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Vertue

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[54] **PARTICULATE MATERIAL CONVEYING APPARATUS**

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[51] **Int. Cl.** **B65g 53/14,** B67b 7/24

[58] **Field of Search** 222/82, 224, 196; 302/25, 302/32, 51, 56–58, 66

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[57] **ABSTRACT**

Particulate material conveying apparatus, e.g. for conveying powder paint from a container to a spray gun, has a gas flow passage extending past an inlet, and a vibrator for vibrating the inlet to counteract clogging of the inlet. The vibrator comprises a ball driven around a circular race by compressed air, which is thereafter discharged from the vibrator into the gas flow passage to entrain the particulate material into the gas flow passage through the inlet.

12 Claims, 4 Drawing Figures

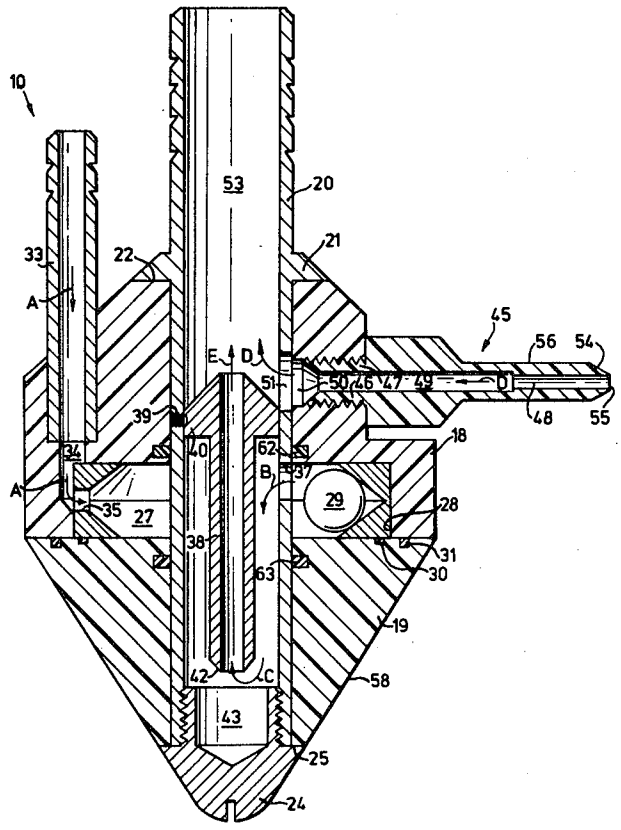
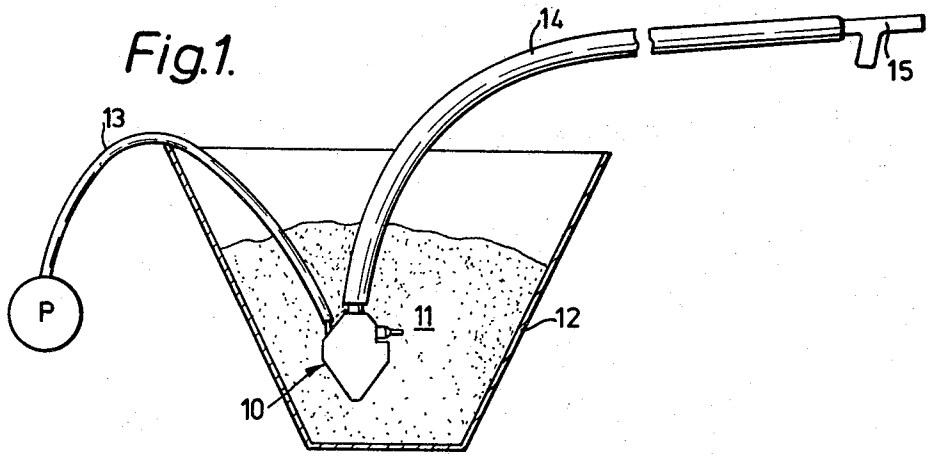


Fig.1.



