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DRYING APPARATUS AND METHOD

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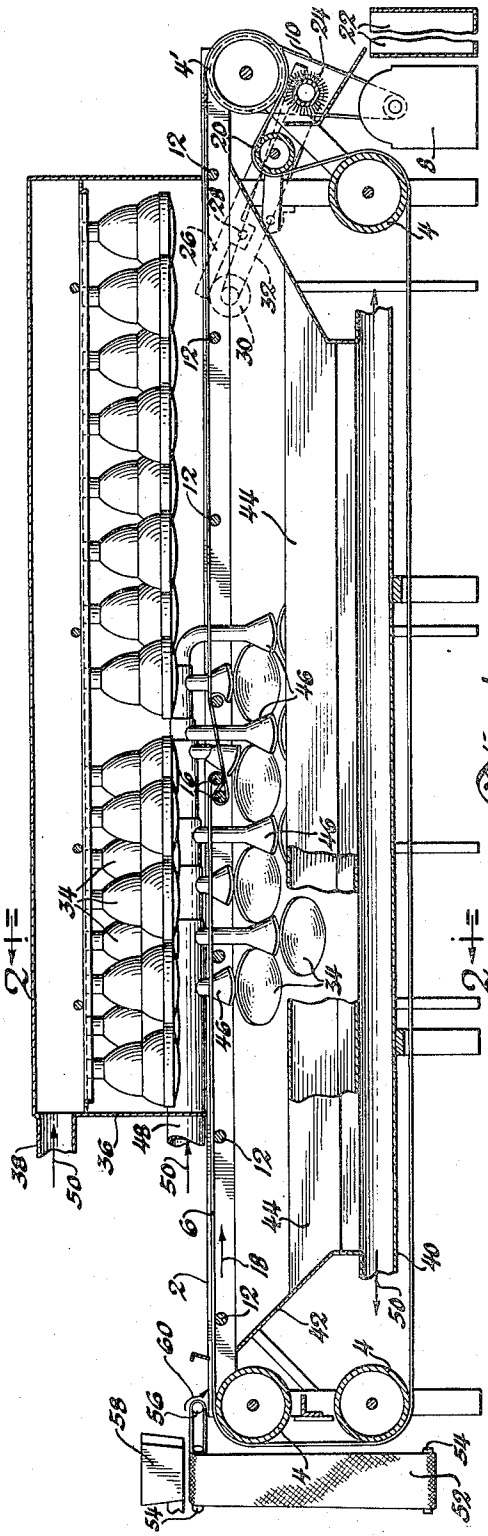


