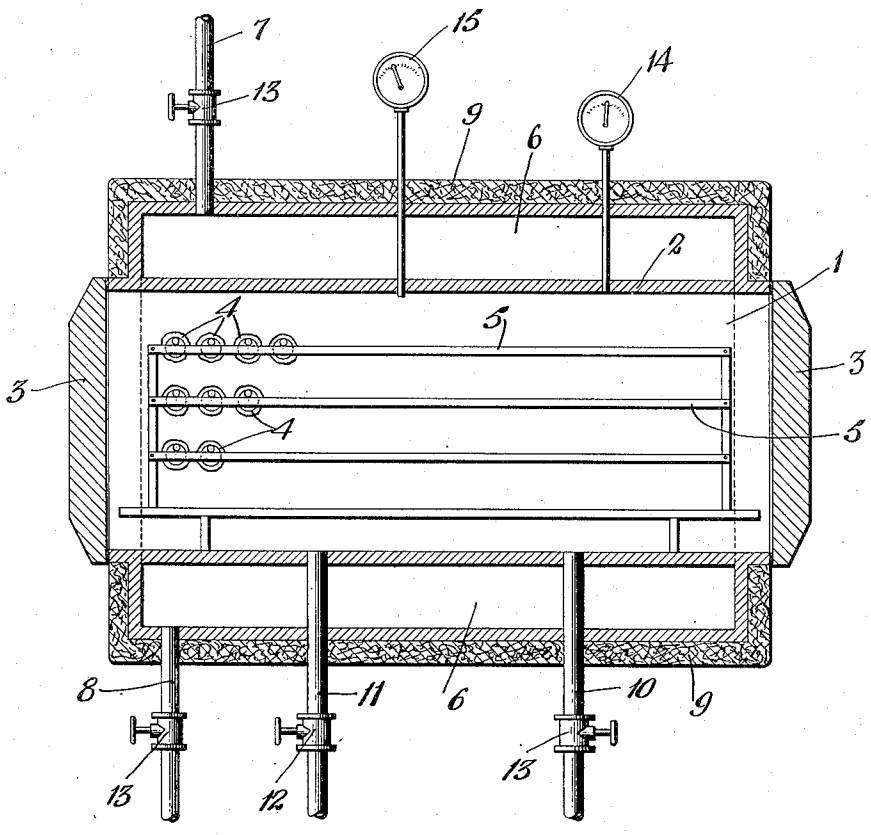
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W. J. PLEWS

METHOD OF DRYING OBJECTS

Filed Dec. 14, 1921



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BY

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UNITED STATES PATENT OFFICE.

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METHOD OF DRYING OBJECTS.

Application filed December 14, 1921. Serial No. 522,298.

To all whom it may concern:

Be it known that I, WILLIAM J. PLEWS, a subject of Great Britain, residing at New Rochelle, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Methods of Drying Objects, of which the following is a specification.

This invention relates to a method of extracting fluid or liquid from, or drying, objects and is particularly applicable to objects and material where it is desired to remove the liquid, or a considerable portion thereof, without materially altering the original form, shape, or dimensions of the object or material.

My invention is particularly applicable to clay products in the manufacture of porcelain, tiles, brick, terra cotta, hollow tiles, porcelain insulators, earthenware, and the like. It is also applicable to the drying of the paste, or active material, for storage battery plates, also to cores for molds and various other objects and material where as aforesaid, it is desired to avoid any material change in the size or shape of the object or material during the drying process.

This application is a continuation in part of my pending applications, Serial No. 340,386, filed November 24, 1919, and Serial No. 480,728, filed June 27, 1921, which relate particularly to the manufacture and treatment of storage battery plates and of the active material thereon, and to which the present invention is applicable. The present application is more general in its scope, and also relates particularly to the drying of clay products and to the new clay product produced by my improved process.

