

-1-

**POWDER FEED SPLITTER FOR HAND-HELD LASER  
POWDER FUSION WELDING TORCH**

**CROSS-REFERENCES TO RELATED APPLICATIONS**

- 5   **[0001]**     This application is related to United States Patent Application Serial Number 10/071,025 filed February 8, 2002 entitled HAND-HELD POWDER-FED LASER FUSION WELDING TORCH, which is incorporated herein by reference.

**BACKGROUND OF THE INVENTION**

10   **FIELD OF THE INVENTION**

**[0002]**     This invention relates to powder fusion welding and more particularly to a splitter for a fluid and powder flow stream that enables a single stream of such powder flow to become several streams.

**DESCRIPTION OF THE RELATED ART**

- 15   **[0003]**     With the increased use of lasers to provide powder fusion welding, articles can be constructed having net shape or near-net shape. This provides significant advantages as compared to casting or other component-making processes.

- [0004]**     In a powder fusion process, fusion material is fed to the active focus point of the welding tool, usually a laser or other energy source. The powder may contain a  
20   variety of different substances including particulate metals and plastics. Generally, a reservoir of fusion powder is used to deliver the fusion powder to the welding torch. In some cases, the powder flow stream must be split into several substreams in order to provide better powder flow to the welding torch through several different flow trajectories. Otherwise, separate, independent, and generally-expensive feed powder  
25   reservoirs and systems would be used where multiple feed powder lines are needed. The fusion powder is generally delivered to the welding torch by means of pressurized gas, or fluid, such as an inert or non-reactive gas such as helium, argon or nitrogen.

- [0005]**     While the art of providing nozzles for laser welding torches is well  
30   developed, the art of powder flow splitters is less developed. Some of the problems arising with the splitting of fusion powder flow relate to aberrations or flaws within the flow lines or system design, which can cause the powder to stick and resist the forward travel of the powder. Over time, particles may collect at a certain point and accumulate into a blockage. Additional problems may arise from the generation of

-2-

static electricity from interparticle friction as well as the loss of downstream pressure during the powder flow splitting process.

[0006] Additionally, in one known splitter design, there is no adjustability of the output flow streams to vary powder and fluid flow between the various output flow streams.

[0007] The conventional splitter has internal recessed apertures set apart from a main block where the channels then diverge in an outward configuration. The splitter is generally in two parts which are held together by a bolt or screw and there can be some relative movement due to the loose fit between the incoming powder flow cap and the outgoing splitter feed channels.

[0008] Under certain circumstances, this powder feed splitter is subject to clogging which dramatically interferes with the operation of any process relying upon the split powder feed. Once the splitter begins to clog, powder flow is reduced and if diminished too much, the entire operation must be stopped and the splitter cleaned and the clog removed. This may involve dismantling the splitter and interrupting the laser fusion process that is dependent upon the split powder flow.

[0009] Additionally, no gas pressure is used in the conventional splitter configuration, above, to enhance powder flow. Gravity flow alone serves as the means by which its powder feed is split into separate powder flow lines.

Additionally, because the powder feed output lines do not travel outwardly straight from the powder feed splitter, but instead radiate outward at an angle, additional clogging may occur in the powder flow lines. Due to both the loose fit between the powder feed splitter halves and the inability to reliably and selectively control the incoming powder flow within the powder splitting portion, it is difficult to repeatably align and adjust such a previously-known powder feed splitter.

[0010] In view of the foregoing disadvantages present in the art, there is a need for an improved powder flow splitter that reduces clogging and/or allows adjustability and/or enhances or overcomes gravity flow with pressurized fluid and powder flow. The present invention solves one or more of these disadvantages.

## SUMMARY OF THE INVENTION

[0011] The present invention provides a powder flow splitter that is reliable and/or adjustable. In particular, the inventive splitter reduces clogging and/or allows output flow adjustability and/or can provide fluid powder flow despite gravitational

-3-

forces. In particular, and by way of example only, the splitter may include a distribution assembly with smooth interior surfaces that generally prevent the powder from sticking or clogging. The splitter also may enable adjustable powder flow distribution between the outgoing lines as well as selectably control the pressure downstream from the powder flow splitter.

