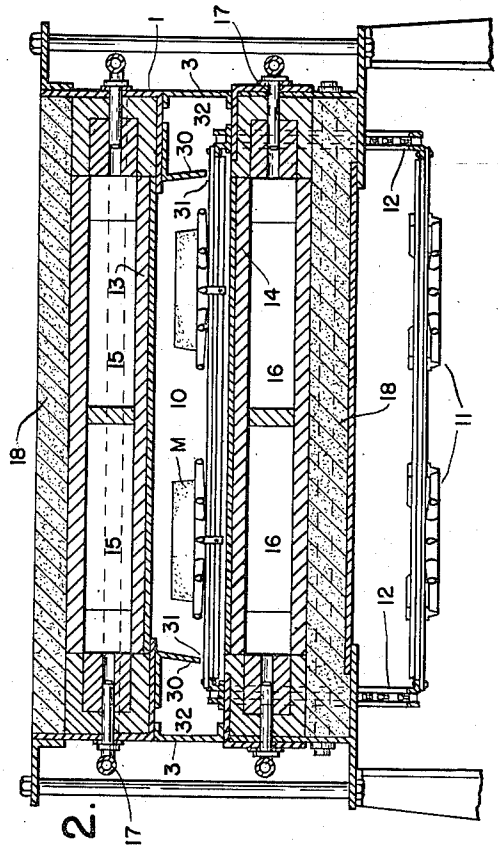


FIG. 2.

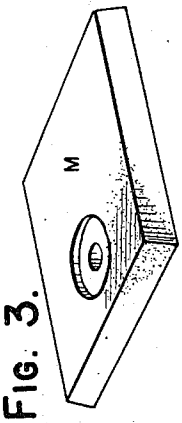


FIG. 3.

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MOLD DRYING METHOD AND APPARATUS

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Original application July 22, 1936, Serial No. 91,897. Divided and this application May 5, 1938, Serial No. 206,151

17 Claims. (Cl. 34—24)

My invention relates to the drying of articles composed of plastic material and particularly the drying of complemental mold sections made of a gypsum base composition. This application is a division of my application Serial No. 91,897, filed July 22, 1936, for Drying apparatus.

Mold sections well adapted to be dried by the herein-described method and apparatus may be made by the process described in my copending application Serial No. 203,872, filed April 23, 1938, for Molding processes. It is desired that such molds have a body of high porosity so that when two complemental mold sections are placed with their parting surfaces in contact and metal is poured between them through the usual sprue, the air in the mold spaces and the gases generated by the molten metal may ooze out through the pores of the mold body without appreciable resistance to the inflowing metal even though no riser or other positive egress aperture communicating with the mold space is provided.

I have found that a very porous mold body, suitable for my purpose, may be constructed by using a large excess of liquid, preferably water, in the plastic mixture and then drying out such excess liquid before the pour is made. The commercial value of such a scheme is greatly enhanced by my invention, for by the application of direct radiant heat to at least the principal surfaces of the mold the free liquid or water may be dried from the mold in about an hour or at most a few hours, instead of the drying requiring several days as has been often required heretofore. Moreover, my drying method may be regulated so that even with such rapid drying the mold will not crack or check or exhibit other physical defects. In order to have the drying most uniform and effective the fluid vapor, as soon as it has been liberated from the mold, is removed from the vicinity of the mold surface and particularly from between the radiant heating surfaces and the principal mold surfaces.

My main object, therefore, is to provide a method for drying molds having a large excess of liquid which can remove such liquid in a minimum amount of time without warping the mold or injuring its strength or other physical properties.

It is more specifically an object to dry the mold by the application thereto of direct radiant heat as distinguished from circulating or convection heat, and to apply such heat to at least the principal surfaces of each mold section.

A further object is to remove from the vicinity of the mold surfaces as rapidly as possible the liquid vapor as it is released from the mold, thus to avoid the presence of a gaseous, heat absorbing, insulating layer between the mold and the radiant heating surfaces, and to provide suitable means to accomplish this purpose.

Other objects of my invention will be understood from a study of the following detailed description of an operative example of my method and apparatus, and the particular novel features thereof are set forth in the appended claims.

