

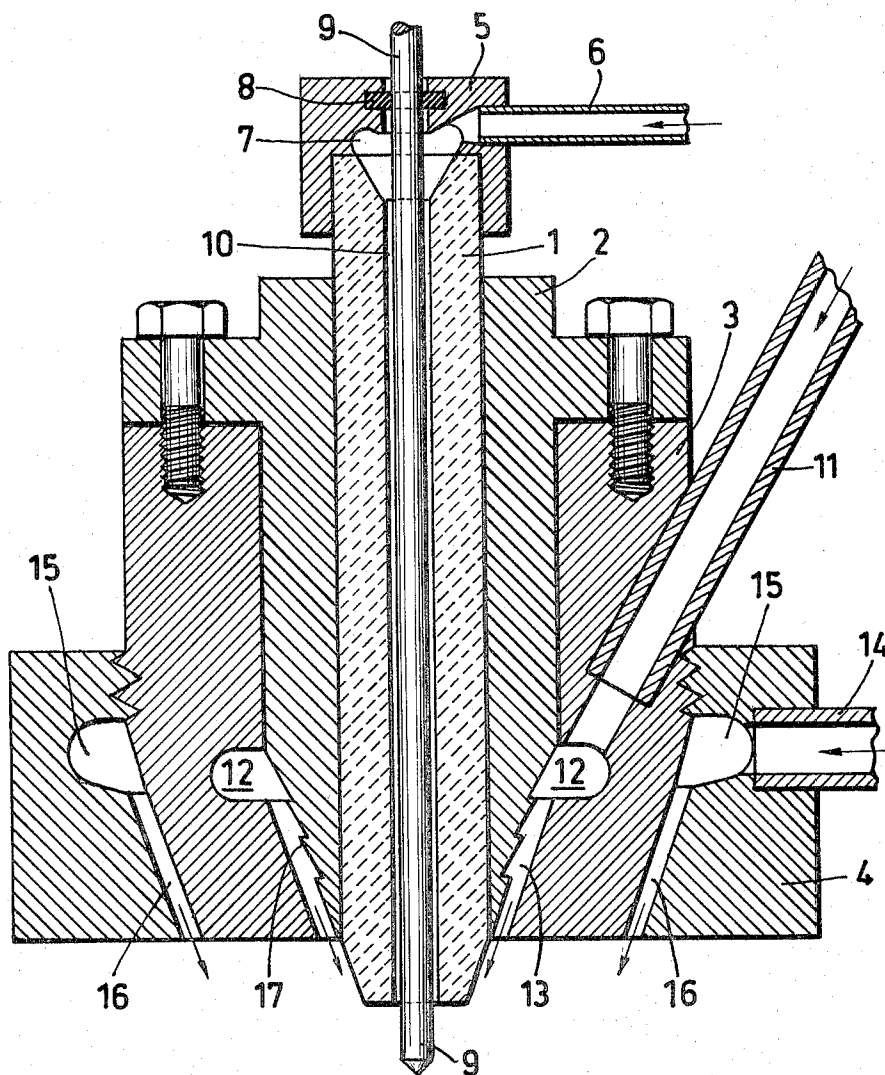
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METHOD AND A DEVICE FOR PULVERIZING SOLID MATERIALS

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METHOD AND A DEVICE FOR PULVERIZING SOLID MATERIALS

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It is very difficult finely to pulverize solid materials (i.e., materials which are solid at ordinary temperatures). The known methods of such pulverization suffer from serious disadvantages; as a rule the powder produced is not sufficiently fine and the costs are high.

The present invention refers to a method and an apparatus for efficiently effecting pulverization to very fine (minute) particle sizes, very rapidly and at low costs.

During this procedure the material may be in solid or molten state, but it must be solid at ordinary temperature (room temperature).

One embodiment of an apparatus in accordance with this invention is shown in vertical section in the annexed drawing.

Referring now to the drawing a tube or lining 1 of an insulating material is mounted in a block or holder composed of the parts 2, 3 and 4. The tube 1 carries a head 5 with an inlet 6 for a protective gas (inert gas) and a cavity 7, into which a sealing member 8 is inserted. This member seals tightly around a rod or bar 9 of the material to be pulverized. The rod 9 is fed downwards through the cavity 7 and the channel 10 of the tube 1.

