Oct. 19, 1948. H. R. FORTON 2,451,546

METHOD AND APPARATUS FOR FORMING A POWDER FROM METALS

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FIG.6.

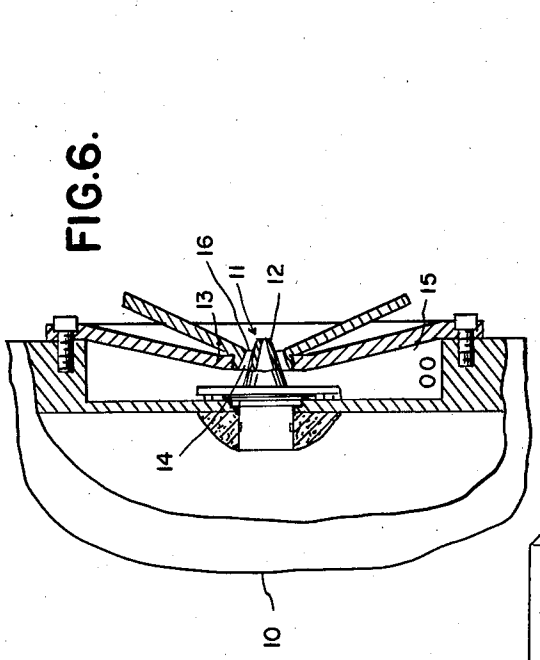


FIG.1.

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FIG.2.

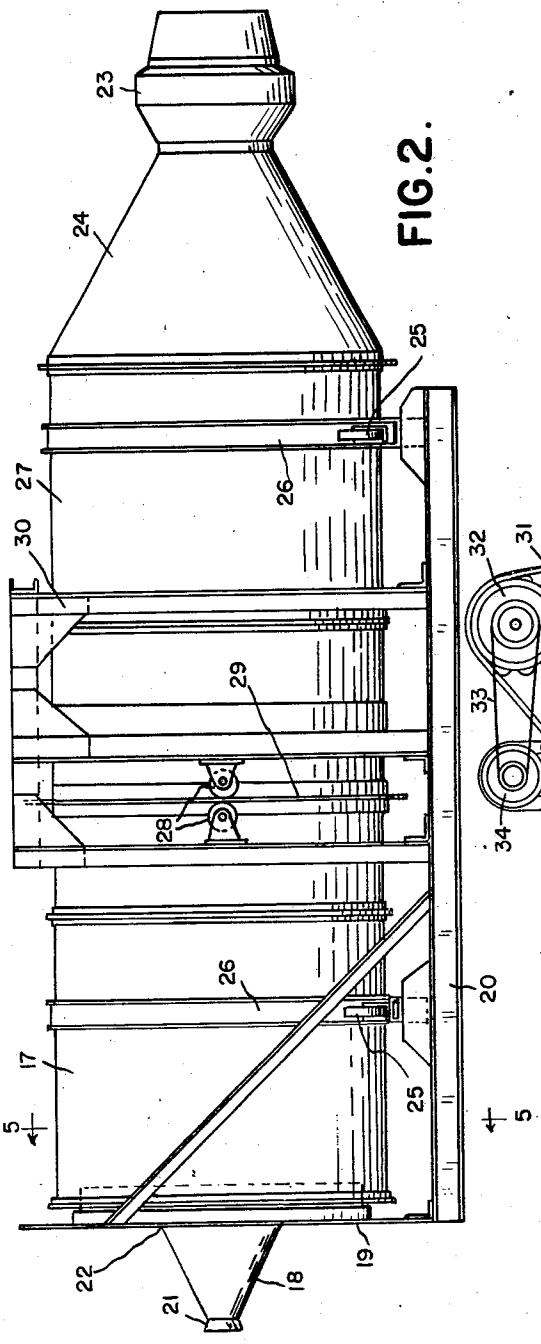
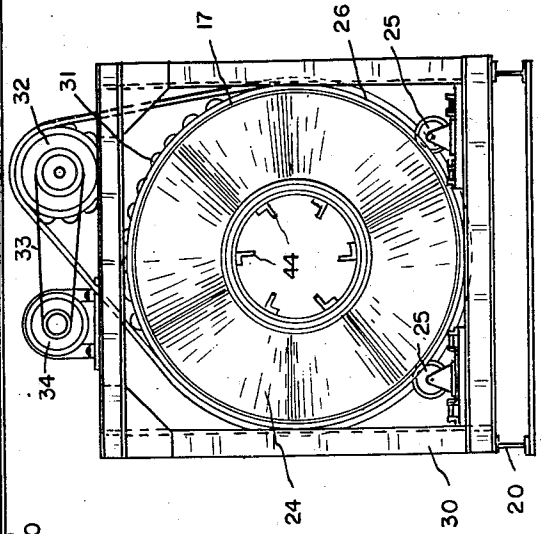