Fig. 1 is a side elevation view of a drying oven showing parts thereof in section.

Fig. 2 is a transverse section of the oven taken along the line 2—2 of Fig. 1, and

Fig. 3 is a perspective view of a mold section adapted to be dried in the oven.

While my method and apparatus is adapted to dry products of similar type, it is particularly useful in drying mold sections made by the process described in detail in my aforesaid copending application for molding processes. In the manufacture of such molds the drying problem is particularly acute, for unusually great porosity is obtained by using in the mix a very excessive amount of liquid which must be dried out of the mold after it has set, yet the surface of the mold is relatively non-porous, largely owing to the drying method employed.

The mold is of the gypsum base type, the dry material including calcined gypsum, and the mix including sufficient water to supply the balance of the water of crystallization for the gypsum, and in addition perhaps ten times that amount of vaporizable fluid, which may be water, which does not combine chemically with the calcined gypsum, and which free liquid is dried out of the mold to produce mold porosity. It may also be desirable to incorporate in the mix a strengthening binder such as asbestos pulp or fiber. I have found a suitable mix, for example, to be, by weight, one hundred sixty parts of water to one hundred parts of dry material, the latter being eighty percent calcined gypsum and twenty percent asbestos pulp. From a mold made of such ingredients by my process and using my apparatus the liquid or water may be dried quickly and effectively without injuring or appreciably weakening the mold.

In the preparation of a mold section a homogeneous mixture is formed as described in my previously mentioned application and allowed to set in a mold form. This form is then completely removed from the set plastic mold section leaving it wholly unconfined. The mold section is then ready to be dried by my method without first being assembled with another mold section. Dur-

ing the drying operation, preferably not only is all the sensible liquid or free water dried out, but also some of the water of crystallization chemically combined with the gypsum, perhaps even sufficient to reduce the gypsum again substantially to the calcined form. The act of removing water of crystallization or chemically combined water from the set gypsum is known as recalcination.

The drying oven illustrated includes a body 1 having in its central portion the drying chamber 10 within which are received molds M. These molds, supported on grids 11, are preferably moved through the oven from end to end in the direction indicated by conveyor chains 12 driven by suitable mechanism as shown. The grids are of special construction to support the molds so that they will remain unwarped during drying and will not stick to the grids. The grids and related structure are particularly described in my copending application Serial No. 206,150, filed May 5, 1938, for Drying apparatus and methods.

The top and bottom walls 13 and 14, respectively, of the drying chamber 10, are heat radiating surfaces preferably formed of silicon carbide, but which may be of any suitable heat conducting and radiating material such as various steel alloys. Above the wall 13 and below the wall 14 heating chambers are provided, designated 15 and 16. These chambers may extend over the entire length of the chamber 10, but preferably only over the entrance portion thereof, the exit portion being covered with sheet metal enclosed chambers 20 and 21, preferably forming continuations of chambers 15 and 16, respectively, but not being directly heated, to enable the mold to cool off gradually after being dried and before leaving the drying chamber. The stresses which would be set up in a hot mold by the shock of suddenly being moved into a relatively cold atmosphere are thereby avoided.

The heating chambers 15 and 16 are heated by suitable individually regulatable fuel jets or burners 17 which project into the sides of the chambers at spaced intervals along its length and are provided with suitable air supply means for supporting the combustion of the gas or oil vapor. The hot gases may be required to traverse a tortuous path, if desired, to heat the imperforate radiating plates 13 and 14 evenly by providing suitable baffles. Heat is conserved by layers of insulation material 18, such as asbestos, covering the top and bottom of the oven adjacent to the heating chambers. The combustion gases pass from such heating chambers to the uninsulated chambers 20 and 21 and are progressively cooled as they pass therethrough by dissipation of heat through the uninsulated walls thereof until they are discharged through the stack 22. The drying chamber is corresponding progressively cooled from the junction of the heating chambers and sheet metal covered chambers to its exit by transfer of heat therefrom and from the molds therein to the gradually cooling combustion gases. The molds are thereby cooled gradually to eliminate the shock of abrupt emergence from a hot to a cold atmosphere upon discharge from the drying chamber as previously mentioned.