[0012] In one embodiment, which will be described subsequently in greater detail, a fusion powder flow splitter is provided that allows one stream of fusion powder to be selectively split into several streams as needed by an operation. A powder fusion machine is also provided that includes the inventive powder splitter.

[0013] In one embodiment, the splitter housing forms part of a housing assembly and includes a central aperture for a powder feed disk that feeds powder flow into an internal splitter area. The splitter housing generally defines a longitudinal axis and accepts an insert that uniquely fits in position inside the main exterior cylinder by means of an aligning dowel pin. The splitter area is coated on the insert and uses funnel-shaped flow paths to channel the powder transmitted from the powder flow disk into the separate output lines exiting from the splitter.

[0014] The splitter housing may have a gas inlet that is in communication with holes or apertures in the side of the interior splitter to transmit inert or non-reactive flow gas under pressure to the separating flows of fusion powder.

[0015] The powder flow feed regulator may be centrally located between the diverging flow lines of the splitter cylinder. An adjustment mechanism, which may be thumb screws or computer controlled servos allows for radial adjustment of the powder inlet disk (with respect to the longitudinal axis of the housing) so that one or more of the outgoing powder flow channels may receive more or less of the incoming powder flow. This adjustability enables powder flow to be biased according to the welding process or the welder's preferences.

[0016] Smooth surfaces inside the powder feed splitter and mediating surfaces between transition surfaces enable the powder to flow smoothly with lower risk of blockages or clogging.

[0017] Additionally, material to be treated by powder fed in a split manner may also be achieved by providing a reservoir of powder or other fluid-like material by which the material is to be treated. The powder or fluid reservoir is then transmitted to a powder feed or fluid feed splitter which splits the incoming integrated powder or fluid flow into two or more outgoing feed lines. The material to be treated may then

be subject to powder and/or fluid flow via the separate lines emerging from the powder feed splitter. This output powder flow can be adjusted or allocated amongst the output lines emerging from the splitter.

[0018] Other features and advantages of the present invention will become  
5 apparent from the following description of the preferred embodiment(s), taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention.

### BRIEF DESCRIPTION OF THE DRAWINGS

10 [0019] Figure 1 is a front, side, perspective, and exploded view of the powder flow splitter of the present invention.

[0020] Figure 2 is a side elevational view of the assembled powder flow splitter of Figure 1.

[0021] Figure 3 is a cross sectional view of the assembled powder flow splitter of  
15 Figure 2 taken along line 3-3 of Figure 2.

[0022] Figure 4 is a side elevational view of the main exterior cylinder of the powder flow splitter shown in Figure 1 with interior elements and surfaces shown in phantom.

[0023] Figure 5 is a rear cross sectional view of the main exterior cylinder of  
20 Figure 4 taken along line 5-5 of Figure 4.

[0024] Figure 6 is a front plan view of the main exterior cylinder of the powder flow splitter of Figure 1.

[0025] Figure 7 is a side cross sectional view of the main exterior cylinder taken along line 7-7 of Figure 6.

25 [0026] Figure 8 is a side cross sectional view of the main exterior cylinder taken along line 8-8 of Figure 6.

[0027] Figure 9 is a side plan view of the main exterior cylinder of the powder flow splitter of Figure 1 showing the thumb screw holes on opposite sides of the gas inlet hole.

30 [0028] Figure 10 is a side plan view of the main exterior cylinder similar to that of Figure 9 showing in phantom elements and surfaces interior to the main exterior cylinder.

[0029] Figure 11 is a side elevational view of the interior surfaces and elements of the powder inlet regulator disk shown in Figure 1.

