June 3, 1930. R. P. KOEHRING ET AL 1,761,016

DRYING METAL POWDERS

Filed Nov. 7, 1927 2 Sheets-Sheet 1

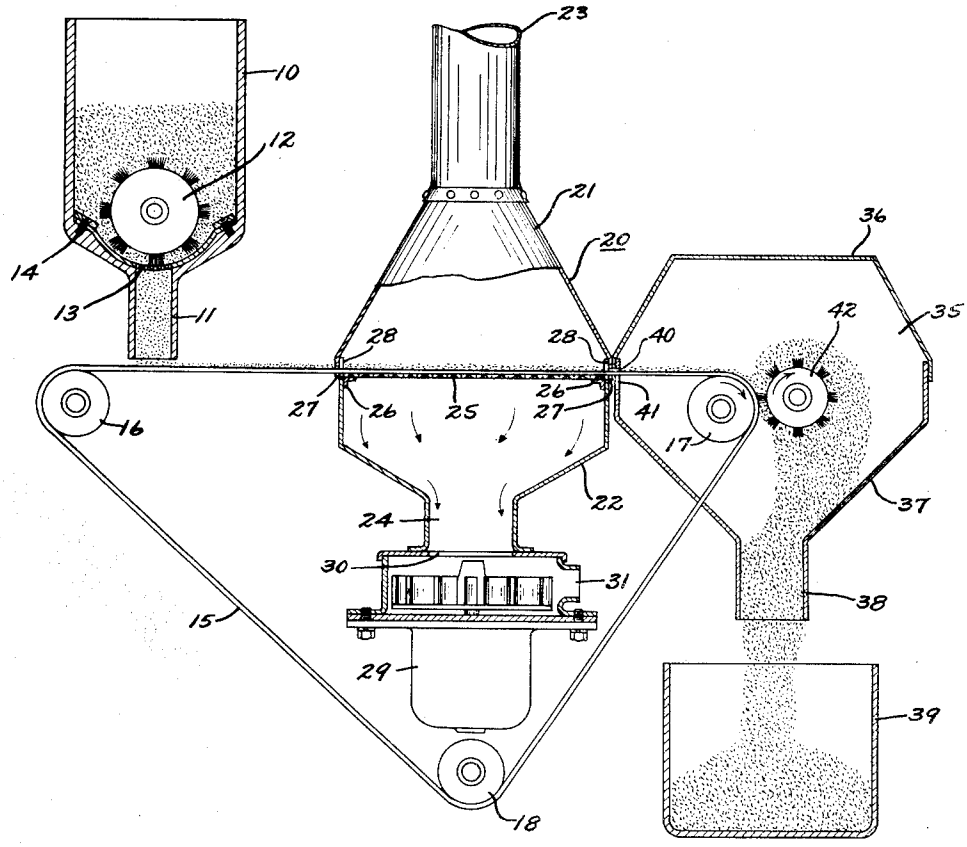



Fig. 1

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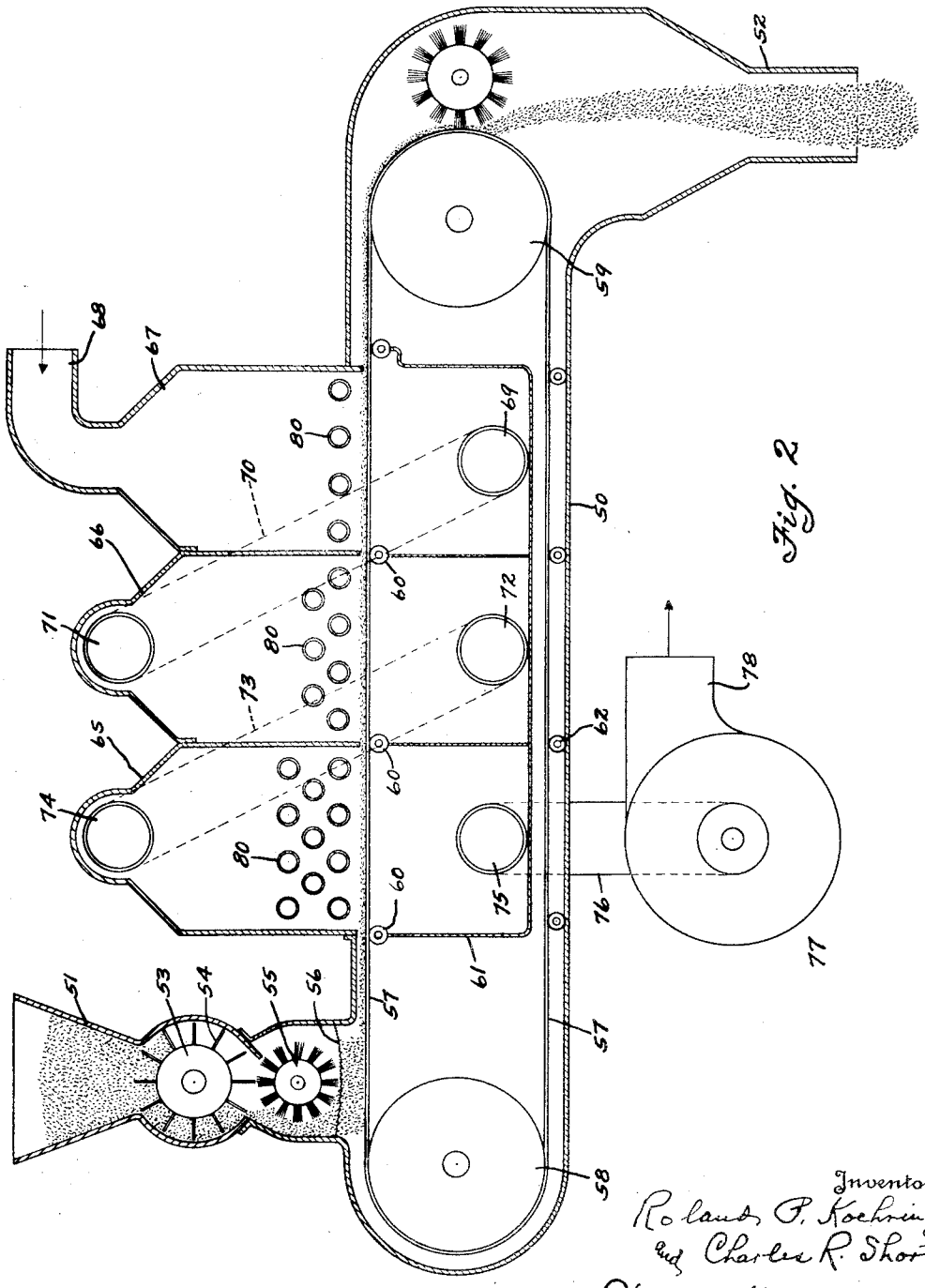



Fig. 2

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Patented June 3, 1930 1,761,016

# UNITED STATES PATENT OFFICE

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## DRYING METAL POWDERS

Application filed November 7, 1927. Serial No. 231,410.

This invention relates to the drying of powdered material by bringing heated air into contact therewith.

It is the principal object of this invention to devise a novel method of, and apparatus for, drying any wet powdered material rapidly and efficiently without injury to the material being dried.

A desirable method of manufacture of powdered copper involves precipitation of the copper from a solution of some copper salt, as for instance copper sulphate. The precipitate, which is an amorphous powder, is washed and after the washing operation as much water as possible is separated from the wet powder by rotating the wet mass in a centrifugal machine. After such treatment, however, the mass still contains some twenty per cent water, and this water must be separated from the powder before the latter can be used for various purposes. It has been found difficult to dry this powder because copper oxidizes very readily and unless the drying operation is carried out very rapidly within certain narrow temperature limits considerable oxidation of the powder will take place.

More specifically, therefore, an object of the invention is to devise a novel method of drying wet copper powder in such a way as to reduce or practically prevent the formation of copper oxide during the drying operation, and to provide a suitable apparatus for carrying out this method.

With these objects in view a feature of the invention resides in a method of drying wet powdered material which consists in depositing the material to be dried in a thin layer on a porous support and forcing heated air through the material while on said support.

A further feature of the invention resides in the method of drying wet powdered material which includes the step of depositing the material in a thin layer on a fabric conveyor and operating the conveyor continuously to carry said material through a drying chamber in which heated air is forced through said material while on the conveyor.

An additional feature of the invention resides in the method of drying wet powdered material as above set forth, said method including the step of repeatedly subjecting the powdered material to the action of heated air the temperature of which is varied as the air absorbs moisture, to maintain the relative humidity of the air substantially constant. A still further feature of the invention consist in the provision of an apparatus for carrying out the above method which comprises a drying chamber, a conveyor passing through said chamber, means forcing heated air through said chamber, and means for depositing material to be dried on said conveyor and removing the material after it is dried.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein preferred embodiments of one form of the present invention are clearly shown.

In the drawings:

Fig. 1 is a sectional view more or less diagrammatic of a drier constructed in accordance with this invention.

Fig. 2 is a similar view of a modified form of drier.