FIG.4.



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FIG.3.

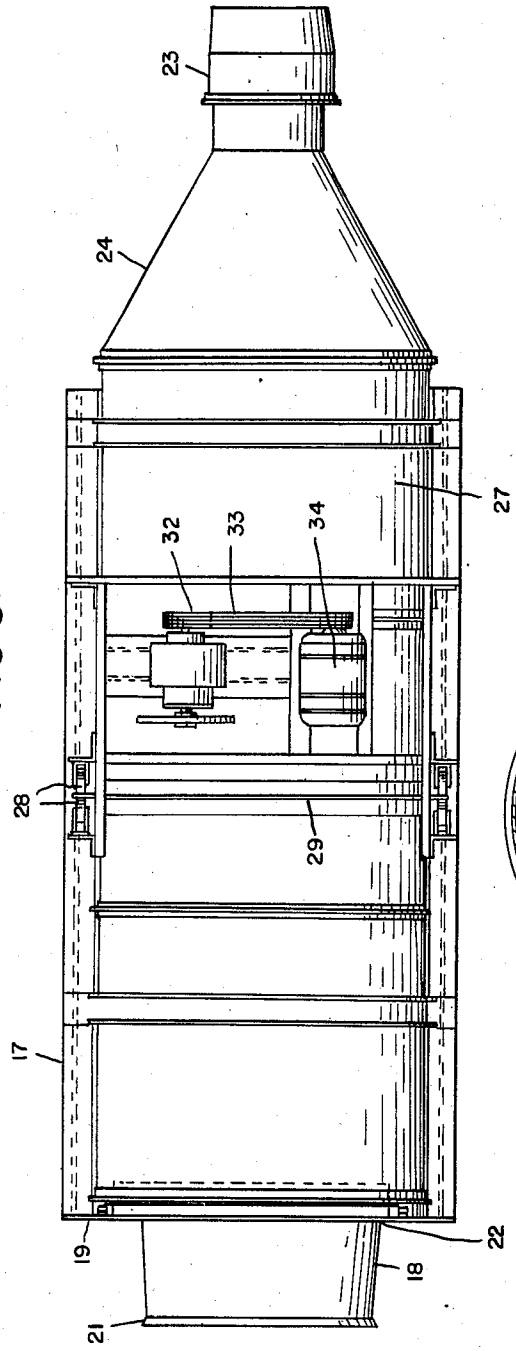
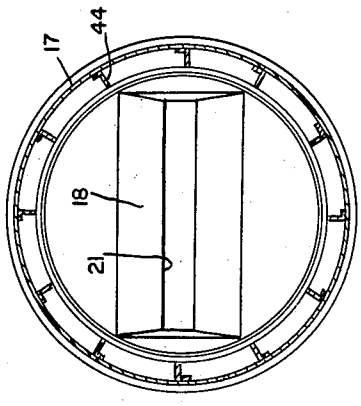


FIG.5.



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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR FORMING A POWDER FROM METALS

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Application June 25, 1945, Serial No. 601,417

2 Claims. (Cl. 18—2.4)

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This invention relates to an improved method and apparatus for producing powdered material. More particularly, the invention concerns itself with the manufacture of a powder from a molten metal such, for example, as zinc, aluminum, alloys of aluminum and metals having characteristics similar to aluminum.

