NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

Lewis

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REPLY TO
ATTN OF: GP

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U. S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code USI, the attached NASA-owned U. S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U. S. Patent No.	: 3,472,202
Government or Corporate Employee	: Government
Supplementary Corporate Source (if applicable)	: n/a
NASA Patent Case No.	: XLE-04946

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:
Yes ☐ No ☑

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of . . ."

Dorothy J. Jackson

Dorothy J. Jackson
Enclosure
Copy of Patent cited above

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Oct. 14, 1969 JAMES E. WEBB 3,472,202

ADMINISTRATOR OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SHOCK TUBE POWDER DISPERSING APPARATUS

Filed Dec. 27, 1966 2 Sheets-Sheet 1

FIG. 1

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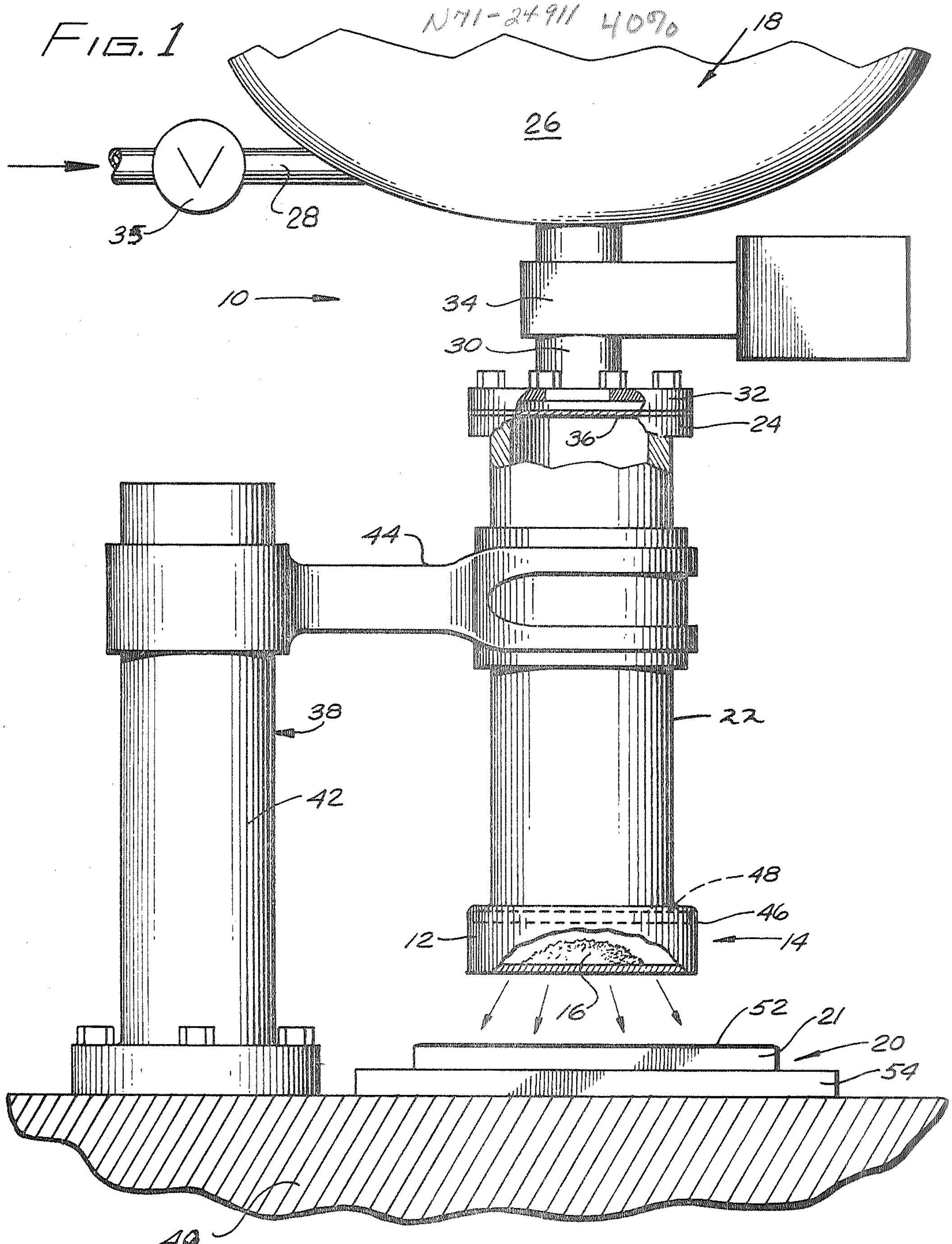