Referring to Fig. 1 of the drawing the reference numeral 10 indicates a hopper in which the powdered material to be dried is placed. The hopper is provided with a contracted outlet neck 11 from which the material is fed to an endless conveyor belt hereinafter described. The material is ejected from the hopper continuously by means of a rotating brush 12 suitably supported within the hopper and driven by any suitable means. A screen 13 is fixed in the bottom of the hopper by screws 14, in close proximity to the brush 12. As the brush is rotated it forces the powdered material through the screen and such material falls through the outlet neck 11 to the surface of the belt conveyor. The quantity of material ejected from the hopper, per unit of time is, of course, dependent on the speed of rotation of the brush.

An endless belt conveyor 15 receives the material from the hopper. This conveyor is

made of relatively strong, heavy fabric, such for instance as the cloth employed in the making of bags for vacuum cleaners, and the belt is supported on three rollers 16, 17 and 18 mounted in any suitable manner and rotated by any suitable driving means to operate the belt continuously. The rollers are driven at such speed relative to the speed of the brush 12, that the powder ejected from the hopper is spread in a thin layer on the belt.

The rollers 16 and 17 are arranged in the same horizontal plane, so that the belt travels in a horizontal path between such rollers. Between the rollers 16 and 17 is a heating chamber indicated in its entirety by the reference numeral 20. This chamber is formed by upper and lower hoods 21 and 22 respectively, the enlarged lower end of hood 21 being joined to the enlarged upper end of hood 22 by any suitable means. The chamber 20, has a contracted inlet 23, a contracted outlet 24 and an enlarged middle portion in which a perforated screen 25 is mounted on ledges 26 projecting from the wall of the lower hood. The conveyor belt 15 passes through the drying chamber 20 immediately above the screen 25, suitable slots 27 and 28 being provided in the hoods 21 and 22 respectively to permit passage of the belt 15 when the hoods are secured together.

The inlet 23 of the drying chamber is connected to any suitable source of hot air, while an air pump 29, having intake 30 and outlet 31 is secured to the outlet 24 of the drying chamber. The pump is of ordinary type and as the construction of the pump is of no importance so far as the present invention is concerned, it will not be described in detail.

The roller 17 over which the conveyor belt passes is positioned within a discharge chamber 35, formed of upper and lower hoods 36 and 37 respectively, the upper hood being closed and the lower being provided with a contracted discharge neck 38, through which the dried material is discharged into a receptacle 39. The hoods 36 and 37 are secured together in any desirable manner to form the chamber 35, and the latter is positioned immediately adjacent the chamber 20, the walls of the chambers contacting. Slots 40 and 41 are formed in hoods 36 and 37, respectively, to permit passage of the conveyor belt.

Mounted for rotation in chamber 35 with its axis of rotation parallel to that of roller 17 and positioned close enough to the roller to contact with the conveyor belt, is a rotating brush 42. This brush is rotated by any suitable means in the same direction as the roller 17, that is both roller 17 and brush 42 are rotated in a clockwise direction which causes the brushes at its point of contact with the conveyor belt to travel in a direction opposite to the travel of the belt, as indicated by the arrows in Fig. 1. The rotating brush 42 operates to brush the dried powder from the surface of the conveyor, the powder being discharged through the outlet 38 into the receptacle 39.

In the form of the invention shown in Fig. 2 a single main casing 50 is provided having a hopper 51 at one end in which the powder to be dried is received and a contracted outlet neck 52 at the other end through which the dried powder is discharged. The hopper which is at the top of an upstanding portion of the main casing is reduced in size at its lower end and immediately below the reduced portion the casing is enlarged to receive a rotating member 53 having projecting blades 54 thereon forming measuring troughs between the blades. A rotating brush 55 is provided below the dispensing member, above described and immediately below the brush 55 is a screen 56 which extends entirely across the upstanding portion of the casing previously referred to. The dispensing element 53 and the brush 55 are rotated by any suitable mechanism, the element 53 operating to deposit successively measured increments of the powder on the screen 56 as the element rotates. The brush 55 forces this powder through the screen to the surface of a belt conveyor hereinafter more fully described.

The belt conveyor 57 is a continuous strip of strong fabric of the type previously described. The conveyor passes over two rollers 58 and 59 situated in opposite ends of the main casing and rotated by any suitable mechanism to continuously move the conveyor. A plurality of small rollers 60 mounted in a supporting frame 61 support the upper part of the conveyor between the driving rollers 58 and 59 and rollers 62 support the lower part of the conveyor between its driving rollers.