The drying of objects and material to which my invention is applicable, has commonly been done heretofore by drying in the open air, or by heating, or by causing a blast or current of warm air to be passed over or around the object or material. Any such process and particularly where the drying is slow, is expensive in the handling of the material and in the amount of stock in process of manufacture and space required; it furthermore results in an inferior product due to cracking, warping, or other distortion of the object and also is not of homogeneous structure throughout and is lacking in strength. For example, in the manufacture of porcelain and other clay products, the former method of drying results in the above difficulties because the molded object is dried more quickly at its surface than within the body of the object and even at and near the surface dries unevenly and irregularly; also the subsequent drying within the body of the object occurs more or less unevenly and irregularly largely due to the formation of cracks at the surface and even causes cracks to be formed within or through the object. The resultant distortion of the object as a whole, its shrinkage, cracking, and lack of homogeneity, sets up internal strains and causes a lack of strength which even subsequent firing in a furnace will not remove. These difficulties of prior drying methods result in a large percentage of waste of material in the ordinary process of manufacture through breakage of the parts in handling or treatment during manufacture; and even the completed objects are objectionable and unsatisfactory in use owing to the distortion, shrinkage, internal strains and lack of uniformity in the completed articles.

A particular example of these difficulties arises in the manufacture and use of porcelain insulators, such as insulating tubes for electrical resistance units, insulating tubes for wiring buildings and high tension insulators for transmission lines. Here it is not only important to have an insulator of strength and homogeneous structure and which will be free from cracking or breaking, in handling, installation and when in use, but it is also desirable that the insulators for certain purposes shall be uniform in shape, and dimensions. Thus in the manufacture of tubular resistance units, on which the resistive conductor is wound on the outside of the porcelain tube, it is desirable to have all the tubes for a certain resistance and use to be uniform in size and of the same resistance. If all the porcelain tubes are uniform in shape and dimensions, they may be more conveniently wound with the resistive conductor so as to give a uniform resistance and will also properly fit into the structure or place in which they are intended for use.

One important object, therefore, of my invention is to provide a process of drying which will result in the production of objects which will be uniform in size and shape, homogeneous throughout their structure and of greatly increased strength compared with similar manufactured objects dried according to prior methods.

Another important object is to produce a process of drying which will be rapid as compared with the many hours, days or even weeks required by some prior methods with certain classes of objects. This results in reduced cost of manufacture and a large reduction of material on hand in course of manufacture for the same output, as compared with prior methods. Another important object which is particularly important in manufacturing clay products and in the drying of the active material in battery plates and the like is the production of a product, after drying, which will be uniformly porous throughout its structure. The production of this condition not only avoids shrinkage, cracking and distortion of the shape of the object or material, but results in giving greatly increased strength in the final product. Another advantage, in the production of clay products, for example, is that the shrinkage and drying is not only greatly reduced or substantially avoided as compared with prior methods, but in the firing of the objects in a furnace or kiln, the shrinkage occurring during the firing is also greatly reduced or substantially overcome. These and other objects and advantages of my invention will be understood from the following description.

In applying my invention to the manufacture of porcelain, for example, the molded object formed from a mixture, say of clay, flint and feldspar, is in a plastic condition and needs to be dried before placing in the firing furnace or kiln. My process is particularly applicable to the drying stage. The molded object is placed in a chamber or receptacle adapted to be closed tightly and to withstand internal pressure and heat. After the chamber is closed a suitable fluid medium under pressure is admitted to the chamber and the temperature raised. As a convenient means of applying the desired temperature and pressure, I employ preferably a heated fluid pressure medium, for example, steam. Other heated gases may be used where preferable, as for example exhaust from an internal combustion engine, or any suitable gas, which will be inert as regards any objectionable effect on the object. When steam is used, it is preferably superheated.

