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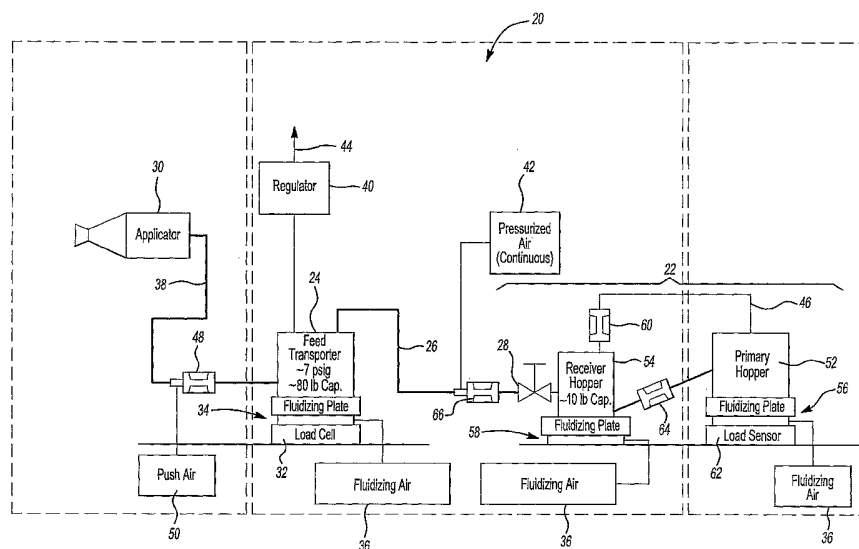
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(54) Title: POWDER PAINTING TRANSPORT SYSTEM AND METHOD



(57) Abstract: The present application discloses the method and system for transporting a powdery substance from a source to an applicator for application to an article. A feed transporter is fluidly connected to the source by a feed line for receiving the powdery substance under pressure. The feed transporter has a regulator for regulating and maintaining a constant pressure in the feed transporter. An applicator is fluidly connected to the feed transporter for receiving the powdery substance under pressure and applying the powdery substance to an article. Pressurized air is connected to the feed line for continuously supplying the pressurized air to the feed transporter. The continuous supply of pressurized air allows for better regulation of the pressure in the feed transporter, and thereby improved control of the flow rate to the applicator.

POWDER PAINTING TRANSPORT SYSTEM AND METHOD

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of provisional application serial number 60/658,127 filed on 3/3/2005.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] This invention relates to a powdery substance transport system and a method of transferring a powdery substance in bulk phase to an applicator. More specifically, this invention relates to a powdery substance transport system for transporting powder paint to an applicator disposed within a paint application housing.

2. Description of the Prior Art

[0003] The use of powdery substances in manufacturing operations has increased in recent years, primarily due to the restrictions placed by various government agencies upon volatile emissions vented to the atmosphere. The application of powdery substances such as, for example, powder paint, is gaining wider acceptance in vehicle manufacturing as the application of powder paint to vehicle bodies inside the powder paint application housing typically is performed with a complete absence of volatile emissions.

[0004] In a typical application facility, the powdery substance, i.e. powder paint, is received in a primary hopper having a fluidized bed to maintain the powder paint in a fluidized state. Air is mixed with the powder paint to give the powder paint flowing

properties similar to a liquid. The powder paint is then delivered to a remote location having a final feed transporter connected to one or a plurality of paint applicators. The transportation and delivery of the powder paint is performed by vacuum dilute phase equipment as disclosed, for example, in United States Patent No. 6,679,193 where vacuum pumps are used to create negative pressure within a powder receiver unit associated with a primary hopper to draw virgin powder material from a source of the powder material into the powder receiver unit. A second vacuum pump applies a negative pressure in each powder receiver unit associated with the feed hoppers so the powder material from the primary hopper located at a remote location is drawn through long transfer lines into the powder receiver units associated with the feed hoppers adjacent the powder application booth. The powder receiver units at the powder application housing fill respective feed hoppers with the powder paint, which in turn is transferred from the feed hoppers at powder pumps to the powder applicators inside the powder application booth.

[0005] While the use of vacuum pumps to create negative pressures within the various hoppers has gained widespread use, it is also exceedingly expensive due to the number of vacuum pumps required to create vacuums within the various hoppers. Furthermore, the transport of the powdered paint using negative pressure lends itself to line blockages if the negative pressure is not continuously maintained at a necessary level. Still further, a complicated valve arrangement is required at a location between the applicator and the feed hoppers where the powder has been transferred at a negative pressure and must be provided to the applicator at a positive pressure.

[0006] Therefore, it would be desirable to provide a new apparatus and method for transporting powdery substance, such as, for example, powder paint, between a source of the powdery substance and an applicator in a simplified cost-effective manner. In addition, it would be desirable to provide a controlled flow rate of the powdery substance at a substantially constant pressure and flow rate to the paint applicator for uniform application of the powdery substance to an article.

SUMMARY OF THE INVENTION AND ADVANTAGES

[0007] The present application discloses the method and apparatus for transporting a powdery substance from a source of the powdery substance to an applicator for applying the powdery substance to an article. A feed transporter is fluidly connected to a source of the powdery substance for receiving the powdery substance under pressure. The feed transporter has a full state and a refill state for signaling a transfer of the powdery substance from the source. An applicator is fluidly connected to the feed transporter for receiving the powdery substance under pressure and applying the powdery substance to an article. Pressurized air is connected to the feed transporter for continuously applying the pressurized air to the feed transporter. The pressurized air continuously feeds into the feed transporter which allows for better control in maintaining a substantially constant pressure in the feed transporter and thereby a substantially constant flow rate of powdery substance from the feed transporter to the applicator. In addition, the pressurized air assists in pushing the powdery substance during the transfer from the source to the feed transporter. Further, the substantially constant pressure in the feed transporter allows for continuous application on the article with little variation of the

pressure in the feed transporter and therefore with little variation to the flow of the powdery substance to the applicator.