INVENTOR
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BY [signature]
[signature]
ATTORNEYS

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FIG. 2

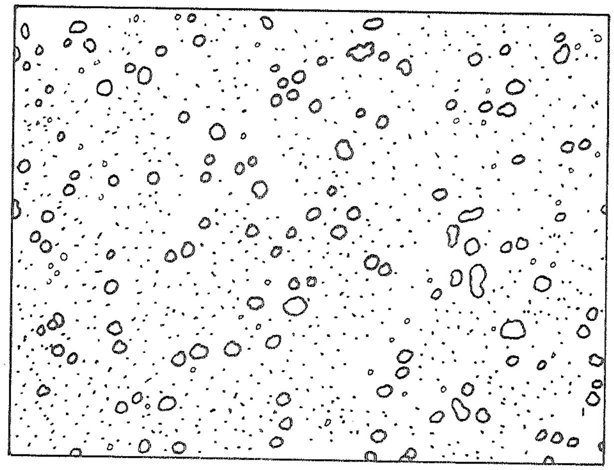
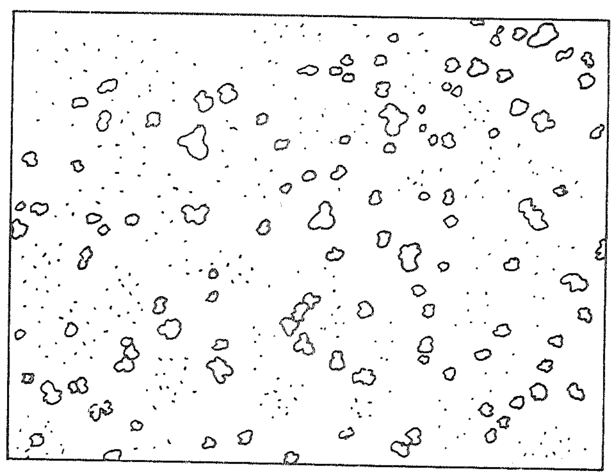


FIG. 3



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United States Patent Office

3,472,202
Patented Oct. 14, 1969

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3,472,202

SHOCK TUBE POWDER DISPERSING APPARATUS

James E. Webb, Administrator of the National Aeronautics and Space Administration, with respect to an invention of Hoyt H. Todd, La Habra, Calif.

Filed Dec. 27, 1966, Ser. No. 605,093
Int. Cl. B05c *5/02;* B65d *47/10*
U.S. Cl. 118—308 3 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for treating metal powders to separate or disperse the powder grains to permit microscopic observation thereof. A rupturable supporting cup holds a mass of powder and is broken by a high intensity shock wave generated in a shock tube having an opening toward the supporting cup. A collection means receives and retains the dispersed powder grains from the ruptured cup.

The invention described herein was made in the performance of work under an NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85–568 (72 Stat. 435; 42 USC 2457).

This invention relates generally to the art of treating metal powders and other powdered materials to separate or disperse the powder grains or particles. More specifically, the invention relates to an improved apparatus for mechanically dispersing or deflocculating powders, especially ultrafine metal powders.