As seen in Fig. 2 the extreme sides of the drying chamber 10 are preferably closed by plates 3. Along the sides of the drying chamber proper are aprons 30 extending from the ceiling of the chamber downward well below the upper surfaces of the mold sections. Below these aprons are slots 31 along the opposite sides of the drying chamber proper which communicate with side passages or flues 32 for a purpose hereinafter explained. In some installations the sides 3 of the drying chamber may be omitted, the mold containing portion thereof being in direct lateral communication with the atmosphere through the slots 31.

In operation, a single wet mold section M is placed upon each of the grids 11 with its parting face upward, at the right hand end of the oven, as shown in Fig. 1. Upon entering the drying chamber the surfaces of the mold are subjected to direct radiant heat from the plates 13 and 14 in close proximity to the respective upper and lower mold surfaces, which are the principal surfaces, preferably being spaced therefrom only a few inches. A small amount of the hydrated gypsum is dissolved in the free water in the wet mold. As the sensible liquid in the molds vaporizes, the vapor is formed and liberated mainly at the principal, or upper and lower surfaces of the molds and flows, because of the increase in pressure caused by emission of such vapor, from the drying chamber proper laterally outward through the slots 31 beneath the aprons 30 into the ducts 32, or, if the side plates 3 have been omitted, directly into the atmosphere. The vapor, thus continuously and immediately upon liberation being removed from the vicinity of the mold, eliminates all substantial blanketing or insulating of the principal mold surfaces from the heat radiating action of the plates 13 and 14. The heat is not unduly dissipated, however, for its tends to remain above or to rise into the space above the lower edges of the aprons 30. Even if these aprons were omitted, allowing hot air to escape, the molds would still be dried quite effectively by the radiant heat to which they are subjected. There is no appreciable convection drying action by thermal or forced circulation of air.

Heretofore it has been thought that molds and articles of gypsum base and similar plastic material had to be air dried in a heated room and could not be dried without injury by the application thereto directly and proximately of radiant heat. Not only is the mold not injured by my radiant heat drying method, however, but a finer surface than would be expected on such a porous body is obtained. Since the water vaporizes chiefly at the surfaces of the mold, the hydrated gypsum dissolved in the free water is deposited at the surface as the liquid evaporates. The result is a finer and less porous surface, yet one which is sufficiently thin so that the pouring gases in the mold cavity have no difficulty escaping therethrough into the porous mold body.

It is desirable that the molds move continuously past the radiant surfaces during the drying operation. This movement assists in freeing the vapor or steam from the mold surfaces. After all the free liquid is vaporized at least a partial recalcination of the mold material takes place. The interior of a mold during this operation finally reaches a temperature preferably between 340 degrees F. and 420 degrees F. The temperature of the exterior surfaces will be higher since the heat radiant surfaces are much hotter than this. When spaced about four inches from the mold surfaces, for example, their temperature will be within a couple of hundred degrees above or below 1400 degrees F., which has been found to be the most suitable average temperature in such an installation for most gypsum base mold compositions and mold shapes. After molds thus dried are poured the recalcined

material may be re-employed in the production of other molds, usually being mixed with fresh calcined gypsum.

The complete drying operation for a mold section about two and one-half inches thick may be performed in an hour and a half including passage through the portion of drying chamber 10 adjacent to chambers 20 and 21 during which passage the molds are gradually cooled. For such drying time and temperature the over all length of the chamber 10 can be about thirty-two feet, which includes both the entrance and exit portions thereof. The heat is regulated so that each mold section is dried evenly, that is, the moisture withdrawn from the upper surface will be equal to the amount withdrawn from the lower surface in a given time interval and warping of the mold section will thus be avoided. It may be necessary to regulate compensably the temperatures of the two radiant surfaces to obtain this equal removal of moisture from the opposite mold surfaces, owing to the unequal areas of the exposed mold faces and variation of area of cavity surface in different molds, or to slight differences in proximity of the mold faces to the adjacent heat radiant surfaces caused by varying mold thickness. Ordinarily, however, satisfactory operation may be obtained if the oven is regulated for average conditions of mold height and mold cavity surface.