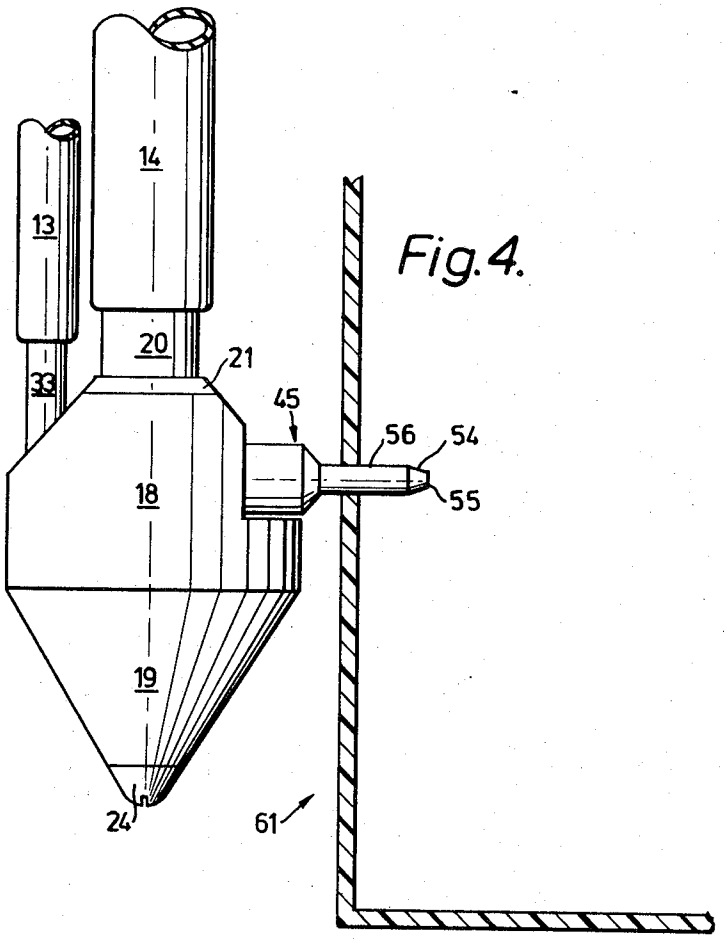


Fig.4.