A supply pipe 11 for mercury under pressure discharges into an annular channel 12 in the block 2-4. From this channel a conical, annular slot 13 is directed obliquely downwards and inwards toward the rod 9 so that the latter is struck all around by the mercury ejected from the slot 13. An inlet 14 for protective gas discharges into an annular channel 15 in the block 2-4, and from there the protective gas flows downwards-inwards through a number of outlets 16. These outlets are directed downwards and inwards toward the rod 9 and their center lines are preferably not in the same plane as the center line (axis) of the channel 10. Thus, the protective gas flowing out will get a helical motion around the rod 9.

The apparatus described operates as follows:

When the mercury under pressure strikes the rod 9, the material of said rod is very efficiently pulverized and a very fine powder is produced. The ambient protective gas prevents the powder formed from being oxidized. The powder is then separated from the mercury, and as a rule the powder rises to the surface of the mercury and may easily be separated therefrom. Preferably, the separated powder is distilled in vacuum to remove remaining traces of mercury therefrom. Now and then, as needed, also the whole bulk of mercury may be distilled to separate powder possibly remaining therein. The mercury is used over again and thus circulates in the system. The quantity of mercury necessary for a pulverizing plant is thus moderate and the loss of mercury is very slight, if proper arrangements are made.

Many different materials, above all metals and metal alloys, may be pulverized in accordance with this invention. However, the material must be of such character that it is not substantially amalgamated by the mercury. But it is to be observed that even if a certain degree of amalgamation takes place, the mercury will become saturated and, therefore, does not thereafter

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amalgamate any more of the material to be pulverized. Instead of, or together with, mercury liquid amalgams may be used.

It is particularly advantageous that in accordance with the invention alloyed materials may easily be pulverized to a fine, homogenous powder at low costs. As an example, there may be mentioned austenitic stainless steel and cobalt-nickel-alloys of various compositions and possibly containing also other alloying elements. Also alloys on beryllium basis may be mentioned. By pulverization according to this invention powders may be produced which then by use of powder-metallurgical methods may be worked to products resistant to high temperatures. The powder according to this invention renders a pressing material which is resistant to creeping also at high temperatures. Because the grains or particles of the alloyed materials are combined with oxide material by a treatment of a powder-metallurgical nature, so that in the interfaces between the alloyed particles there are particles of oxide material, the resulting materials are of a very high quality and resistant to high temperatures and to creeping. In accordance with the invention such materials may be produced at a lower price and/or with a higher quality than heretofore possible.

The material to be pulverized may be cold or hot, or even in a molten state, when it is subjected to the mercury jet. Generally, it is economically advantageous to heat the material, in order to reduce its strength (coherence) and thus to facilitate the pulverization (and reduce the costs thereof).

The mercury pressure is chosen to suit the particular conditions in each individual case, such as the character and the temperature of the material, the particle size to be attained, etc. Generally, the higher the mercury pressure is, the finer powder will be attained, up to a certain limit in each individual case.

As an example, a mercury pressure of 5 atmospheres above atmospheric or higher may be mentioned. In many cases 10 or 20 atmospheres above atmospheric render quite acceptable results. In one case a pressure of 60 atmospheres above atmospheric was used, but this is by no means any maximum value. Pressures up to 150 atmospheres above atmospheric are suitable in some cases. The pressure should be chosen with regard to the desired fine size of the powder. But if the pressure is increased above a certain value, which depends on the material, etc., the powder obtained will not have a smaller size of particles.

The particle size varies according to the character of the material, the mercury pressure etc. In one case the particles obtained had a size of 2.6 microns. By varying the conditions a finer or a coarser power may be produced. A powder of an alloyed material was produced having a particle size of 1.8 microns.

In some cases the powder produced has the shape of extremely small angular flakes which indicates that the particles of the powder were torn off violently from the material. On the rod of material, from which the powder was produced, incisions and streaks are visible in some cases. In these cases the mercury has had a cutting or tearing action on the material.