- [0030] Figure 12 is an enlarged view of the rear surface of the powder inlet disk shown in Figure 11 taken along circle 12 of Figure 11.
- [0031] Figure 13 is a side plan view of the inlet tube of the powder inlet disk of Figure 11 with interior surfaces and elements shown in phantom.
- 5 [0032] Figure 14 is a top view of the inlet tube shown in Figures 13 and 11.
- [0033] Figures 15 and 16 are the top and bottom inlet and outlet ends of the inlet tube shown in Figure 13 being taken respectively along circles 15 and 16 thereof.
- [0034] Figure 17 is a front plan view of the interior splitter cylinder of Figure 1.
- [0035] Figure 18 is a side plan view of the interior splitter cylinder.
- 10 [0036] Figure 19 is a side cross sectional view of the interior splitter cylinder of Figure 18 taken along line 19-19 thereof.
- [0037] Figure 20 is a rear plan view of the interior splitter cylinder of Figure 18.
- [0038] Figure 21 is a side and partial cross sectional view of the interior splitter cylinder of Figure 18 taken along cross section line 21-21 in Figure 20.
- 15 [0039] Figure 22 is a rear perspective view of the interior splitter cylinder of Figure 18.

#### **DESCRIPTION OF THE PREFERRED EMBODIMENT(S)**

- [0040] The detailed description set forth below in connection with the appended  
20 drawings is intended as a description of presently-preferred embodiments of the invention and is not intended to represent the only forms in which the present invention may be constructed and/or utilized. The description sets forth the functions and the sequence of steps for constructing and operating the invention in connection with the illustrated embodiments. However, it is to be understood that the same or  
25 equivalent functions and sequences may be accomplished by different embodiments that are also intended to be encompassed within the spirit and scope of the invention.
- [0041] As shown in Figure 1, the invention is embodied in a powder feed splitter  
100 for hand-held or floor-mounted laser powder fusion welding torch systems or the like. The splitter is used to divide the flow of powder from a single incoming line to  
30 two or more, or in this case four, exiting or outflow lines. In doing so, additional gas may be used to pressurize the powder flow as the cross sectional area of the single incoming line may need to be accommodated by the greater cumulative outflow cross section of the outgoing lines. Additionally, the distribution of powder flow among the outgoing lines can be adjusted in a manner to accommodate the device ultimately

using the powder flow such as when a hand-held laser torch is tilted at an angle which may cause the powder flow to increase through a lower powder flow line. It should be appreciated that the powder feed splitter **100** can be used in a hand-held laser torch system or a stationary floor-mounted laser powder fusion machine.

5    **[0042]**    As shown in Figure 1, the powder feed splitter **100** has an exterior encasing cylinder **102** that cylindrically surrounds a removable interior splitter cylinder **104**. A sealing powder inlet regulator or plate, in this instance in the shape of a disk **106**, has a central powder flow inlet **108** through which powder flows onto the interior splitter cylinder **104**. A powder inlet tube **110** allows the injection of powder  
10   flow into the central inlet aperture **108** and onto the interior splitter cylinder **104**. Depending on the geometry and application for the splitter **100**, inlet regulators of various shapes and configurations may be used.

**[0043]**    The exterior encasing cylinder **102** provides an exterior case for the interior splitter cylinder **104**. The exterior cylinder **104** enables the alignment,  
15   adjustment, and the coupling of gas flow to the interior splitter cylinder **104**.

**[0044]**    As shown in Figure 1, the splitter has an adjustment mechanism. In particular, two sets of oppositely opposed thumb screws **120** threadably or otherwise are passed through rear thumb screw apertures **122** to engage the flat cylindrical side **124** of the sealing inlet disk **106**. Other adjustment mechanisms can be used that use  
20   electrical or mechanical engagement to provide movement, including servomotors to control the thumbscrews. As shown in Figure 3, the exterior cylinder **102** has a rear seat **126** against which the rear side of the inlet disk **106** sits. As described in more detail below, the inlet disk **106** sits against the rear cylinder seat **126** to generally provide a gas-proof seal. However, the outer diameter of the inlet disk **106** is  
25   significantly less than that of the interior diameter of the exterior cylinder **102**. The flat cylindrical side **124** of inlet disk **106** generally does not sit flush against the interior cylindrical side **128** of exterior cylinder **102**. This allows adjustment of the position of the central powder flow inlet aperture **108** so that it can be offset from the center of the interior splitter cylinder **104**. This enables selectable biasing of the  
30   powder flow amongst the four exit tubes **130** of the interior splitter cylinder **104**.