Fig. 1

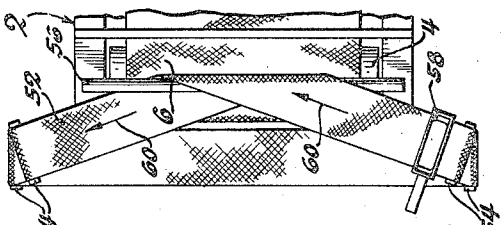


Fig. 4

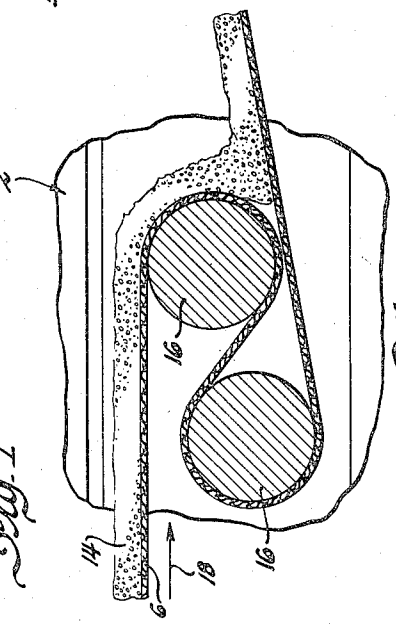


Fig. 3

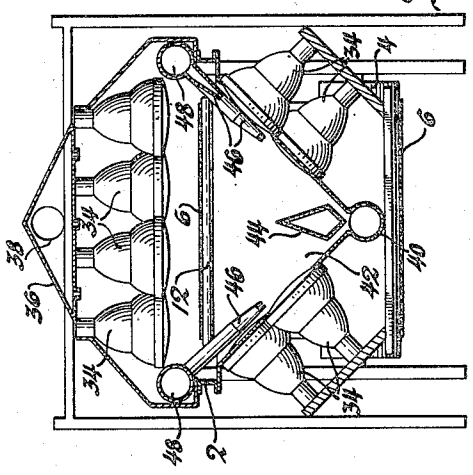


Fig. 2

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DRYING APPARATUS AND METHOD

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16 Claims. (Cl. 34—17)

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

It is the practice in the spark plug industry today to form the insulators by mixing the noncohering powder with a small amount of a binder; the resulting mixture is coherent enough to permit shaping of the powder by methods known to the art. In the spark plug industry, however, the product after molding is an intermediate one rather than being the finished article. The binder serves only to hold the otherwise non-coherent particles of dielectric together to permit easy handling preliminary to firing. Either during or after the molding process the molded articles are heated sufficiently to set the binder. In this form the molded article can be readily handled. In the course of the final heat treatments the binder is substantially all burned out, leaving the completely formed dielectric or insulator.

It has been found that material used for pressed bodies or molded insulators as described in United States Patent 2,122,960 to Schwartzwalder must be dried before it can be used to .2% maximum moisture content as charged into the hot press dies. In effecting such drying the temperatures must not exceed 120° F., higher temperatures would cause premature setting of the resin bond ingredient. In some of the dryers used in the past, dehumidified air at a temperature of 120° F. has been used with the air passing over the granulated material in trays in layers about ¼ inch thick. Such methods have proven to require too much time and too much handling. If the trays of this apparatus are agitated or vibrated to shorten the drying time the wet granulated material will be found to form balls or lumps which are dry on the outside but which remain moist inside.

It is the specific object of this invention to provide a method of and apparatus for drying the granulated insulator material containing a small percentage of resin bonding ingredients which will dry the material with the minimum of handling and in a minimum of time. This is accomplished by the use of a porous or air pervious support preferably in the form of a conveyor belt which carries the granulated material between a plurality of sources of infrared rays. Dehumidified low pressure air is circulated past the infra-red ray sources onto the material on the belt. Due to the pervious nature of the belt some of the air will find its way therethrough. At one or more points along the travel of the belt, means are provided to at least partially invert the material on the belt to facilitate the drying process. The conveyor is conveniently made in the form of an endless belt so that it may move continuously in one direction. The belt is preferably made of glass or of the synthetic fabric known commercially as Nylon because Nylon and glass fabrics have a high strength, high fatigue resistance and have low specific heat. The latter characteristic is desirable because the endless belt moves out of the heated zone into a cool zone and back again through the heated zone.

Figure 1 of the drawing is a view with parts broken away and in section of a machine made according to this invention.

Figure 2 is a view in section substantially on line 2—2 of Figure 1.

Figure 3 is an enlarged detail view showing the means provided for inverting the granulated material on the belt, and

Figure 4 is a top plan view showing a form of apparatus which may be used to supply the conveyor with granulated material.

A supporting frame 2 is provided with rotary cylinders or pulleys 4 and 4' on which is mounted a porous or air pervious endless material supporting conveyor 6. The fabric of conveyor belt 6 is preferably made of glass or Nylon yarn. One of these cylinders may be driven by an electric motor 8 through any suitable connection such as drive belt 10. A plurality of spaced supports 12 may be provided to keep the belt from sagging during the material carrying part of its travel. Supports 12 may be stationary or rotary as desired. Similar supports, not shown, may be provided for the return, or lower half of the belt, if desired.