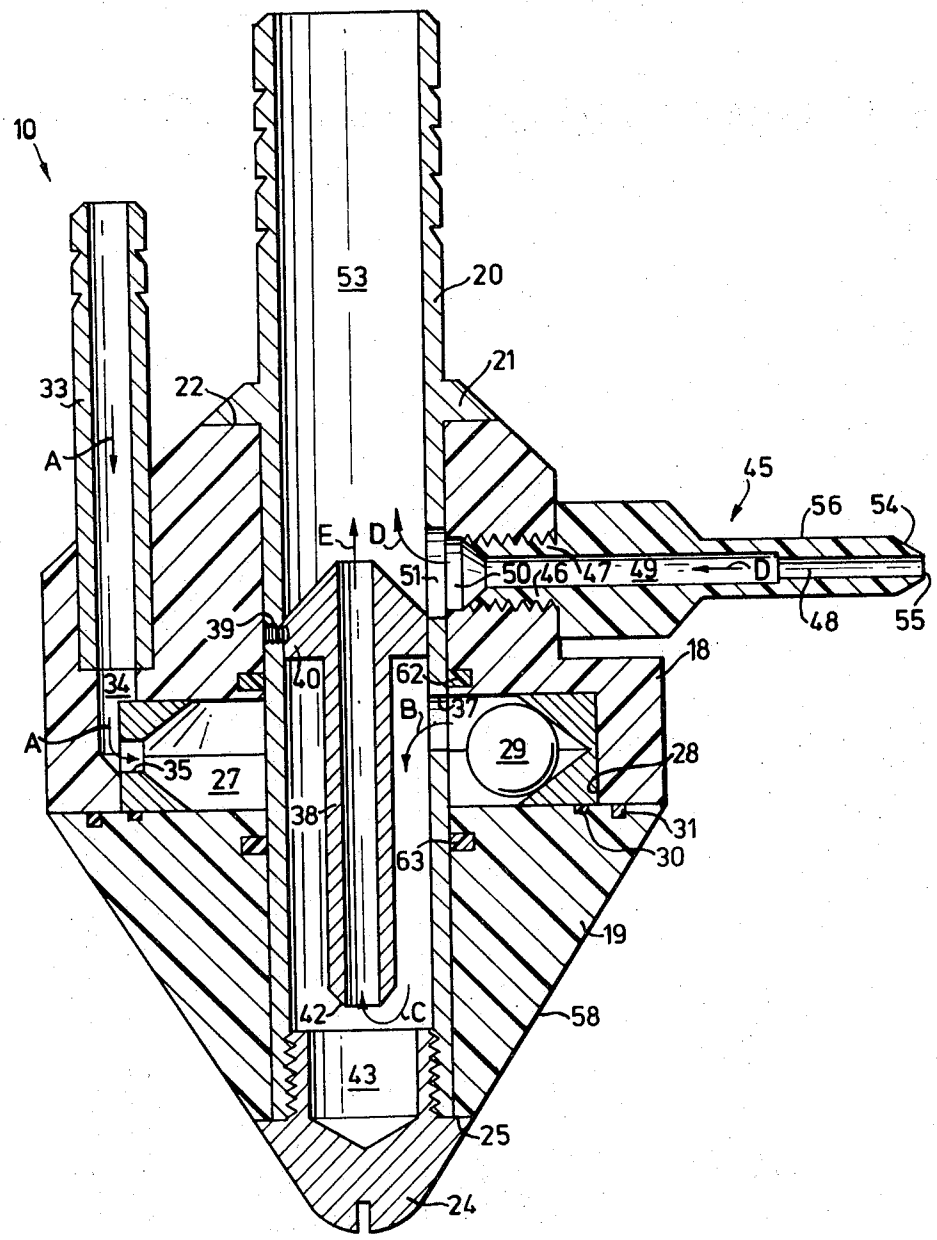

10
53
20
21
33
22
A
45
56
54
E
D
51
50
46
47
49
D
48
55
39
18
34
40
62
B
37
A
35
27
29
28
38
31
30
63
19
42
C
58
43
25
24

Fig. 2.

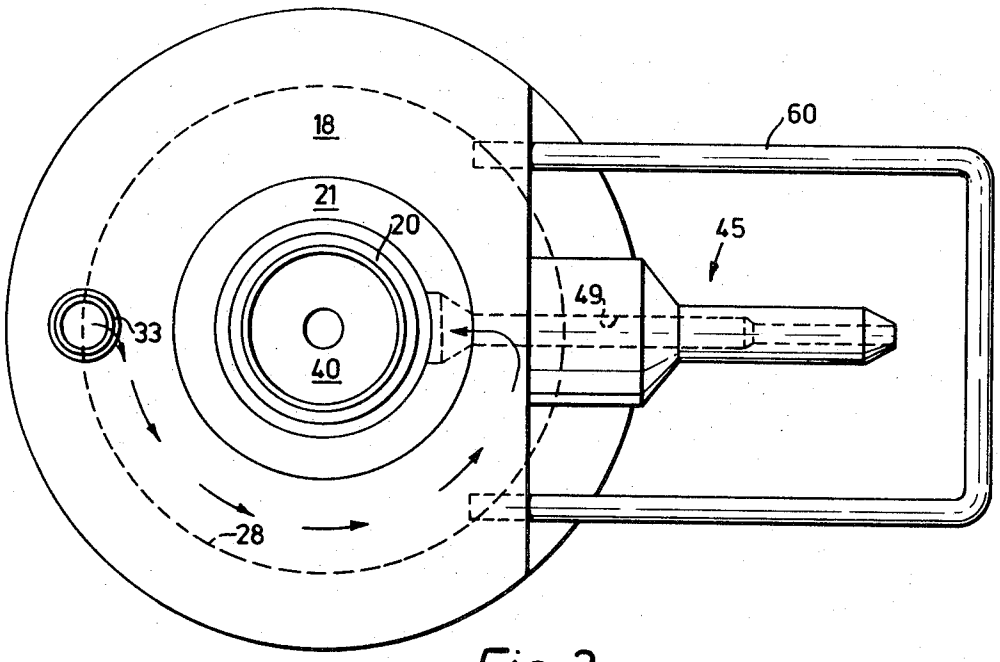


Fig. 3.