In the manufacture of powdered metals, it is customary to collect the powder in bags formed of a porous material having interstices of a size sufficient to permit relatively free passage of air and, at the same time, prevent the escape of the metal particles therethrough. The material best suited for producing the bags is not capable of withstanding high temperatures and, therefore, the powder must be cooled to a temperature below the critical temperature of the bag material before it is introduced into the bag house. This requirement has a tendency to slow down production as sufficient time must elapse between atomizing the molten metal and introducing the metal particles into the bag house to enable the particles to cool below the critical bag temperature.

The present invention contemplates improving handling of the metal particles from the atomizing equipment to the bag house so that there is always a substantial available supply of cooled particles at the receiving side of the bag house. The temperature of these particles is well below the critical temperature of the bags and the rate at which these particles are introduced into the bag house depends on the capacity of the bag house rather than on the temperature of the particles. Thus, the process may be continuous and considerably greater production is possible with an installation of given size.

Another object of this invention is to introduce the molten particles of metal into a rotating chamber or drum and to flow a stream of gaseous cooling medium such as air through the drum. The particles are advanced through the chamber by the combined effect of the rotating action of the drum and the action of the air stream. The particles falling out of suspension in the air stream are collected in the bottom portion of the chamber and are returned to the air stream by the rotating action of the chamber, until they eventually pass through the outlet opening in the chamber. In this manner the particles are not only effectively cooled and separated from one another, but in addition, are individually oxidized, which is especially desirable in cases where the particles are formed of a combustible material, because it reduces the pyrophoric characteristics of the particles.

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A further object of this invention is to collect the particles discharged from the chamber aforesaid in a second chamber or drum which also has a stream of gaseous cooling medium flowing therethrough and which is rotated at a speed somewhat less than the first chamber. The particles in the second chamber are subjected to the same general type of turbulent action imparted to the particles in the first chamber with the result that the particles are further cooled, and any particles adhering to one another are separated. The second chamber, in addition to rotating at a slower rate than the first chamber, may also be somewhat longer than the latter to assure an accumulation of particles therein and to enable mixing of the particles, which is advantageous because it provides a more consistent product.

The foregoing as well as other objects will be made more apparent as this description proceeds, especially when considered in connection with the accompanying drawings, wherein:

Figure 1 is a diagonal illustrating one type of apparatus that may be employed for manufacturing powdered material in accordance with this invention;

Figure 2 is a side elevation of a part of the apparatus shown in Figure 1;

Figure 3 is a top plan view of the construction shown in Figure 2;

Figure 4 is an end elevation of the part shown in Figure 2;

Figure 5 is a cross-sectional view taken on the plane indicated by the line 5—5 of Figure 2; and

Figure 6 is a fragmentary sectional view through another part of the apparatus shown in Figure 1.

The process forming the subject matter of this invention will be more fully understood upon considering a detailed description of the apparatus shown in the accompanying drawings. It is to be understood, however, that various different specific types of apparatus may be employed to carry out the several steps of this method and, therefore, the latter should not be considered as restricted to the particular apparatus shown.

With the above in view, reference is now made more in detail to the drawings, wherein the reference character 10 indicates a melting chamber or furnace into which briquettes or blocks of the selected metal are introduced in any accepted manner not shown herein. The metal selected, of course, depends upon the type of powder to be produced and, for the purpose of illustrating this

invention, may be considered as aluminum, or metals having characteristics similar to aluminum. In any case, the temperature of the metal is increased in the furnace sufficiently to provide a molten body of metal having the required viscosity and this molten metal is discharged through the front wall of the furnace in the form of a spray by a nozzle 11. The nozzle 11 may be of any suitable construction, but is preferably of the general type shown in my copending application Serial No. 601,418 filed June 25, 1945. In general, the nozzle comprises a discharge tube 12 through which molten metal is permitted to flow out of the furnace and a member 13 which surrounds the tube 12 in spaced relation to the latter. The member 13 coacts with the tube 12 to form an annular passage 14, which communicates with a chamber 15 and is provided with a restricted discharge port 16. The chamber 15 is adapted to contain a gaseous fluid medium such as air under pressure and the discharge port for the annular passage 14 is so positioned with respect to the discharge end of the tube that the molten metal flowing from the tube is atomized by the air to provide a multiplicity of fine particles.