At one or more points along the material carrying portion of the conveyor's travel I may provide means to reverse granulated material 14. This means comprises a pair of supporting members 16 which may be rotary or stationary as desired. The conveyor winds about members 16 in such a manner as to double back upon itself so as to permit the material 14 to drop off where the conveyor or belt goes around the first support onto the belt again at a lower level, as best shown in Figure 3. This arrangement permits the granulated material 14 to be at least partially inverted, bringing to the top considerable amounts of the material which was at the bottom or adjacent the belt for the first part of the travel of the material through the dryer. The direction of belt travel is indicated by arrows 18 in Figures 1 and 3.

At the extreme right end of the machine as seen in Figure 1 an auxiliary support 20 is provided to bend the belt back upon itself about pulley 4'. Support 20, which may be rotary if desired, is so disposed as to bend the belt through an angle greater than 180° about member 4'. This great angle of bend is provided to more readily remove granulated material 14 from the belt. The material drops off belt 6 into a bin 22 conveniently located beneath member 4'. A scraper of any suitable type such as a rotary brush 24 may be provided to still further aid in removing dried material 14 from the belt. Brush 24 may be supported on a frame 26 pivotally mounted at 28 and may be driven by an electric motor 30 through a drive belt 32. Motor 30 may conveniently form part of the weight of the upper end of frame 26 to bias this frame counterclockwise about its pivot 28 to effect good contact between brush 24 and belt 6. Support or pulley 26 may conveniently be mounted in such a manner as to permit tightening of the belt.

A plurality of sources of infra-red rays such as lamps 34 may be mounted as shown, some above the belt and others below. The lamps are so mounted as to direct their rays upon the belt. Infra-red rays are preferred because rays of this type have been found to work much better than merely dehydrated hot air. When dry hot air was used as a drying medium considerable difficulty was experienced in removing the last 1% of moisture.

The reason appears to be that, in drying with hot air, the moist particles assume the wet bulb temperature, which is very low in the case of dehumidified air. Each particle is therefore surrounded with a thin film of cool air. The increased humidity of the immediately surrounding atmosphere lowers the difference between the vapor pressure of the moisture in the particle and the vapor pressure of the immediately surrounding atmosphere, thereby slowing down the drying process. With infra-red heating the particle itself acts as a heat source, so that the temperature gradient from particle to air is reversed—i. e., the layer of air closest to the particle is the hottest, its relative humidity is low, and the drying process is appreciably accelerated.

It has been found that drying of the granulated material can be expedited to a considerable extent by the use of air forced past the upper lamps onto and at least partially through belt 6. To this end a suitable hood 36 may be provided to which air is supplied from a duct 38. The air thus furnished to the drying apparatus is drawn off under suction through a lower duct 40. Air flow to the duct 40 may be facilitated by the use of an apron 42 disposed beneath the material carrying portion of belt 6 and also by means of a baffle 44. Additional air under pressure may be supplied to nozzles 46 from ducts 48; nozzles 46 direct the air across the lenses of the lower bank of lamps 34 in order to keep these lenses free from dust and other particles which might impede transfer through the lenses of the heat rays. The direction of air flow is indicated by arrows 50. The air supplied to ducts 38 and 48 may be dehydrated, if desired.

In Figures 1 and 4 I have shown the elements of an apparatus for depositing granulated material on the conveyor 6. This apparatus may conveniently comprise an endless belt 52 mounted on rollers 54. Belt 52 is made to pass over a support 56 stretched across the left end of the apparatus as seen in Figures 1 and 4 and just a short distance above conveyor 6. Support 56 may be rotary or stationary as desired. Rollers 54 and support 56 may be mounted on any suitable frame, not shown. Belt 52 may be supplied with granulated material from any suitable hopper 58. The driving means for belt 52 is not shown but it may comprise any satisfactory source of power applied to any of rollers 54. The direction of motion of belt 52 is indicated by arrows 60.