**[0045]**    The adjustment of the sealing inlet disk **106** is achieved by use of the thumb screws **120** as their ends **140** proximate the side **124** of the inlet disk **106** engage the disk side **124** in order to adjustably dispose it with respect to the interior splitter cylinder **104**. While thumb screws **120** are shown in Figure 1, the present

invention is susceptible to modification in order to provide automatic adjustment and/or electronic adjustment of the inlet disk 106 by computer or other controlled servo motors operating the thumb screws 120 or similar adjusting devices.

[0046] The exterior encasing cylinder 102 also has an alignment dowel 150 that  
5 fits into an alignment hole 152 that serves to engage the interior splitter cylinder 104 and so consistently and uniquely position the splitter cylinder 104 within the interior 154 of the exterior cylinder 102.

[0047] As shown in Figure 1, the splitter cylinder 104 has an alignment slot 156 at the rear 158 of splitter cylinder 104. As shown in Figure 3, the alignment dowel 150  
10 travels into the alignment slot 156 in order to position the splitter cylinder 104 in the same position every time with respect to the exterior cylinder 102. Once in place, the splitter cylinder 104 may then be held against the inlet disk 106 by compression pins 160 which may threadably engage the cylinder 102 via threaded or otherwise compression pin apertures 162 and hold the splitter cylinder 104 in place as shown in  
15 Figure 3.

[0048] In order to allow the transmission of inert or other gas to the splitter cylinder 104, the exterior cylinder 102 has an interior groove 170 circumscribing the interior 128. This interior groove 170 corresponds with the gas inlet holes 172 of the splitter cylinder 104. The construction and operation of the interior splitter cylinder  
20 104 is set forth in more detail below. However, Figure 4 shows in phantom the gas flow channel, or gas inlet, 174 in communication with the interior groove 170. When the splitter cylinder 104 is in place within the confines of the exterior cylinder 102, pressurized gas may enter into the interior gas groove 170 and flow into the splitter cylinder 104 via the gas inlet holes 172 thereof. The addition of such gas through the  
25 gas flow inlets 172 by necessity dilutes the powder flowing through the splitter cylinder 104.

[0049] The exterior cylinder 102 has a front aperture 180 into which the splitter cylinder 104 and the inlet disk 106 fit. The rear aperture 182 is smaller than the front aperture and provides the rear seat 126 onto which the inlet disk 106 rests. The rear  
30 seat 126 prevents the further travel of the inlet disk 106 which as described above has a diameter greater than that of the rear aperture 182 but less than that of the interior 154 of the exterior cylinder 102. To prevent the escape of gas from the exterior cylinder 102, the inner splitter cylinder 104 generally has an outer diameter minimally less than the diameter of the exterior cylinder interior 154 such that the splitter

cylinder **104** is able to slide into the cylinder **102** but prevents or inhibits the passage of gas between the splitter cylinder **104** and the exterior cylinder **102**.

[0050] Figures 4-10 show alternative and visually-descriptive views of the exterior cylinder **102**.

5 [0051] In Figure 11, the sealing inlet disk **106** is shown in side and partial cross sectional view. As with the other components of the present invention, the inlet disk may be made of suitable material, such as resilient and machinable metal. As the flowing powder may have abrasive qualities, the materials used in the present invention may include those that can withstand such abrasion or that are easily  
10 replaced once abrasion has significant deleterious effects on the powder feed splitter set forth herein. The inlet disk **106** has a central aperture **108** into which the outer inlet tube **110** may fit or be attached.