The particles issuing from the nozzle 11 are conducted into the receiving end of a cylindrical chamber or drum 17 by a conduit 18. The conduit 18 is supported beyond the receiving end of the drum 17 on a vertical frame 19 having the lower end fixed to a base frame 20, which extends longitudinally of the drum 17 and forms a support for the latter. The conduit 18 is elongated transversely of the drum and has a length which approximates the diameter of the receiving opening at the front end of the drum 17. The entrant end 21 of the conduit is of reduced width in comparison to the discharge end 22 and the top and bottom walls of the conduit diverge from the entrant end to direct the particles into the drum 17.

The delivery end of the drum 17 is formed with a coupling section 23 having a diameter substantially less than the diameter of the drum and connected to the latter by a frustro-conically shaped section 24. The drum is rotatably supported on the base frame 20 by means of rollers 25 and channel-shaped rings 26. The rollers 25 are supported on the base frame 20 in spaced relation to each other longitudinally of the drum and are arranged in pairs with the rollers of each pair spaced at opposite sides of the axis of rotation of the drum. The rings 26 are secured to the main section 27 of the drum and are positioned to respectively engage the pairs of rollers 25. Thus the channel-shaped rings 26 cooperate with the rollers 25 to guide rotation of the drum 17 about its axis. Additional guiding of the drum 17 is effected by two pairs of rollers 28, respectively supported at opposite sides of the drum with their axes disposed in a common plane perpendicular to the axis of rotation of the drum 17. The rollers of each pair 28 respectively engage opposite sides of an annular web 29 surrounding and secured to the main section 27 of the drum. As shown particularly in Figure 2 of the drawings, the rollers 28 are carried by a vertical subframe 30, which is secured to the base frame 20. Thus the rollers coact with the web 29 to prevent axial displacement of the drum 17 during rotation of the latter.

Upon reference to Figure 4 of the drawings, it will be noted that a sprocket 31 is secured to the main section 27 of the drum in concentric relation thereto and is connected to a sprocket 32 on a suitable speed reducer by a chain 33. The speed reducer is driven by a prime mover 34 in the form of an electric motor, which together with the speed reducer, is mounted on the vertical subframe 30.

A second chamber or drum 35 is supported for rotation in spaced relation to the drum 17. The chamber 35 may be supported and driven in the same manner as the chamber or drum 17. In the interests of simplicity, therefore, the chamber 35 is not illustrated or described in detail. It will suffice to point out that the receiving end of the chamber 35 is provided with a reduced coupling section 36, which is connected to the coupling section 23 at the discharge end of the chamber 17 by a conduit 37. The delivery end of the chamber or drum 35 is also provided with a reduced coupling section 38 and the latter communicates with the interior of a conventional bag house 39.

The bag house in turn communicates with a suction blower indicated by the reference character 40 and contains the usual bags (not shown) for receiving the powdered metal. In accordance with conventional practice, the bags in the house 39 are of porous material having interstices dimensioned to permit the passage of air and to prevent the passage of the metal particles therethrough. The metal particles trapped in the bags are deposited on a conveyor indicated by the reference character 41 and are conducted by the latter to a device 42, which serves to classify the particles as to size prior to depositing the particles in a suitable shipping container indicated generally by the reference character 43.

It will be noted from the above, especially when considered in connection with Figure 1 of the drawings, that the two drums and the bag house are, in effect, connected in series with the suction blower. As a result, a stream of air is caused to flow through each chamber or drum. The velocity of the air flowing through the drums, of course, depends on the size of the latter and on the capacity of the blower. By way of example, let it be assumed that the capacity of the blower approximates forty-two hundred feet of air per minute and that the main sections of both drums are substantially eight feet in diameter. Assuming now that the diameter of the duct or conduit 37 connecting the drums is approximately twenty-four inches in diameter, it follows that the air velocity in the duct 37 approximates forty-two hundred feet per minute and the air velocity in both rotating drums may be considered substantially three hundred and eight feet per minute. The above values are merely noted for the purpose of explanation and should not be considered as restricting the invention, because they are not necessarily critical to successful performance of the apparatus.