The wet powder is deposited on the conveyor adjacent the roller 58 and the dried powder is discharged from the conveyor as it passes around the roller 59. Between the two rollers that portion of the belt 57 comprising the wet powder passes through three adjacent heating chambers 65, 66 and 67. A part of the main casing forms the upper portion of these chambers while the roller supporting frame 61 constitutes the lower part of such chambers. The chamber 67 is provided with an air inlet 68 and an outlet 69. A pipe 70 connects the outlet 69 with an inlet 71 to carry the air from chamber 67 to chamber 66. Air flows from the chamber 66 through an outlet 72 and a pipe 73 conveys the air to the inlet 74 in chamber 65. Chamber 65 is provided with an outlet 75 which is connected by a conduit 76 with an air pump 77 having an outlet 78. The inlet 68 and outlet 78 may communicate with the atmosphere, or they may be connected by a conduit to form a closed circuit through which the air is circulated and recirculated by the pump 77.

Steam pipes 80 are provided in the drying chambers 65, 66 and 67, there being one row of heating pipes in chamber 67, two rows of pipes in chamber 66 and three rows of pipes in chamber 65. It will be obvious that the air passing through chamber 65, through which the powder to be dried first passes, is heated to a higher temperature than the air in chamber 66 which in turn is kept at a higher temperature than the air in chamber 67. The wet powder is therefore subjected to the action of the heated air repeatedly, and at progressively decreasing temperatures, that is, the heated air which first passes through the powder in chamber 65 is at higher temperature than that which passes through such powder in chamber 66 and so on.

The air entering chamber 67 is comparatively dry and absorbs a part of the moisture contained in the wet powder. This air then passes to chamber 66 where, being heated to a higher temperature it can absorb more moisture, and being heated to a still higher temperature in chamber 65 it can absorb still more moisture. In other words, by increasing the temperature of the air as its humidity is increased, moisture is absorbed from the wet powder each time the air passes through the powder. Moreover, by increasing the temperature of the air as the moisture absorbed by the air is increased, the relative humidity of the air as it passes through the various drying chambers is maintained relatively constant. If this air inlet were in chamber 65 and outlet in chamber 67, the arrangement of heating pipes disclosed could be reversed, that is one row of pipes could be placed in chamber 65 and three rows in chamber 67. However, as it is desired to handle the powder soon after it leaves the drier, it is desirable that the chamber 67 have the lowest temperature. For this reason the air from the pump is admitted first to this chamber, and the smallest number of heating pipes are placed therein. Also there is less tendency to oxidize the material when said material is a metal if it is first subjected to the action of drying air at the maximum temperature of the latter.

In the manufacture of porous metal bearings from powdered metals and other materials, as set forth in the patent to H. M. Williams No. 1,642,347 the principal material used is powdered copper. It is important to produce the copper powder as cheaply as possible and one desirable method of making it is to precipitate such powder from a solution of copper sulphate or other copper salt and to recover the precipitate. The latter is washed and after the washing operation is subjected to the action of a centrifugal machine to eliminate water. It is impossible to completely dry the powder by this method, however, and before the powder can be used it must be subjected to a further drying operation. Copper oxidizes so easily that it is more or less difficult to dry the powder successfully without some degree of oxidation. It must be dried quickly, but must not be subjected to too high a degree of heat during the drying operation. Applicants have discovered that by passing a current of heated air, at a temperature approximately that of the boiling point of water, through a very thin layer of the powder for a very brief interval of time, the powder may be dried effectively substantially without oxidation.

While the above described apparatus is designed to dry any powdered material whatever, it is particularly suitable to dry copper powder. To employ the device disclosed in Fig. 1 for this purpose the air passing through chamber 20 should be approximately 100° C. If the form disclosed in Fig. 2 is used for drying copper powder, the air passing through chamber 65 should be heated to approximately 100° C., the air in chambers 66 and 67 being heated to a lesser degree.

While the form of embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. The method of drying wet copper powder which consists in depositing the powder in such a thin layer that drying air can pass therethrough substantially uniformly over its area on a foraminous support and forcing heated air through said powder at progressively decreasing temperatures as the moisture evaporates whereby tendency toward oxidation of the copper powder is reduced.

2. The method of drying wet copper powder which consists in depositing the powder in a relatively thin layer on a foraminous support, first forcing air heated to approximately 100° C. through said powder for a time insufficient to cause oxidation of the copper, and later progressively decreasing the heated air temperature until the copper powder is dry.

3. The method of drying wet copper powder which consists in depositing the powder in a relatively thin layer on a foraminous support and repeatedly forcing heated air therethrough at progressively decreasing temperatures as the moisture is evaporated.

In testimony whereof we hereto affix our signatures.

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