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PROCESS AND APPARATUS FOR COMMINUTING
LIQUID SUBSTANCES
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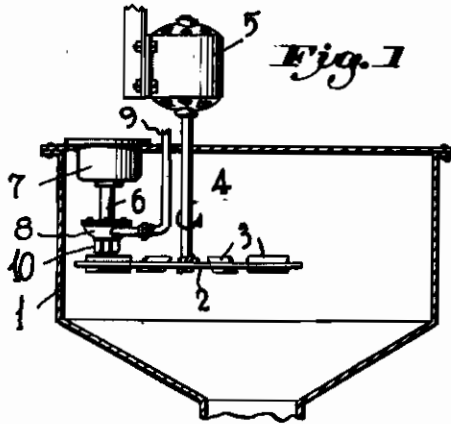


Fig. 1

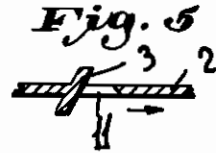


Fig. 5

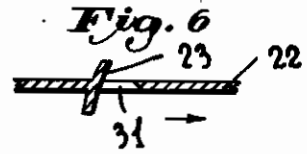


Fig. 6

Fig. 2

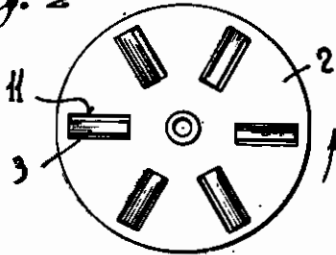


Fig. 3

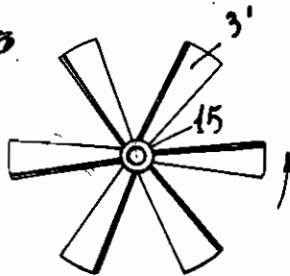


Fig. 4

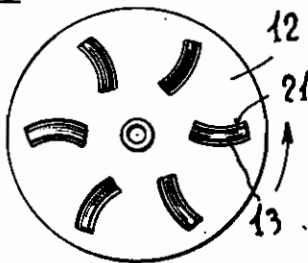
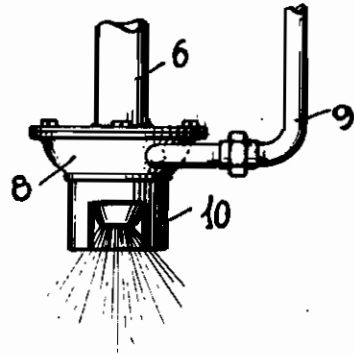


Fig. 7



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PROCESS AND APPARATUS FOR COMMINUTING LIQUID SUBSTANCES

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Application filed November 26, 1940

The present invention relates to an improved process and apparatus for converting liquid materials, especially metals, into a finely divided form.

This application is a continuation-in-part application of my application S. N. 273,330, filed May 12, 1939.

It is an object of the invention to provide an improved process and apparatus for the comminution of liquid materials with the aid of an element rapidly rotating about a substantially vertical axis.

It is a special object of the invention to provide an improved process and apparatus for the preparation of finely divided metals suitable for use in the powder metallurgy art.

Various types of rotating disc processes and apparatus have been developed for the comminution of fused materials in which a stream of fused material is directed against a rapidly rotating disc-like element. However, great difficulties have been encountered with such processes and apparatus when an extremely finely divided product was sought to be obtained, especially when fused materials having a high melting point, such as metals, were to be comminuted. For example, it was found that rotating discs having a substantially flat comminuting surface were not especially suited for the comminution of metals as the degree of comminution obtained depended a great deal upon the speed at which the molten metal was supplied to the rotating disc. In order to increase the speed of the metal supplied to the rotating disc it was sought to allow the stream of metal to drop from a considerable height as the use of pressure in supplying the metal proved difficult. However, when molten metal was allowed to drop upon the rotating disc from a considerable height, the metal cooled to such a degree that it was not as readily comminuted in view of its increased viscosity. Rotating discs provided with inequalities upon the comminuting surfaces have also been employed for comminution. Such discs proved deleterious in many respects as, for example, accumulations of solidified particles tend to grow very rapidly thereupon and, also, at higher speeds the air cushioning effects which are obtained often prevent the fused material from even striking the rotating element.

All of these drawbacks in the previously employed rotating elements made it exceedingly difficult to obtain extremely finely divided products therewith.

In accordance with the present invention it

has now been found that a special construction of the rotary element will make it possible to overcome the problems encountered with the previously employed rotary comminution elements.

The rotary elements to be employed in accordance with the present invention are provided with a plurality of substantially radially disposed beating blades, the faces of which are disposed at an angle with respect to the vertical axis of the rotary elements. The purpose of this inclination of the blades is that they possess a propeller-like action upon rotating and, also, to prevent particles of the comminuted material from sticking to the rotating comminution element.