PARTICULATE MATERIAL CONVEYING APPARATUS

The present invention relates to particulate material conveying apparatus, and to a method of conveying particulate material, and is useful in particular in connection with the conveyance of powder paint from a container e.g. to a spray gun for discharge into an electrostatic field or to an electrostatic spray gun.

It has previously been proposed to provide a particulate material conveying apparatus in which a flow of compressed gas travelling along a gas flow passage is employed to draw particulate material into the gas flow passage through an inlet passage opening into one side of the gas flow passage. A vibrator is provided for vibrating the inlet passage to counteract clogging of the inlet end of the inlet passage. Separate gas supply pipes are required to provide the compressed gas to the vibrator for operating the latter and to provide a flow of gas at high speed past the inlet passage along the gas flow passage.

It is an object of the present invention to provide a novel and improved particulate material conveying apparatus in which the need for separate compressed gas supply pipes for operating a vibrator and for entraining the particulate material is eliminated.

It is a further object of the present invention to provide a novel and improved apparatus and method for conveying particulate material by which particulate material can be extracted from a container, e.g. a plastic bag, without opening the container.

According to one aspect of the present invention, there is provided a particulate material conveying apparatus comprising an inlet for the entry of particulate material into the apparatus, a gas flow passage extending past the inlet, means for vibrating the inlet, a compressed gas supply passage communicating with the vibrator means for supplying compressed gas to the vibrator means to drive the latter, and the vibrator means having a compressed gas outlet communicating with the gas flow passage for discharging the compressed gas from the vibrator means along the gas flow passage past the inlet to thereby entrain the particulate material through the inlet into and along the gas flow passage.

With the present apparatus, by employing the compressed gas discharged from the vibrator means to entrain the particulate material from the inlet and along the gas flow passage, only a single compressed gas supply pipe is required for operating the apparatus.

Preferably, the vibrator means comprise a ball race extending around and spaced outwardly from the gas flow passage, thus providing a compact assembly of the vibrator and the gas flow passage, and the gas flow passage is provided with a flow constrictor for increasing the speed of flow of the compressed gas past the inlet, the flow constrictor being in the form of a tube extending along the gas flow passage and spaced from the wall of the gas flow passage to allow the compressed gas to flow from the vibrator along the gas flow passage between the wall of the gas flow passage and the tube to an inlet end of the tube, at which a particulate material collecting space is provided for collecting any particulate material which may flow through the tube in a direction opposite to the normal direction of flow of the compressed gas through the tube during the operation of the apparatus. By collecting such particulate material in the particulate material collecting space, the thus-collected particulate material is prevented from flowing back into the vibrator.

The gas flow passage may be formed by a tube extending through a body of the apparatus, the body being formed in two separate parts held together, with the vibrator housed therebetween, by means of a projection on the gas flow passage tube bearing against one of the body parts and a retainer in abutment with the other body part and secured to the gas flow tube.

According to another aspect of the present invention, there is provided a method of conveying particulate material from a container, which comprises piercing a tube through the container and drawing the particulate material from the interior of the container through the tube and through an opening into a gas flow passage by discharging a flow of gas along the gas flow passage past the opening to entrain the particulate material in the gas flow.

Using this method, any need for a hopper for containing the particulate material is eliminated, and consequently the particulate material cannot be spilled during emptying of the particulate material from the container into the hopper. Thus, risk of contamination of the particulate material is greatly reduced, since the container, which may be a plastic bag or a cardboard box, remains unopened. When the particulate material is powder paint, rapid changeover from spraying of one colour to another is facilitated, since there is no necessity to clean out or replace a powder hopper.

The invention will be more readily understood from the following description of an embodiment thereof given, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 shows a side view in section through a powder paint container provided with a conveying apparatus for transferring powder paint from the container to a spray gun;

FIG. 2 shows a view taken in transverse cross-section through the conveying apparatus of FIG. 1;

FIG. 3 shows a plan view of the conveying apparatus of FIG. 2; and

FIG. 4 shows a side view of the conveying apparatus of FIGS. 1 to 3 employed to remove powder paint from a plastic container.