As my invention, I claim:

1. The mold drying method which comprises exposing a suface of a gypsum base mold for use as a casting matrix to a proximate source of direct radiant heat, the temperature of such heat source and the time of mold exposure thereto being sufficient to dry from the mold all chemically uncombined liquid and also to recalcine, at least partially, the gypsum in the mold.

2. The mold drying method which comprises exposing a surface of a gypsum base mold for use as a casting matrix to a direct radiant heating surface in close proximity thereto, and moving the mold in a path substantially parallel to such heating surface during such exposure, the temperature of such radiant heating surface and the time of mold exposure thereto being sufficient to dry from the mold all chemically uncombined liquid and also to recalcine, at least partially, the gypsum in the mold.

3. The mold drying method which comprises simultaneously exposing the parting surface and the back of a gypsum base mold section for use as a casting matrix to proximate sources of direct radiant heat, the temperature of such heat sources and the time of mold section exposure thereto being sufficient to dry from the mold section all chemically uncombined liquid.

4. The mold drying method which comprises simultaneously exposing the parting surface and the back surface of a gypsum base mold section for use as a casting matrix to substantially equal degrees of direct radiant heat applied substantially uniformly over each such surface, thereby to preserve the mold section unwarped during drying by substantially equal and concurrent evaporation of moisture from such opposite surfaces, the mold section being heated by such radiant heat at a temperature and for a length of time sufficient to dry from the mold section all chemically uncombined liquid and also to recalcine, at least partially, the gypsum in the mold.

5. The mold drying method which comprises moving a gypsum base mold section for use as a casting matrix between parallel, radiant heating surfaces in close proximity thereto, thereby exposing the parting surface and the back surface of such a mold section to substantially equal degrees of direct radiant heat applied substantially uniformly over each surface, thereby to preserve the mold section unwarped during drying by substantially equal and concurrent evaporation of moisture from such opposite mold surfaces, the temperature of such heating surfaces and the time of mold section movement therebetween being sufficient to dry from such mold section substantially all the chemically uncombined liquid.

6. The mold drying method which comprises simultaneously exposing the parting surface and the back surface of a gypsum base mold section for use as a casting matrix to direct radiant heating surfaces in close proximity thereto, the temperature of such heating surfaces and the time of mold section exposure being sufficient to dry from the mold section substantially all chemically uncombined liquid, and removing the vapor released from the mold section laterally from the space between each such mold surface and its adjacent heating surface as rapidly as moisture is liberated, thereby to minimize the blanketing of the mold surfaces from the radiant heating surfaces by such vapor.

7. The mold drying method which comprises simultaneously exposing the parting surface and the back surface of a gypsum base mold section for use as a casting matrix, each to a direct radiant heating surface in close proximity thereto, moving the mold in a path parallel to such heating surfaces during such exposure, the temperature of such radiant heating surfaces and the time of mold section exposure thereto being sufficient to dry from the mold section all chemically uncombined liquid and also to recalcine, at least partially, the gypsum in the mold section, and removing the vapor released from the mold section laterally from the space between each such mold surface and its adjacent heating surface as rapidly as moisture is liberated, thereby to minimize the blanketing of the mold surfaces from the radiant heating surfaces by such vapor.

8. In a mold drier, elements forming two radiant heating surfaces spaced apart to constitute a drying chamber, a support within the drying chamber for positioning a mold section with each principal face adjacent to one of said sufaces, means to move said support lengthwise of the drying chamber, and a duct extending lengthwise along the drying chamber to remove vapor escaping from the mold section laterally from such chamber.

9. In a mold drier, elements forming upper and lower radiant heating surfaces spaced apart to constitute a drying chamber, a support within the drying chamber to position a mold section with each principal face adjacent to one of said surfaces, and an apron extending lengthwise along each side of the drying chamber and depending from the roof thereof, the bottom edge of said apron being lower than the upper face of a mold section positioned by said support but spaced above the drying chamber floor to define a slot along the side of the drying chamber, for escape therethrough of vapor dried from the mold section.