The preferred modification of such rotating element in accordance with the present invention is a rotary disc provided with a plurality of slots which extend toward the peripheral edge of the disc, the trailing edge of each of such slots being provided with a blade-like flange which is disposed at an angle of less than 90° with respect to the surface of the disc in the direction of the slot. Upon rotation of the disc, the flanges act as blades of a propeller which will produce a downward draft in the ambient medium and engage with the material to be comminuted. Obviously it is not necessary to support such blades upon a slotted disc as such blades could easily be secured to a hub which is to be attached to the shaft serving to rotate the comminuting element. In such constructions the inclination of blades prevents accumulations of the material to be comminuted, as well as provides the downward draft which prevents the formation of air cushions which may prevent actual contact of the material to be comminuted with the rotating element.

The rotating elements in accordance with the present invention are arranged within a casing to catch the comminuted material. The fused material to be comminuted is supplied to the rotating element in a thin stream through a nozzle preferably arranged as close as practically possible to the upper edges of the blades. An arrangement wherein the discharge nozzle is about 3 cm. above the upper edge of the blades has been found very suitable.

It has also been found that comminution is facilitated if a stream of a cooling liquid is supplied to the rotating element so that it strikes the element simultaneously with the material to be comminuted. For this purpose a nozzle for directing a stream of a cooling fluid towards the rotating blades is also provided within the casing. The nozzle is preferably so arranged that

the stream of liquid does not contact the stream of molten metal until such stream of metal contacts the rotating beating blades, but that it contacts the rotating blades simultaneously with the stream of molten metal so that an immediate explosive cooling action is obtained when the stream of molten metal strikes the rotating blades. The stream of cooling liquid may not contact the stream of molten metal before it strikes the rotating blades as this would increase the viscosity of the molten metal and thereby decrease the comminution obtained. The stream of cooling medium serves several functions besides cooling the comminuted particles sufficiently to prevent agglomeration thereof. For example, it also serves to lubricate the heating surfaces of the blades and thereby prevents growth of accumulations of the material being comminuted upon the blades. Furthermore, the explosive vaporization thereof, when it strikes the blades simultaneously with the molten metal, increases the comminution effect obtained.

Preferably the cooling liquid is supplied to the rotating element through an annular nozzle surrounding the pouring spout for the molten metal so that a jacket of the cooling liquid spaced from the stream of molten metal is impelled toward the rotating element. The nozzle is also preferably constructed so that a rotating conical stream of cooling liquid issues therefrom. The rotation of the stream of cooling liquid renders it more uniform. In order to prevent the stream of cooling liquid from being blown against the stream of molten material, it is preferable to provide a windshield extending from the nozzle for the cooling liquid to a point directly above the top edges of the rotating, blade-like elements.

The number of blades upon the rotating element may be varied, depending upon the height of the blades and the desired speed of rotation of the rotary element. The height and number of the blades must be so selected that none of the stream of molten material may pass through the path of the rotating blades without being struck thereby. For example, if the velocity of the stream of molten material to be comminuted is two meters per second, a rotating element provided with six blades of a height of 30 mm. would be more than adequate if the rotating element makes 4300 rotations per minute, as the blades would pass by the stream of molten material 430 times per second. It has been found that as long as the number of blades is over the minimum required to prevent the stream of molten material to pass between the individual blades without being struck thereby, additional blades produce no discernible effect upon the comminution obtained.

It has been found preferable to incline the beating flanges upon the rotary element at least 20° from vertical position to prevent accumulations of the material to be comminuted thereupon. However, the greater the inclination of the blade from the vertical position, the lower is its comminuting effect per se. Nevertheless, blades with greater angles are sometimes preferable as the nearer the blade is to vertical position, the more power is required for the rotation of comminuting elements. In general, inclinations of between 20° and 32° from the vertical position are preferred. Care must be taken that no surfaces which are vertical or nearly vertical are presented to the molten material during the rotation of the comminuting element. Furthermore, it is preferable that the upper edge of the

beating blades is sharp so that it has a cutting action upon the stream of molten material to be comminuted. Also, the upper edge is preferably shaped so that it presents no surface which would tend to deflect the material to be comminuted upwardly.

The rotating comminuting elements are preferably operated at very high speeds, such as 2,000 to 10,000 revolutions per minute. At these speeds the beating blades carried by such rotary elements produce a tremendous impact upon the stream of fused material which they strike. It has been possible, for instance, to produce metal powders of which over 42% is of a particle size of less than 0.06 mm. diameter.