In FIG. 1, there is diagrammatically illustrated a particulate material conveying apparatus, indicated generally by reference numeral **10**, embedded in an accumulation **11** of powder paint, which is contained in a hopper **12**. A pump P is connected to the conveying apparatus **10** by a compressed air supply pipe **13**, and an outlet of the conveying apparatus **10** is connected by an outlet pipe **14** to an electrostatic spray gun **15** for spraying the powder paint onto articles (not shown) which are to be painted. The pipes **13** and **14** are flexible pipes, for example of rubber or plastic material, so that the conveying apparatus **10** can be readily removed from the hopper **12**.

The construction of the conveying apparatus **10** is illustrated in greater detail in FIGS. **2** and **3**.

The conveying apparatus **10** has a body made of plastics material, for example nylon, and formed in two separate parts, namely an upper part **18** and a lower part **19**.

A gas flow tube **20** extends through the body parts **18** and **19** and is formed with a radially outwardly projecting collar **21**, which abuts a top surface **22** of the body part **18**.

A retainer in the form of a cup nut **24** in threaded engagement with the lower end of the gas flow tube **20** abuts against the bottom **25** of the lower body part **19**, so that the body parts **18** and **19** are secured together in mutual abutment by means of the gas flow tube **20** and the cup nut **24**.

A ball race **27** is accommodated in a cylindrical recess **28** in the underside of the upper body part **18** and is thus housed between the upper and lower body parts **18** and **19**. A ball **29** is free to roll around the ball race **27** and the ball **29** and the ball race **27** together form a vibrator, the purpose of which is described in greater detail hereinafter and which extends around and is spaced radially outwardly of the gas flow tube **20**.

An O-ring **30** recessed in the top of the lower body part **19** and compressed between the latter and the underside of the ball race **27** serves to prevent rotation of the ball race **27** relative to the body parts **18** and **19** when the ball **29** is driven around the ball race **27**, as described hereinafter.

In addition, a further O-ring **31** recessed in the top of the lower body part **19** and compressed between the latter and the upper body part **18** serves to provide a seal between the upper and lower body parts **18** and **19**.

In a modification, which is not illustrated in the drawings, the two O-rings **30** and **31** are replaced by a single sealing ring recessed in the top of the lower body part **19** and straddling the underside of the ball race **27** and the underside of the upper body part **18**.

A compressed gas inlet tube **33** is press-fitted into the upper body part **18** and communicates with a boring **34** in the upper body part **18**, the boring **34** communicating in turn with a radial boring **35** formed in the ball race **27**. The pipe **33** and the borings **34** and **35** form a compressed gas supply passage through which compressed gas is supplied, in the direction of arrows A, into the vibrator for driving the ball **29** around the ball race **27**.

The side of the gas flow tube **20** opposite from the boring **35** is formed with an opening **37** which serves as an outlet for the flow of the compressed air from the vibrator into the gas flow tube **20**, as indicated by arrow B. A flow constrictor in the form of a tube **38** extends along the gas flow tube **20** and is secured in position in the gas flow tube **20** by means of a grub screw **39** in threaded engagement with the wall of the gas flow tube **20**.

The flow constrictor tube **38** is formed at its upper end with an enlarged portion **40**, which extends into engagement with the wall of the gas flow tube **20** and prevents the flow of the compressed gas between the constrictor tube **28** and the gas flow tube **20** past the upper end of the constricted tube **38**.

However, the remainder of the flow constrictor tube **38** is spaced from the wall of the gas flow tube **20** to allow the compressed gas from the outlet opening **37** to flow downwardly and into the lowermost end **42** of the flow restrictor tube **38**, as indicated by arrow C.

Beneath the lowermost end **42** of the flow constrictor tube **38**, the cup nut **24** has a hollow interior which provides a powder collection space **43**, the purpose of which is described hereinafter.

A powder inlet nozzle indicated generally by reference numeral **45** is formed with a threaded end portion **46** which is in threaded engagement in an opening **47** formed in one side of the upper body part **18**.