The manufacture and use of metal powders and other powdered materials often requires separation or dispersion of the individual powder grains or particles. For example, such particle dispersion may be necessary to permit microscopic observation of an individual particle for the purpose of accurately determining particle size and/or shape. Accordingly, much effort has been expended in the direction of developing an efficient and practical method of deflocculating or dispersing powders. However, effective dispersion of powder particles, especially those of ultrafine metal powders, is extremely difficult and is not accomplished with complete satisfaction by the existing powder dispersion method and means. Effective deflocculation or dispersion of powders is difficult for the reason that fine powder particles acquire electrostatic charges which create electrostatic attraction forces between the particles. Moreover, fine powders absorb moisture from the air, and this moisture forms films about the individual particles which create cohesive forces between the particles. These electrostatic and cohesive attraction forces are relatively large compared to the particle separation forces developed in, and thus effectively resist separation of the particles by the existing powder deflocculating or dispersing methods and means. The existing methods, for example, generally involve the simple treatment of the powder to be dispersed with various liquid and gaseous deflocculants. Moreover, the attraction forces between powder particles increases as the particle size diminishes. As a consequence, while the existing powder dispersing techniques may produce satisfactory particle separation in specific powdered materials, these techniques are relatively or markedly ineffective when applied to most fine and ultrafine powders, notably ultrafine metal powders. Thus, most if not all the existing powder dispersing techniques are incapable of effectively dispersing or deflocculating tungsten microspheres below 2μ in diameter.

It is a general object of this invention to provide an improved apparatus for effectively dispersing or deflocculating powders, particularly fine and ultrafine metal powders.

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A more specific object of the invention is to provide an improved powder dispersing apparatus wherein the powder to be dispersed is subjected to a high intensity shock wave which produces on the powder particles separation shock forces far exceeding the natural cohesive forces between the particles, whereby the latter are effectively dispersed, and wherein further the dispersed powder particles are received by a collecting surface, such as a glass microscope slide, which is treated to retain the dispersion of the particles and thus permit microscopic observation or other treatment of the individual particles.

A further object of the invention is to provide an improved powder dispersing apparatus which is relatively simple and economical in practice and construction, capable of effectively dispersing fine and ultrafine powders, particularly ultrafine metal powders, and are otherwise ideally suited to their intended purpose.

Other objects, advantages and features of the invention will become readily evident as the description proceeds, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a side elevation, partly in section, of a powder dispersing apparatus according to the invention; and

FIGURES 2 and 3 represent microscopic enlargements of powder grains which have been dispersed in accordance with the invention.

Generally speaking, the powder dispersing method of the invention involves initial placement of a small mass of selected powder within a dispersion zone and subsequent transmission of a high intensity shock wave into the powder. This shock wave is controlled in direction and intensity to produce on the powder particles separation shock forces which substantially exceed the nautral cohesive forces between the particles and which forcibly separate or disperse the particles in such manner that at least a number of the particles are impelled from the dispersion zone into an adjacent collection zone. The dispersed particles entering the latter zone are collected with the aid of a particle collecting medium which preserves the dispersion of the entering particles for subsequent microscopic observation or other treatment of the individual particles. According to the preferred practice of the invention, the shock wave for dispersing the powder particles is generated by abrupt release of high pressure gas into one end of a shock wave guide or tube which confines and directs the shock wave energy into the powder mass. According to a further preferred practice of the invention, the mass of powder to be dispersed is supported within the dispersion zone by a frangible supporting medium which is ruptured or disintegrated by the powder dispersing shock wave in such a way as to release the powder particles for dispersion and impulsion into the particle collection zone.

Reference is now made to the attached drawings, wherein there is illustrated an exemplary particle dispersing apparatus **10** for practicing the particle dispersing method explained above. In general terms, the apparatus which has been selected for illustration in the drawings includes a means **12** for supporting, within a dispersion zone **14**, a mass **16** of powder to be dispersed, and means **18** for generating a high intensity shock wave and transmitting or directing this shock wave into the powder **16**. The shock wave produced by the generating means **18** creates high intensity shock forces on the powder **16** and its supporting means **12**, which forces effectively disintegrate the supporting means and simultaneously disperse the powder particles and impel these particles from the dispersion zone **14** into a following collection zone **20**. Located within this collection zone are means **21** for collecting and preserving the dispersion of at least a number of the entering powder particles.