Referring now more in detail to the operation of the apparatus previously described, it will be noted that as the particles of molten metal are discharged into the rotating drum 17, they are admitted to the air stream passing through this drum. However, the velocity of the air stream in the main section 27 of the drum is not sufficient to carry the particles directly into the duct or conduit 37. On the contrary, the particles fall out of suspension in the air stream and are collected by the bottom portions of the drum. These particles are returned to the air stream by the rotating action of the drum and in order to facilitate this operation, the drum is provided with a plurality of circumferentially spaced baffles 44,

which are secured to the inner surface of the main section 27 of the drum and extend for substantially the full length of this section 27. These baffles are responsive to rotation of the drum to raise or lift the particles back into the air stream and in this manner the particles are eventually advanced to the reduced coupling section 23 at the rear end of the drum, where they are forcibly conveyed to the drum 35 by the relatively high velocity air stream in the conduit 37.

The length of the drum 17 and the speed of rotation of the latter are predetermined to delay the passage of particles through the drum for a period of time. This time period is sufficient to not only effectively cool and separate the particles from one another, but in addition, enables oxidation of the individual particles, which is highly desirable in cases where the particles are formed of a combustible material because it reduces the pyrophoric characteristics of the particles. In actual practice, a drum 22 feet long and rotating at approximately 4 R. P. M. affords particularly satisfactory results.

The particles drawn through the conduit 37 from the drum 17 are discharged into the drum 35. As previously stated, this drum is of the same general construction as the drum 17 and accordingly imparts the same turbulent action to the particles passing therethrough. In an installation where the drum 17 is rotated at approximately 4 R. P. M., it is preferred to rotate the drum 35 at the reduced rate of substantially 1½ R. P. M. Also, the drum 35 is preferably longer than the drum 17 and accordingly the particles pass through the drum 35 at a rate somewhat slower than they pass through the drum 17. As a result, the particles accumulate in the drum 35 and this is highly desirable in that it provides for obtaining a thorough mixture of the particles and assures a more uniform or homogenous product.

The particles in the rotating drum 35 are eventually conducted to the bag house 39 and are drawn into the bags by the action of the blower 40 in accordance with orthodox practice. The particles accumulating in the bags fall by gravity onto the conveyor 41, which deposits the particles into the classifying device 42. This device is also of standard design and functions to separate the particles in accordance with their size before actually depositing the particles in the shipping containers 43.

It follows from the foregoing that the nature of the apparatus is such as to enable supplying the metal particles to the bag house 39 at a rate depending on the capacity of the bag house. This is true because by the time the metal particles approach the discharge end of the rotating drum 35, they are cooled substantially below the critical temperature of the bags in the house 39. As a result, the rate of production of the equipment is not only greatly increased, but the danger of burning the bags by the metal powder is reduced to a minimum.

What I claim as my invention is:

1. The method of forming a powder from a molten material which comprises reducing the material to fine particles, successively advancing particles of the material through spaced chambers to a point of distribution by flowing a stream of gaseous cooling medium through the chambers, collecting particles falling out of suspension in each chamber, returning these particles to the stream of gaseous cooling medium in the respective chambers by rotating the latter, and accumulating particles in the chamber adjacent the point of distribution of the particles by rotating the latter chamber at a rate somewhat slower than the preceding chamber.

2. Apparatus for producing a powder from a molten material comprising an elongated chamber having an intake opening at one end and having a restricted outlet opening at the opposite end, means for introducing particles of the molten material into the chamber through the intake opening, a second elongated chamber having an intake opening at one end communicating with the outlet opening in the first chamber and also having an outlet opening, means connected to the outlet opening of the second chamber for drawing air through both chambers to successively convey material particles through said chambers, means supporting the chambers for rotation independently of one another about their respective longitudinal axes, means responsive to rotation of the chambers to introduce material particles which have accumulated in the bottom portions of said chambers into the air stream flowing through the chambers, and means for rotating the second chamber at a slower rate than the first chamber to provide an accumulation of material particles in the second chamber.

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