[0052] As indicated in Figure 12, the rear surface **200** of the inlet disk **106** may be scored with a series of concentric circles **202** centered upon the central aperture **108**.  
15 These concentric circles are visible from the rear of the powder feed splitter **100** via the rear aperture **182** of the exterior cylinder **102**. The concentric engraved circles **202** may be approximately one ten-thousandth of an inch deep and separated by a distance of approximately one one-thousandth of an inch. The concentric circles **202** indicate the alignment of the inlet disk **106** with respect to the splitter cylinder **104**.  
20 The degree to which the inlet disk is off center is indicated by the number of circles occluded by the rear seat **126** that would otherwise be visible but for the inlet disk **106** being off center. The depth of the grooves **202** is sufficient for visual inspection and the distance between the engraved circles **202** is one of choice and general utility with respect to the powder feed splitter **100**.

25 [0053] Generally, when the inlet disk **106** is centered over the splitter cylinder **104**, the powder flow is distributed equally amongst the outlet tubes **130**. When the inlet disk is off center, the powder flow distribution amongst the several tubes **130** is generally biased according to those tubes receiving the biased amount of incoming powder flow. More detail is given below with respect to the splitter cylinder **104** with  
30 respect to Figures 17-21.

[0054] Figures 13-16 show pertinent views of the inlet tube **110** to which a powder flow line is attached for the introduction of flowing powder into the powder feed splitter **100**. The inlet tube **110** may be copper tubing with a chamfered inlet **210** and exit **212**. The tube **110** is constructed to prevent caking, clogging, or obstruction

of flowing powder in order to ensure that the maximum cross section is available for the flow of powder. The chamfered inlet **210** and exit **212** generally contribute to such anti-caking, anti-clogging, and/or anti-obstruction properties. Figure 14 shows an aspect of the inlet tube **110** a view taken down the center while Figures 15 and 16 show the inlet **210** and exit **212** respectively. The chamfering of the tube **110** enables incoming powder to be channeled towards the interior passage **214** while the chamfering of the exit tube **212** allows the powder to disperse better and more smoothly before engaging the splitter cylinder **104**.

**[0055]** As shown in Figure 17, splitter cylinder **104** is preferably generally cylindrical in nature and may have a beveled shoulder **220** that mediates the wider diameter of the main body portion with respect to the narrower front face of the splitter cylinder **104** from which the outlet tubes **130** emerge. The outlet tubes **130** may be similar in construction to the inlet tube **110**. The interior confines of the splitter cylinder **104** are shown in the cross sectional view of Figure 19. At the rear end **222** of the splitter cylinder **104**, a series of four funnel-like, or conical, cavities, or hoppers, **224** are present that guide the powder from the inlet disk aperture **108** to the outlet tubes **130** via intermediating internal channels **226** inside the splitter cylinder **104**. Each of the funneling cavities **224** is coupled to a gas inlet **172**. Each of the gas inlet tubes **172** may incline towards the outlet tubes **130** so as to provide directionality for gas flow and to inhibit powder flow back into the gas inlet **172**. The conical cavities **224** intersect at a central point **228** which serves to provide a minimal flat surface on which powder may collect. It also serves to better split the incoming single powder flow stream into one of the intermediating internal channels **226**. When the inlet disk **106** is centered with respect to the exterior cylinder **102**, the central aperture **180** is preferably aligned with the central point. The conical shape of the cavities **224** provides a guide for the powder as the powder travels through the cavity. The conical nature of the cavity **224** is generally that of a right circular cone to provide better funneling, or channeling of the flowing powder. The right circular nature of the cavities **224** may be altered at the intersection of the cones to generally provide for equal cross sectional areas between cavities **224**.