The pressure in the chamber must be sufficient during the heating, to prevent material vaporization of the fluid in or near the surface of the object so as to avoid shrinkage, or cracking, or irregular vaporization in different parts of the object such as occurs in air drying. That is, the pressure must at all times be approximately equal to, or greater than, the vapor pressure of the fluid in the object at the increasing temperatures to which the object is subjected. This will prevent any appreciable vaporization of the fluid from the object. The introduction of pressure from an external source may be done quickly and the heating process thus permitted to be accomplished quickly. When the pressure fluid introduced also heats the object, as in the case of steam or hot gas, the pressure increases sufficiently rapidly to avoid the objectionable vaporization of the fluid from the object during the heating process. The simultaneous introduction of pressure and heat in this manner may thus be done conveniently and the temperature of the object and the pressure in the chamber may be made comparatively high rapidly. The more rapidly the pressure and temperature are raised, the less will be the time required for this step of the process, and the more quickly will the object be uniformly heated.

The amount of pressure required, the degree of temperature and also the length of the heating will depend upon the particular character of the object or material treated and the results required in a particular case; but the time required in this portion of the process is short. Also in some cases during the pressure and heating process there may take place chemical changes in the material to a greater or less degree and in other cases there may be no chemical change or no appreciable chemical change in the material, this depending upon the nature of the object or material worked upon and the ingredients of which it is composed. The object or material may acquire a permanent set during this heating process, due to chemical changes or to physical changes, or the object may become set during the following portion of the process.

The pressure is now reduced, but this pressure must be relieved gradually. The reduction in pressure is gradually continued until atmospheric pressure is reached. In some cases where it is desired to obtain a comparatively high degree of drying of the object or material, the article may remain in the vessel for a time at atmospheric pressure and in some cases a vacuum may be created in the chamber to a considerable degree for further drying of the article if desired.

During the gradual pressure reduction portion of the process, the decrease of pressure permits the fluid within the object or material to vaporize, not only at the surface but also throughout the body of the object. As the reduction in pressure con-

tinues, the vaporization continues, resulting in a uniform, gradual, continuous and comparatively rapid vaporization of the liquid contained in the object. This action in the case of clay products and in drying the active material of battery plates for example, results in producing a uniformly porous structure in the object or material, extending throughout the body thereof. The avoidance of uneven or irregular drying and the provision of pores uniformly through the mass for the passage of vapor from the object, produces a product which does not crack, warp or become otherwise distorted or materially change its dimensions by shrinkage. It also produces an article of a homogeneous character having uniform strength throughout its parts and in which there are no appreciable internal strains.

The process may be repeated for further drying of the object or article if desired or, as above stated, the object may be further dried or heated at atmospheric pressure or by the application of a vacuum.

The provision of the uniformly porous condition in the object by the above drying, or dehydrating, process is particularly advantageous in the manufacture of clay products, because the subsequent firing in the furnace or kiln enables the chemical change and union of the ingredients to be accomplished uniformly throughout the structure producing a final product of greatly increased strength over prior methods of drying, while at the same time avoiding internal strains. Also the shrinkage or distortion of the object which has heretofore occurred in the firing of objects dried by former methods, is largely reduced or substantially eliminated, because the object has a homogeneous structure when placed in the furnace or kiln and the heat of firing thus has a uniform effect throughout the body of the object. Also the length of time required in firing is reduced, because the object, being porous and homogeneous throughout, the vitrification may take place more uniformly and all parts are correspondingly vitrified in substantially the same length of time.

The accompanying drawing is a vertical cross section of one form of apparatus for carrying out the above described process.

The size, form and arrangement of the apparatus will, of course, be adapted for the particular character of the objects or material to be dried or dehydrated by the above process. The drawing illustrates a chamber 1 having a cylindrical wall 2 and end heads 3, the end heads making a tight joint with the cylinder and may be held in place in any suitable manner; and one or both of the end heads should be removable for permitting the introduction and removal of the objects or material to be dried. In the present instance there are indicated tubes 4 to be dried, which are supported by rods passing through them and which in turn are supported by a rack 5 which is removable from the chamber. Any suitable racks or supporting means for the objects may be provided to suit the particular requirements. The cylinder 2 is shown as having a jacket 6 which may be heated by exhaust gases, or from any suitable source of auxiliary heat, an intake pipe being shown at 7 and an outlet pipe at 8. The apparatus may also be covered by any suitable heat insulator as indicated at 9. An inlet pipe to the drying chamber is shown at 10 through which the superheated steam or other heated gas may be introduced to provide the pressure and heat required, and an outlet pipe from the chamber is shown at 11 with a valve 12 for gradually relieving the pressure and providing an exit for the gas and vapor, as above described. The other inlet and outlet pipes are also shown provided with valves 13. A pressure gauge 14 is connected with the chamber and a temperature indicating device 15 is also shown connected with the chamber so that the operator may know the pressure and temperature conditions in the chamber at all times and regulate them as required.