Referring now in greater detail to the illustrated powder dispersing apparatus, the shock wave generating means 18 comprise an upright shock wave guide or tube 22 having open upper and lower ends. The upper end of the shock tube is surrounded by a flange 24. Above the shock tube is a pressure vessel 26 having a fluid inlet conduit 28 and a lower fluid outlet conduit 30. The lower end of the outlet conduit 30 is surrounded by a flange 32 which is bolted to the shock tube flange 24. Positioned in the outlet conduit, between the shock tube and the pressure vessel, is a quick opening solenoid valve 34. The inlet conduit 28 to the pressure vessel 26 is connected to a high pressure source (not shown) of working fluid, such as nitrogen gas, and may contain a check valve 35 for permitting fluid flow into the vessel 26 and blocking reverse flow of the fluid. Firmly clamped between the confronting shock tube and outlet conduit flanges 24, 32 is a frangible diaphragm 36 constructed of a material, such as Mylar, which is capable of rupture by the working fluid in the pressure vessel 26 under the conditions hereinafter stated.

The shock wave generating means 18 are mounted on a support 38. The illustrated support has a base 40 and a standard 42 rising from the base. Fixed to this standard is a clamp arm 44 which is secured to the shock tube 22, as shown.

The means 12 for supporting the powder 16 to be dispersed comprises a frangible cup 46 constructed of a light gauge material, such as aluminum foil, which is capable of rupture or disintegration under the force of the shock wave generated by the shock wave generating means 18, as hereinafter explained. The mouth of the powder cup 46 telescopes over the lower end of the shock tube 22. The cup is retained in position on the shock tube in any convenient way, as by crimping the cup rim over a bead or flange 48 which encircles the lower end of the shock tube. As noted earlier, the powder supporting means or cup 46 is located within the powder dispersion zone 14 of the apparatus 10.

Directly below this dispersion zone is the collection zone 20 which contains the dispersed particle collecting means 21. In the illustrated embodiment of the invention, the particle collecting means 21 comprises a glass microscope slide having its upper surface coated with a thin layer of transparent adhesive 52. Slide 21 is positioned on the axis of the shock tube 22, a short distance below the bottom wall of the powder cup 46. The slide may be retained in position in any convenient way, as by providing the shock tube base 40 with a suitable slide support 54.

The operation of the illustrated powder dispersing apparatus will now be explained. At the outset of the operation, the powder cup 46 is removed from the shock tube 22 and a small mass of the powder 16 is placed within the cup. The cup is then telescoped over the lower end of the shock tube 22 and the cup rim is crimped over the bead 48 on the tube, thus to retain the cup in position on the tube. The pressure vessel 26 is then filled, through its inlet conduit 28, with working fluid, such as nitrogen, under predetermined pressure, typically on the order of 600 p.s.i. At this point, the apparatus 10 is conditioned for operation.

Operation of the apparatus is initiated by energizing the quick opening solenoid valve 34 to abruptly release the working fluid from the pressure vessel 26. This action results in abrupt exposure of the Mylar diaphragm 36 to the working fluid pressure within the vessel 26. According to the invention, the working fluid pressure in the pressure vessel 26 and the thickness of the diaphragm 36 are selected to effect sudden rupture of the diaphragm by the working fluid in such a way as to create within the shock tube 22 a high intensity shock wave. This shock wave travels downwardly at high velocity through the shock tube and eventually impinges the powder 16 and its supporting cup 46. The force of the shock wave ruptures or disintegrates the powder cup thereby releasing the powder. The force of the shock wave also drives or impels the powder particles downwardly at high velocity into the underlying collection zone 20 in such a way that the particles are effectively separated or dispersed. At least a number of the dispersed particles entering the collection zone impinge and adhere to the adhesive coated slide 21 within the collection zone. The adhesive coating 52 on this slide retains the incident particles and preserves the dispersion of these particles. FIGURES 2 and 3 represent magnified views of powder particles which have been dispersed by apparatus according to the invention. The particles in FIGURE 2 have a diameter on the order of 1–10μ and are magnified 400 times. The particles in FIGURE 3 have a diameter on the order of 0–1μ and are magnified 1,000 times.