**[0056]** Although there may be a strict separation between any two cavities, or hoppers, **224**, an intercavity valley **230** (Figure 21) may be present between cavities **224** to allow better dispersion of powder between two adjacent cavities **224**.

[0057] As indicated above, a variety of materials may be used to construct the powder flow splitter 100 of the present invention. However, stainless steel is seen as being amenable to the present embodiment for the interior splitter cylinder 104 and the exterior encasing cylinder 102. Steel or other materials may be used for the thumb screws 120 or compression pins 160 with copper being seen as adapted for use for the inlet 110 and outlet 130 tubes. However, just as other shapes than cylinders may be used for the exterior 102 and interior 104 portions of the present invention (including squares, triangles, and the like), different materials may also be used so long as they are adaptable and useful in providing the structures and geometries necessary for the present invention.

[0058] Additionally, the interior splitter cylinder 104 may take a variety of configurations and/or geometries as an interior insert for an exterior casing having the qualities, characteristics, and aspects of the exterior encasing cylinder 102. The sealing inlet disk 108 may also take the form of a plate, other flat structure, or otherwise so long as it performs as indicated herein. Also, while in one embodiment the gas flow inlets 107 are shown in a co-planar configuration, other configurations may also be achieved.

[0059] When assembled, the inlet disk 106 sits flush against the rear seat 126 of the exterior cylinder 102. The inlet tube 110 projects rearwardly from the exterior cylinder 102 and away from the rear aperture 182. The inlet disk 106 may be centrally disposed between the thumb screws 120 and their proximate ends 140 that engage the flat cylindrical side 124 of the inlet disk 106. The interior splitter cylinder 104 sits flush against both the inlet disk 106 and the interior side 128 of the exterior cylinder 102. In this way, the interior splitter cylinder 104 seals off the conical cavities 224 and prevents the transmission of powder save by travel through the intermediating internal channels 226 and the exit tubes 130.

[0060] The splitter cylinder 104 engages the dowel pin 150 with its alignment slot 156 such that the splitter cylinder 104 generally has one unique operating engagement configuration with respect to the exterior cylinder 102. When the splitter cylinder 104 has been properly situation with respect to the exterior cylinder 102 and the dowel 150 is seated in the alignment slot 156, the gas inlet apertures 172 of the splitter cylinder 104 are aligned and surrounded by the interior gas groove 170 of the exterior cylinder 102. The flush seating between the interior splitter cylinder 104 and the interior 128 of the exterior cylinder 102 generally serves to seal the interior gas

groove 170 and to prevent the flow of gas beyond the gas groove 170. The compression pins 160 then engage the splitter cylinder 104 at or about the beveled shoulder 220 and serve to compress the splitter cylinder 104 against the inlet disk 106. The outlet tubes 130 then project past the compression pins 160 and are available for engagement by additional powder flow lines. Such powder flow lines may be flexible in nature and similar to that which engages the inlet tube 110 in order to provide the initial powder flow stream to the powder flow splitter 100.

[0061] Having assembled the powder flow splitter 100, inert, noble, and/or appropriate gas flow may be introduced into the apparatus via the gas inlet 174 of the exterior cylinder 102 (Figures 4 and 9). Such gases are generally chosen to prevent oxidation of hot and/or melted powder. Gas then flows into the gas groove 170 and is transmitted to the outlet tubes 130 via the splitter cylinder gas inlets 172. The gas then travels through the conical-shaped funneling cavities 224 and through the intermediating internal channels 226 before exiting via the outlet tubes 130. In one embodiment, the splitter cylinder gas inlets 172 may be tapered in nature to provide some back pressure on the gas flow. The gas flow used and introduced via the exterior cylinder gas inlet 174 may be the same as that used to transport the powder from the main powder reservoir (not shown). The additional gas is used to propel the powder through the feed splitter and onto the main tool requiring powder feed such as a laser welding torch or other laser fusion device. The introduction of additional gas enables the better control of the powder flow and ensures that there is no loss of pressure despite the possible greater cumulative cross section available amongst the several outlet tubes 130 as compared to the single inlet tube 110.