It will of course be understood that the temperature and pressure required and the length of time required in the above process will depend upon the character of the object or material which is to be dried or dehydrated. In the case of dehydrating molded objects composed of a mixture of clay, flint and feldspar for the manufacture of porcelain, I have attained excellent results by using superheated steam and bringing it to a maximum pressure of from 50 to 200 pounds and at a temperature of about 550° F., the pressure and heating operation being acomplished within about 5 to 15 minutes and the time during which the pressure is gradually reduced being carried out in about 1 to 2 minutes.

The product obtained by the above process in the case of clay products is, as above stated, uniformly porous and homogeneous in characteristics and the process avoids distortion, shrinkage or cracking, resulting in a new product not attained by prior methods.

Although I have described my process with particular reference to the drying of clay products and particularly in connection with the manufacture of porcelain, yet my invention is applicable to the drying or dehydrating of other objects or materials.

In some cases, it may be desirable to permit an exit, to some degree, of the heat and pressure supplying medium while the pressure is being increased, or while being maintained, and thus in some cases obtain a more rapid drying and a more complete drying where desirable.

Where I refer in the claims to objects or material being moulded, I intend to include material which is cast or otherwise formed.

I claim:—

1. The process of removing fluid from material which comprises subjecting the material to heat and external pressure, and gradually reducing said pressure.

2. The process of removing fluid from material which comprises subjecting the material to heat and external pressure at least substantially equal to the vapor pressure of the fluid at the temperature to which the material is heated, and gradually reducing said external pressure.

3. The process of removing fluid from material which comprises subjecting the material to heat and external pressure greater than the vapor pressure of the fluid at the temperature to which the material is heated, and gradually reducing said external pressure.

4. The process of removing fluid from material which comprises placing the material in a closed chamber, applying heat and pressure to the material within the chamber, and gradually reducing the pressure.

5. The process of removing fluid from material which comprises placing the material in a closed chamber, applying heat and pressure to the material within the chamber, said pressure being at least equal to the vapor pressure of the said fluid at the temperature to which said material is heated, and gradually reducing the pressure.

6. The process of removing fluid from material which comprises placing the material in a closed chamber, applying heat and pressure to the material within the chamber, said pressure being greater than the vapor pressure of said fluid at the temperature to which said material is heated, and gradually reducing the pressure.

7. The process of removing fluid from a moulded clay mixture which comprises placing the moulded clay in a closed chamber, applying heat and pressure to the moulded clay within the chamber, and gradually reducing said pressure.

8. The process of removing fluid from a moulded clay mixture which comprises placing the moulded clay in a closed chamber, applying heat and pressure to the moulded clay within the chamber, said pressure being at least equal to the vapor pressure of said fluid at the temperature to which said moulded clay is heated, and gradually reducing said pressure.

9. The process of removing fluid from a moulded clay mixture which comprises placing the moulded clay in a closed chamber, applying heat and pressure to the moulded clay within the chamber, said pressure being greater than the vapor pressure of said fluid at the temperature to which said moulded clay is heated, and gradually reducing said pressure.

10. The process of removing water from a moulded clay mixture which comprises placing the moulded clay in a closed chamber, injecting steam into said chamber and heating the moulded clay thereby under pressure of the steam, and gradually reducing the pressure.

11. The process of removing water from a moulded clay mixture which comprises placing the moulded clay in a closed chamber, injecting superheated steam into said chamber and heating the moulded clay thereby under pressure of the steam, and gradually reducing the pressure.

WILLIAM J. PLEWS.