The powder inlet nozzle **45** is formed with an axial boring **48** extending from the free end of the powder inlet nozzle **45** and communicating with the boring **49** which extends from the boring **48** to the end portion **46** of the nozzle **45** and which is of slighly larger diameter than the boring **48**.

The boring **49** communicates with a boring **50** in the upper body part **18**, which in turn communicates through a powder inlet opening **51** formed in the wall of the gas flow tube **20**, with the interior of the gas flow tube **20**.

The borings **48**, **49** and **50** and the powder inlet opening **51** form a powder inlet passage for the flow of powder through the nozzle **45** into the interior of the gas flow tube **20** as indicated by arrows D. The interior of the gas flow tube **20** forms a gas flow passage indicated by reference numeral **53**.

The free end of the nozzle is formed with a frusto-conically tapered outer surface **54** which converges with the wall of the powder inlet passage to form therewith a thin annular edge **55** at the mouth of the powder inlet passage in order to counteract build-up of powder at the inlet end of the powder inlet passage and thus to counteract clogging of the powder inlet passage.

The tapered surface **54** extends from the annular edge **55** to a relatively long cylindrical outer surface **56** of relatively small diameter, so that the outer end of the powder inlet nozzle **45** is of sufficiently small diameter and has a sufficiently tapered end, to enable it to be readily pushed through and to pierce the side or bottom of a powder paint container, for example a plastic bag or a cardboard box, as referred to again hereinafter with reference to FIG. **4**.

The lower body part **19** is formed with a downwardly frusto-conically tapered undersurface **58** in order to allow the conveying apparatus **10** to sink readily into the accumulation of powder paint **11** until the conveying apparatus **10** is embedded or immersed in the powder, as illustrated in FIG. **1**.

In operation of the above-described apparatus, the compressed air supplied by the pump P through the supply pipe **13**, the outlet end of which is fitted onto the upper end of the compressed gas supply pipe **33** as illustrated in FIG. **4**, passes through the compressed gas inlet passage in the direction of arrows A into the vibrator, and causes the ball **29** to rotate about the ball race **27**, as mentioned above, which causes vibration of the whole of the conveying apparatus **10**. The compressed air flows from the vibrator and into the constrictor tube **38**, as indicated by arrows B and C, and is discharged from the upper end of the flow constrictor tube **38** as indicated by arrow E.

As can be seen from FIG. **2**, the upper or outlet end of the constrictor tube **38** is opposite the powder inlet opening **51**, and the discharge of the compressed air from the constrictor tube **38** as indicated by arrow E causes powder to be drawn in through the inlet nozzle **45** as indicated by arrows D and to be entrained in the gas flow along the gas flow passage **53** and thence, through pipe **14**, to the spray gun **15**.

The flow constrictor tube **38**, by constricting the flow of the compressed air, increases the speed of flow of the compressed air past the powder inlet opening **51** and thereby assists in creating a sufficiently strong suction in the powder inlet passage to ensure that the powder is drawn in to the gas flow passage **53**.

The powder collection space **43** serves to collect any powder which may flow downwardly through the flow constrictor tube **38** when the supply of compressed air is terminated and thereby prevents this backflow of powder from reaching and contaminating the vibrator and impeding the rotation of the ball **29**. When the supply of the compressed air is again continued, any powder collected in the space **43** is drawn upwardly through the flow constrictor tube **38** by the flow of the compressed air.

In order to protect the relatively fragile powder inlet nozzle **45** from damage, the apparatus may be provided with a U-shaped guard **60** which, as illustrated in FIG. **3**, has its free ends plugged into the upper body part **18** at opposite sides of the powder inlet nozzle **45**. However, the nozzle guard **60**, which for convenience has not been illustrated in FIGS. **1** and **2**, may be omitted entirely.