[0062] Gas-driven powder is then fed into the inlet 110 and flows onto the splitter cylinder 104. If the inlet disk 106 is centrally disposed over the central point 228 of the splitter cylinder 104, the powder is generally evenly distributed amongst the several conical-shaped funneling cavities 224. If the flow inlet aperture 108 is offset from the central point 228, the powder flow will generally be biased so that greater powder flow is transmitted to the exit tube 130 associated with the conical-shaped funneling cavity 224 more disposed under the inlet aperture 108 as that conical-shaped funneling cavity 224 will receive more of the incoming powder flow. The intercavity valley 230 may allow some migration of powder to and from the cavity 224 experiencing predominant powder flow. Such migration may occur for all cavities 224.

[0063] The gas-driven powder is then transmitted to the intermediating channels 226 where it is further pressurized by the incoming gas from the splitter cylinder gas inlets 172. The powder flow is then transmitted onto the exit tubes 130 and out the powder feed splitter 100 of the present invention.

- 5 [0064] Certain accommodations may be made to enhance powder flow and the present invention generally incorporates smooth surfaces to reduce turbulence and to reduce the caking, clogging, or obstruction of powder flow so that maintenance is reduced and performance enhanced. The powder flow splitter 100 may be grounded to alleviate static electricity arising from the self-abrasion of the powder or otherwise.
- 10 Many different types of powders may be used with the splitter 100 not the least of which are finely dispersed refractory metals, ground steel or steel dust, plastic granules and fine particles, and the like.

- [0065] The present splitter can provide independent advantages over prior powder feed splitters due to its adjustable nature, and the ability to dismantle and reassemble
- 15 the component parts in a predictable and reliable manner. The use of smooth surfaces and smooth surface transitions of the present invention reduces turbulence and prevents caking, clogging, or buildup of flowing powder. Powder density can be adjusted both at the initial powder flow reservoir stage or with the introduction of more gas at the gas inlets 172 and 174.

- 20 [0066] While the present invention has been described with reference to a preferred embodiment or to particular embodiments, it will be understood that various changes and additional variations may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention or the inventive concept thereof. In addition, many modifications may be made to adapt a particular
- 25 situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to particular embodiments disclosed herein for carrying it out, but that the invention includes all embodiments falling within the scope of the appended claims.

-13-

What is claimed is:

1. A powder feed splitter, comprising:  
a housing with two openings and an interior surface therebetween;  
an interior insert defining a first funnel cavity, the cavity generally having a  
5 shape that narrows from one end of the cavity to the other, the insert sized to fit into  
the housing; and  
a first outlet tube in communication with the first funnel cavity the tube  
located adjacent to the narrow end of the cavity; whereby  
powder may flow from the first funnel cavity to the first outlet tube with the  
10 first funnel cavity collecting powder from a broader area for transmission to the  
narrower first outlet tube.
2. A powder feed splitter as set forth in Claim 1, wherein the first cavity  
is conically-shaped.
- 15 3. A powder feed splitter as set forth in Claim 1, wherein:  
the interior insert defines a first gas flow inlet enabling gas flow from exterior  
of the interior insert to the first funnel cavity; whereby  
gas may be added to powder flowing from the first funnel cavity to the first  
20 outlet tube.
4. A powder feed splitter as set forth in Claim 1, further comprising:  
the interior insert defining a second funnel cavity; and  
a second outlet tube in communication with the second funnel cavity; whereby  
25 powder may flow from the second funnel cavity to the second outlet tube with  
the second funnel cavity collecting powder from a broader area for transmission to the  
narrower second outlet tube.
5. A powder feed splitter as set forth in Claim 4, further comprising:  
30 the interior insert defining a second gas flow inlet enabling gas flow from  
exterior of the interior insert to the second funnel cavity; whereby  
gas may be added to powder flowing from the second funnel cavity to the  
second outlet tube.