Among the various parameters which determine or control the degree of particle dispersion produced by the present invention are the initial working fluid pressure active on the diaphragm 36 at the instant of rupture and the spacing between the powder cup 46 and the particle collection slide 21. In a typical apparatus according to the invention, the diaphragm 36 is set to rupture at a working fluid pressure on the order of 600 p.s.i. The spacing between the powder cup and the particle collection slide is on the order of 4 to 6 inches. The shock tube 22 in this typical powder dispersing apparatus has a diameter on the order of ¼ inch.

It is evident at this point that the present invention may be employed to disperse or deflocculate various powdered materials. However, the invention has been found to be particularly effective in dispersing very fine and ultrafine metal powders which are incapable of dispersion by most if not all of the existing powder dispersing techniques.

It is now obvious, therefore, that the invention herein described and illustrated is fully capable of attaining the several objects and advantages preliminarily set forth.

It is apparent that many modifications and variations may be made in the embodiments of the invention shown and described without departing from the spirit and scope of the invention.

What is claimed is:

1. In apparatus for dispersing a powder, the combination of:
   - means for supporting a small mass of said powder within a dispersion zone;
   - means for generating a high intensity shock wave comprising a shock tube having one end opening toward said powder supporting means and means at the other end of said shock tube for creating a high intensity shock wave within said tube whereby powder particles are dispersed and impelled into an adjacent particle collection zone, said last named means comprising a pressure vessel communicating with said other end of said shock tube and adapted to contain a working fluid under pressure, a frangible diaphragm extending across said other end of said shock tube, and a quick release valve positioned between said diaphragm and pressure vessel for abruptly exposing said diaphragm to the pressure of working fluid within said vessel and thereby effecting rupture of said diaphragm by said working fluid pressure; and
   - means supporting a collection means within said collection zone for collecting and retaining the dispersion of the particles entering said latter zone.

2. Apparatus for dispersing a powder comprising:
   - means for supporting a small mass of said powder within a dispersion zone, said powder supporting means comprise a frangible cup for containing said powder and adapted to be ruptured by the force of said shock wave, thereby to release said powder particles for impulsion by said shock wave from said dispersion zone to said collection zone;

means for generating a high intensity shock wave and transmitting said shock wave into said powder mass in such manner as to disperse the powder particles and impel at least a number of the dispersed particles into an adjacent particle collection zone; and

means supporting a collection means within said collection zone for collecting and retaining the dispersion of the particles entering said latter zone.

3. Apparatus for dispersing a powder and including in combination:

shock wave generating means comprising a shock tube having an open end, a pressure vessel communicating with the opposite end of said shock tube and adapted to contain a working fluid under pressure, a frangible diaphragm extending across said other end of said shock tube, and quick opening valve means between said diaphragm and pressure vessel for abruptly exposing said diaphragm to the working fluid pressure within said vessel, thereby to affect rupture of said diaphragm to create a high intensity shock wave within said shock tube;

powder supporting means comprising a frangible cup secured to said open end of said shock tube for containing said powder and adapted to be ruptured by the force of said shock wave, thereby to release said powder particles for impulsion by said shock wave from said dispersion zone to said collection zone; and

means supporting a collection means comprising an adhesively coated slide positioned within said collection zone for receiving dispersed powder particles entering the latter zone from said dispersion zone.

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73—32; 117—31, 33; 209—1; 241—39