Several embodiments of my invention are disclosed in the accompanying drawings, in which:

Fig. 1 is a side elevation of an apparatus for comminuting fused materials with a portion of the casing broken away;

Fig. 2 is a plan view of the rotary comminuting element shown in Fig. 1;

Fig. 3 is a plan view of another modification of a rotary element in accordance with the present invention;

Fig. 4 is a plan view of a further modification of a rotary element in accordance with the present invention;

Fig. 5 is a cross sectional view of a rotary disc having attached a beating blade, with portions of the disc broken away;

Fig. 6 shows a cross sectional view of a rotary disc of a modified beating blade with portions of the disc broken away; and

Fig. 7 is an enlarged view of the element for supplying the molten material to be comminuted and the cooling liquid to the rotary comminuting element.

In the drawings, 2 represents a rotating, disc-like element which is provided with inclined blades 3, each of which is mounted at the trailing edge of a substantially radially disposed slot 11 in such disc-like element. The disc-like element is mounted on shaft 4, which is driven by the motor 5 in the direction indicated by the arrow. A conduit 6 for supplying a stream of fused material to be comminuted from the crucible 7 is arranged above the rotary disc. The lower end of such conduit 6 is provided with a nozzle 8 for supplying a cooling liquid to the rotating element 2 simultaneously with the stream of material to be comminuted. Such nozzle 8 surrounds the conduit 6 and is provided with an annular opening which is concentric with the opening in the lower end of conduit 6 from which the stream of fused material to be comminuted issues. Conduit 9 serves to supply the cooling liquid to the nozzle 8 and is arranged to cause rotation of the cooling liquid in the nozzle so that a rapidly swirling, hollow, conical stream of cooling liquid issues from the annular opening in its lower end 10 as a shield to protect the streams issuing from conduit 6 and nozzle 8 from currents produced in the gaseous medium by the rotation of the disc-like element 2. The rotating element 2 and the conduit 6 and cooling liquid supply nozzle 8 are housed within the casing 1.

In the modification of the rotating comminuting element shown in Fig. 3, the inclined beating blades 3' are supported upon the hub 15 which serves for securing the rotating element to a rotating shaft.

In the modification shown in Fig. 4, a disc-like element 12 is provided with slightly curved slots 21, each of which is provided at its trailing edge

with an inclined blade 13, which is correspondingly curved.

In Fig. 6 a beating blade 23 of a curved cross sectional form is shown at the trailing edge of a slot 31 in a rotating disc 22.

The apparatus shown in Fig. 1 is excellent for the production of metallic powders, such as iron powder and copper powder. The apparatus is also well suited for the production of aluminium powder which is capable of sintering. With such apparatus, for example, 100 kilograms of molten iron may be converted into a fine powder in less than five minutes' time. Water may be employed as the cooling liquid which is supplied to the rotating comminuting element simultaneously with the fused metal. If metals or other materials which tend to react with water are to be comminuted, other cooling liquids may be employed which are inert with respect to the material to be comminuted, such as benzene. Also, in some instances it is possible to employ a stream of a gaseous medium as a cooling fluid. Furthermore, if the material to be comminuted is very reactive, an inert gas, such as nitrogen, may be introduced into the comminuting chamber.

When water is employed as a cooling medium, it has been found suitable to supply 5 to 200 liters, advantageously between 50 to 150 liters, per 10 kilograms of molten metal supplied to the rotary comminuting element. 100 liters of water per 10 kilograms of molten metal have been found to give the best results.

In some instances it is advisable to provide a bath of cooling liquid in the bottom of the comminuting vessel which serves to cool the comminuted material falling into it thoroughly.

The novel process and apparatus shown possess many advantages, for it is possible to regulate the grain size of the comminuted product in various ways. For example, by increasing the viscosity of the fused material to be comminuted,

it is possible to obtain comminuted material of larger grain size. Also, the grain size may be regulated by regulating the speed of rotation of the rotary comminuting element as increased speeds increase the comminution effect obtained. The grain size of the comminuted material is also influenced by the angle of inclination of the beating blades employed, as the nearer the blades are to vertical position the greater the comminuting effect. However, as pointed out before, the blades may not be vertical as with such blades the material being comminuted tends to adhere thereto.

While I have described herein my apparatus with reference to the comminution of fused materials, it is obvious that it may also be employed for the comminution of other liquid solidifiable materials. For example, it is possible to employ such apparatus for the production of powdered milk. In such process obviously it is necessary to supply the necessary heat for the drying of the fine particles of milk rather than to supply a cooling medium.

In the specification and claims the terms "beating blades" and "beating surfaces" are intended only to cover beating blades and surfaces which are not provided with pocket-forming projections in the direction of rotation whereby their propellor-like effect upon rotation would be inhibited. For example, inclined beating blades which are directly affixed to an unbroken disc are not intended to be covered, for in such instance the pocket formed between the horizontal surface of the disc and the inclined surface of the beating blades would prevent the desired propellor-like action and also give rise to the air cushioning effects and the clogging of the blades by the material being comminuted, which are sought to be avoided by the present invention.

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