10. In a mold drier, elements forming upper and lower, imperforate radiant heating surfaces spaced apart to constitute a drying chamber,

heating means above the upper surface, and further heating means below the lower surface, to heat the respective surfaces, a support within the drying chamber to position a mold section with each principal face adjacent to one of said surfaces, conveying means to move said support lengthwise of the drying chamber, an apron extending lengthwise along each side of the drying chamber and depending from the roof thereof, the bottom edge of said apron being lower than the upper face of a mold section positioned by said support but spaced above the drying chamber floor to define a slot along the side of the drying chamber, and a duct extending lengthwise along the drying chamber to convey away vapor evaporated from the mold section and escaping from the drying chamber through such slot beneath said apron.

11. In a mold drier, elements forming upper and lower heat transfer surfaces spaced apart to constitute a drying chamber, and each surface including an entrance section and an exit section, a support within the drying chamber to position a mold section with each principal face adjacent to one of said surfaces, conveying means to move said support lengthwise of the chamber continuously from the entrance end to the exit end thereof, heating means above the upper entrance section, and further heating means below the lower entrance section of said surfaces, adapted to heat such sections for radiation of such heat into the entrance end of the drying chamber, and the exit sections of said upper and lower surfaces being remote from said heating means and of heat conducting material, operating to transfer heat out of the exit end of the drying chamber where necessary, to maintain a progressively decreasing temperature gradient over the exit sections of said heat transfer surfaces to the exit end of the drying chamber.

12. The mold drying method which comprises simultaneously exposing the parting surface and the back surface of a gypsum base mold section for use as a casting matrix, each to a proximate source of direct radiant heat, the temperature of such heat sources and the time of mold section exposure thereto being sufficient to dry from the mold section all chemically uncombined liquid and also to recalcine, at least partially, the gypsum in the mold section, and thereafter gradually cooling the mold section by exposing the parting surface and back surface thereof to heat conductive surfaces of progressively decreasing temperature.

13. The mold drying method which comprises simultaneously exposing the parting surface and the back surface of a gypsum base mold section for use as a casting matrix, each to a direct radiant heating surface in a close proximity thereto, moving the mold in a path parallel to such heating surfaces during such exposure, and thereafter gradually cooling the mold by moving it between proximate heat conductive surfaces of progressively lower temperature in the direction of mold movement.

14. The mold drying method which comprises exposing the parting surface and the back surface of a gypsum base mold section for use as a casting matrix, each to a direct radiant heating surface at a temperature of approximately 1400° Fahrenheit and spaced from the respective mold surfaces only a few inches, and thereafter exposing such surfaces of the mold to heat conductive surfaces similarly spaced from the mold surfaces, but at a temperature lower than 1400° Fahrenheit and substantially above room temperature, the combined exposure time being of the order of one and one half hours, thereby drying from the mold section all chemically uncombined liquid and recalcining, at least partially, the gypsum in the mold.

15. The mold drying method which comprises exposing the surface of a mold composed of gypsum and asbestos, for use as a casting matrix, to a proximate source of direct radiant heat, the temperature of such heat source and the time of mold exposure thereto being sufficient to dry from the mold all chemically uncombined liquid and also to recalcine, at least partially, the gypsum in the mold.

16. The mold drying method which comprises exposing the parting surface and the back surface of a gypsum base mold section for use as a casting matrix, formed of 100 parts, by weight, of a mixture of asbestos pulp with calcined gypsum to approximately 160 parts, by weight, of water, each to a proximate source of direct radiant heat, the temperature of such heat sources and the time of mold section exposure thereto being sufficient to dry from the mold section all chemically uncombined water and also to recalcine, at least partially, the gypsum in the mold.

17. The mold drying method which comprises exposing the parting surface and the back surface of a mold section for use as a casting matrix, composed of gypsum base material combined with at least an equal weight of water, each to a direct radiant heating surface at a temperature of approximately 1400° Fahrenheit and equally spaced from the mold surfaces only a few inches, thereby to preserve the mold section unwarped by substantially equal and concurrent evaporation of moisture from such opposite surfaces, and thereafter exposing such surfaces of the mold to heat conductive surfaces also spaced from the mold surfaces only a few inches, but at progressively lower temperatures below 1400° Fahrenheit and substantially above room temperature, thereby minimizing the thermal shock to which the mold is subjected, the combined exposure time being of the order of one and one half hours, thereby drying from the mold section all chemically uncombined liquid and also recalcining, at least partially, the gypsum in the mold section.

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