We claim:

1. In combination, a supporting frame, an air pervious nylon fabric mounted on the frame to support a substance to be dried, an infra-red ray source mounted in heat transmitting relation to the fabric, and means to effect relative movement of the fabric and the ray source.

2. The combination of claim 1, in which the fabric is in the form of a conveyor belt.

3. A supporting frame, a flexible air-pervious non-metallic material-carrying support mounted thereon, a plurality of infra-red ray sources mounted in heat transmitting relation to the material-carrying support, means to drive the material-carrying support relatively to the heat-ray sources, and means associated with said support to at least partially invert the material carried thereon, said material-carrying support being made of nylon.

4. A support, a belt conveyor of air-pervious non-metallic material mounted on the support, a plurality of infra-red ray lamps disposed in heat transmitting relation to said belt, means to drive the belt relatively to the lamps, means to reversely bend the belt to at least partially invert the material carried thereon, means to force a current of air past at least some of the lamps toward the belt, and means to force a current of air across the lenses of at least some of the lamps.

5. A supporting frame, a flexible air-pervious non-metallic material-carrying support mounted thereon, a plurality of infra-red ray sources mounted in heat transmitting relation to the material-carrying support, means to drive the material-carrying support relatively to the heat-ray sources, and means associated with said support to at least partially invert the material carried thereon, said material-carrying support being made of glass fabric.

6. In combination, a supporting frame, an air pervious glass fabric mounted on the frame to support a substance to be dried, an infra-red ray source mounted in heat transmitting relation to the fabric, and means to effect relative movement of the fabric and the ray source.

7. The combination of claim 6, in which the fabric is in the form of a conveyor belt.

8. The process of drying a mass of granular material comprising insulator material having moisture therein and containing a small proportion of a resin bonding ingredient which includes simultaneously exposing said material to infra-red rays and to a current of dehumidified air.

9. The method of drying a mass of granular material comprising insulator material having moisture therein and containing a small proportion of a resin bonding agent which includes, placing a mass of the said material on a porous support, exposing said support and said material to infra-red rays and at the same time moving a current of substantially dry air past and at least partially through said porous support and said granular material thereon.

10. The process of drying a mass of granular material comprising insulator material having moisture therein and containing a small propor-

tion of a resin bonding ingredient which includes simultaneously exposing said material to infra-red rays and to a current of air.

11. The method of drying a mass of granular material comprising insulator material having more than .2% moisture therein and containing a small proportion of a resin binder, said resin being adversely affected by drying temperatures above about 120° F. which comprises subjecting the said granular material to infra-red rays while supporting the granular material on a porous support and while a current of dehumidified air is moved at least partially throughout the porous support and granular material thereon, said granular material being maintained at a temperature below 120° during the drying operation and said drying operation being carried out to the point where there is not over about .2% moisture in the granular material.

12. A frame, a flexible, air-pervious, non-metallic, material-carrying support mounted thereon, a plurality of infra-red ray lamps mounted in heat transmitting relation to said support, means to drive the material-carrying support relatively to the infra-red ray lamps, means associated with said support to at least partially invert the material carried thereon, means to force a current of air past at least some of the infra-red ray lamps toward said support, and means to force a current of air across the lenses of at least some of the lamps.

13. The combination of claim 12, in which the material-carrying support is made of nylon.

14. The combination of claim 12, in which the material-carrying support is made of glass fabric.

15. A support, a belt conveyor mounted thereon of air-pervious material formed of one of the class of non-metallic materials consisting of nylon and glass fabric, means to drive the conveyor belt, a source of infra-red rays positioned in heat transmitting relation to the belt conveyor, and means to force a current of air past the ray source and toward the belt conveyor.

16. A method as in claim 11, in which the porous support is formed of one of the class of non-metallic materials consisting of nylon and glass fabric.

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