FIG. **4** illustrates how the above-described apparatus, minus the nozzle guard **60**, can conveniently be employed to extract powder from a container indicated generally by reference numeral **61**, which is shown broken-away in FIG. **4** and which may, for example, be a plastic bag or a cardboard box. As shown in FIG. **4**, it is simply necessary to pierce the powder inlet nozzle **45** through the container **61** from the exterior thereof, whereupon the powder can be readily extracted from the container **61** by supplying compressed gas through the pipe **13**. It will be readily appreciated that, in addition to counteracting clogging of the inlet end of the power inlet nozzle **45**, the tapered surface **54** and the thin annular edge **55** facilitate the piercing of the container **61** by the powder inlet nozzle **45**.

The ball race **27** is made of hardened steel, in order to counteract wear of the ball race by the ball **29**, and the gas flow tube **20**, the cap nut **24**, the compressed air supply tube **33** and the flow constrictor tube **38** are preferably made from a readily-machinable magnesium alloy although, of course, other materials may be employed for these parts, as will be readily appreciated by those skilled in the art.

The nozzle guard **60** is readily removable, by unplugging, from the upper body part **18**, and the gas flow tube **20** is sealed to the upper and lower body parts **18** and **19** by O-ring seals **62**, **63**, respectively, recessed in the upper and lower body parts **18** and **19**.

I claim:

1. Particulate material conveying apparatus, comprising:

an inlet for the entry of particulate material into the apparatus;

a gas flow passage extending past said inlet;

means for vibrating said inlet comprising a ball race extending around and spaced outwardly from said gas flow passage and a ball adapted to be driven around said race; and

a compressed gas supply passage communicating with said vibrator means for supplying compressed gas to said vibrator means to drive the ball around the race;

said vibrator means having a compressed gas outlet communicating with said gas flow passage for discharging the compressed gas from said vibrator means along said gas flow passage past said inlet to thereby entrain the particulate material through said inlet into and along said gas flow passage.

2. Particulate material conveying apparatus as claimed in claim **1**, further comprising a nozzle, said inlet comprising an inlet passage extending through said nozzle from the mouth of said nozzle to said gas flow passage, the outer surface of said nozzle having an outer surface which is tapered and converges with said inlet passage at said nozzle mouth to form a thin annular edge around said mouth.

3. Pariculate material conveying apparatus as claimed in claim **1**, wherein a constriction is provided in said gas flow passage for increasing the speed of flow of the compressed gas past said inlet.

4. Particulate material conveying apparatus as claimed in claim **3**, wherein said constriction comprises a constriction passage extending along said gas flow passage to said inlet and having a cross-sectional area less than that of said gas flow passage.

5. Particulate material conveying apparatus as claimed in claim **4**, wherein said constriction passage is formed in a constrictor extending along part of said gas discharge passage, said constrictor and the wall of said gas discharge passage defining therebetween a space connecting said compressed gas outlet with one end of said constrictor, means being provided for preventing flow of the gas between the wall of said gas discharge passage and said constrictor to the other end of said constrictor.

6. Particulate material conveying apparatus as claimed in claim **5**, wherein said constrictor comprises a tube extending along said gas discharge passage and spaced inwardly of the wall of said gas discharge passage from said compressed gas outlet to said one end of said constrictor.

7. Particulate material conveying apparatus as claimed in claim **4**, further comprising means defining a powder collection space at the inlet end of said constriction passage.

8. Particulate material conveying apparatus as claimed in claim **1**, wherein said vibrator means and said gas flow passage are provided in a common body, and said body has on its exterior a downwardly convergent tapered undersurface.

9. Particulate material conveying apparatus as claimed in claim **8**, wherein said body is formed of two separate parts secured together with said ball race housed therebetween.

10. Particulate material conveying apparatus as claimed in claim **9**, further comprising a gas flow tube through which said gas flow passage extends, said gas flow tube extending through said body and abutting one of said parts of said body, and a retainer in abutment with the other part of said body and secured to said gas flow tube, whereby said two body parts are secured together.

11. Particulate material conveying apparatus as claimed in claim **8**, further comprising a tube projecting from said body, said inlet comprising an inlet passage extending through said tube, and said tube having a tapered outer end.

12. Particulate material conveying apparatus as claimed in claim **1**, wherein said inlet comprises a tube protruding from said apparatus and having a tapered outer end.

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