As an example, it may be mentioned that the annular slot 13 through which the mercury is ejected may have a width of 0.3 millimeter and a diameter of 8 millimeters. In other cases other dimensions are suitable. Instead of an annular slot 13 one or more discharge holes may be used, which preferably are round and arranged symmetrically around the rod. And the holes or channels 16 may be replaced by an annular slot, with or without helical action on the protective gas. As a rule, it is advantageous

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to cause such gas to flow helically, so that it causes a centrifugal action on the generated powder particles and moves them apart. For the same reason it is sometimes advantageous to cause the ejected mercury to assume a helical motion, for instance, by arranging helical ribs (threads) 17 in the slot 13. A helical motion of the mercury and/or the protective gas also aids in generating mechanical vibrations which is advantageous for the pulverizing effect. Such vibrations may also be generated by an electric or mechanical vibrator acting on the block 2-4.

It is also advantageous to apply a direct current and/or an alternating current on the block 2-4 and the rod 9. The alternating current (voltage) preferably has a high frequency. One pole is connected to the rod 9 and the other to the mercury or to the block 2-4, which is electrically (and preferably also in respect of heat) insulated from the rod 9. The charge on the rod also aids in rejecting drops (particles) of mercury from the rod and from cavities therein, where they otherwise would have a damping and hindering action on the mercury under pressure subsequently impinging on the rod.

What I claim is:

1. A method of pulverizing solid materials, comprising, applying mechanical vibrations on said material, and ejecting a mercurial, metallic liquid under pressure against said material.

2. A method of pulverizing solid materials as claimed in claim 1, wherein an electric voltage is applied between said liquid and said material.

3. A device for pulverizing a rod of solid material, comprising, in combination, a holder for feeding said rod forwards and provided with at least one obliquely directed conduit, means for ejecting a mercurial, metallic liquid under pressure through said conduit against said rod, and helical guides in said conduit for giving said liquid simultaneously a helical motion.

4. A device for pulverizing a rod of solid material, comprising in combination, a holder for feeding said rod forwards and provided with at least one obliquely directed conduit, means for ejecting a mercurial, metallic liquid under pressure through said conduit against said rod, and means for ejecting a protective gas helically on said rod.

5. A device for pulverizing a rod of solid material, comprising in combination, a holder for feeding said rod forwards and provided with at least one obliquely directed conduit, means for ejecting a mercurial, metallic liquid under pressure through said conduit against said rod, and a source of electric voltage having one terminal connected to said rod and the other terminal to said liquid.

6. A method of pulverizing solid materials substantially insoluble in mercury, comprising ejecting a metallic mercurial liquid under pressure against said solid material to pulverize it by mechanical force without amalgamating it with mercury.

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7. A method of pulverizing solid materials substantially insoluble in liquid mercury, comprising focussing at least one jet of mercurial metallic liquid with such a high speed and intensity against said material wherein it is mechanically pulverized to minute particles, and separating without distillation the particles formed from the liquid.

8. A method according to claim 6, wherein said liquid is an amalgam.

9. A method according to claim 7, wherein an electric voltage is applied between said liquid and said material.

10. A method of pulverizing solid materials substantially insoluble in liquid mercury, comprising ejecting jets of liquid mercury under a pressure of 10 to 150 atmospheres and focussing said jets against said material to pulverize the same by mechanical force.

11. A method according to claim 10 wherein said material is heated before being subjected to the action of the jets of liquid mercury.

12. A method of pulverizing materials which are substantially insoluble in mercurial metallic liquids and are solid at room temperature, comprising heating said material to a molten state, focussing at least one jet of mercurial metallic liquid with high speed and intensity against said material to pulverize it to minute particles substantially un-alloyed with mercury, and separating from the mercurial liquid said particles, without distilling the mercurial liquid.

13. A method according to claim 7 wherein said particles are separated by settling due to difference of specific gravity (density) from said liquid.

14. A method according to claim 6 wherein the powder formed is skimmed from the surface of the mercurial liquid.

15. A method according to claim 12 wherein an inert, protective gas is ejected helically against said material.

16. A method according to claim 11, wherein said mercurial metallic liquid is ejected helically against said material.

17. A method according to claim 12 wherein mechanical vibrations are applied to said liquid.

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