[0008] The use of positive pressure and pressurized air continuously feeding into the feed transporter solves the problems associated with the prior art, negative pressure, transport systems as disclosed in prior art patents. For example, reduction in the requisite apparatus, such as, for example, negative pressure pumps, reduces the capital expense associated with the prior art systems. Furthermore, the transfer of the powdery substance being transferred under positive pressure with a continuous application of pressurized air on the feed line reduces the propensity of the prior art, negative pressure, transport systems to have blockages and fluctuations in the pressure and flow of powdery substance to the applicator from the feed transporter. Accordingly, there is an industrial need to provide a simplified, more reliable system and method for transporting a powdery substance between a source of the powdery substance and an applicator in a manufacturing setting.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Other advantages of the present invention will be readily appreciated, as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing wherein:

[0010] Figure 1 is schematic view of the inventive powdery transport system.

DETAILED DESCRIPTION OF THE INVENTION

[0011] A method of transporting a powdery substance from a source to a feed transporter for supplying an applicator for application of the powdery substance to an article. The powder transport system is generally shown at **20** in Figure 1.

[0012] The powder transport system **20** includes a source **22** for receiving a source of a powdery substance and transporting to an article (not shown). The source **22** is fluidly connected to a feed transporter **24** for transporting the powdery substance to the feed transporter **24**. A feed line **26** is disposed between the source **22** and the feed transporter **24** for operably transferring the powdery substance. Optionally the feed line **26** can include a restrictor **28** on the feed line **26** for restricting the flow of the powdery substance and pressure from the source **22** to the feed transporter **24**. The system **20** further includes an applicator **30** fluidly connected to the feed transporter **24**. The applicator **30** receives the powdery substance under pressure for application to an article in a paint housing, or booth.

[0013] The feed transporter **24** further defines a full state and a refill state. The feed transporter **24** as known in the art typically would define the full and refill state by a fluidizer load cell **32**. The full state is a state of the feed transporter at which there is enough of the powdery substance present to begin application, which may or may not fill the feed transporter. The refill state the feed transporter may or may not be empty, the refill state designates a level at which a transfer of powdery substance from the source begins. The fluidizer load cell **32** sends a signal to a controller to signify the state of the feed transporter **24** during the operation of the system **20**. The refill and full state of the feed transporter **24** will be further defined below in the operation of the system **20**. The

flow rate and pressure that the powdery substance is delivered from the feed transporter 24 to the applicator 30 is critical for the uniform application of the powdery substance to the article. The feed transporter 24 is pressurized to a set value typically between 3 to 15 psig during the painting process. The feed transporter 24 also includes a transporter fluidizer 34 that has a fluidizing air 36 supply and a fluidizing plate, as known in the art for fluidizing the powdery substance into a state with material properties similar to a liquid material. As known in the art, fluidizing the powdery substance involves the mixing of air with the powdery substance. The pressure in the feed transporter 24 provides the force to transfer the powdery substance through an applicator line 38 to the applicator 30. If the pressure changes, the flow rate of powdery substance to the applicator 30 will also change accordingly to the pressure change. If the pressure and thereby the flow rate of the powdery substance to the applicator 30 changes significantly, the coating on the article will vary in thickness, which is unacceptable, especially on a painted surface of a vehicle. For this reason, the pressure in the transporter must be maintained within a narrow range.

[0014] Therefore advances in the controlling the pressure and increasing the flow rate of air into and through the feed transporter 24 have been found to allow for better control of flow of powdery substance to the applicator 30. A regulator 40 is connected to the feed transporter 24 for regulation of the pressure in the feed transporter 24. The fluctuation of the air flow and thereby the pressure within the feed transporter 24 typically is observed during the transferring of the powdery substance from the source 22 to the feed transporter 24. Therefore, the subject invention has found that a pressurized

air 42 connected by an air line to the feed line 26 allows for a substantially constant flow of air into the feed transporter 24 at a relatively constant air pressure.

[0015] The continuous application of the pressurized air 42 connected to the feed line 26 to the feed transporter 24 allows for the regulator 40 to maintain a vent 44 within a narrow range of air pressure and air flow out of the feed transporter 24. The pressurized air 42 is at a pressure generally equal nominally to the source 22, to provide the flow of the powdery substance toward the feed transporter 24 not allowing for the back travel of the powdery substance to the source 22. However, one skilled in the art would also appreciate that the pressurized air 42 could be controlled to fluctuate during the transferring of the powdery substance to reduce the compression of the powdery substance and air as the powdery substance is transferred. The continuous supply of the pressurized air 42 results in a narrower range of air flow out of the vent 44 therefore a substantially constant pressure in the feed transporter 24. In addition, the increased air flow rate through the feed transporter 24 allows for increase uniform flow of the powdery substance meaning that the feed transporter 24 can supply an increased number of applicators 30. This increase in the number of applicators 30 results in reduced capital and maintenance on the delivery system 20. This will be fully understood with the explanation of the entire transport system 20 and charts below.

[0016] The regulator 40 releases the pressure by venting a flow of air out of the feed transporter 24 to atmosphere. As known in the art venting is typically done in the booth or in an environment where some residual powdery substance would not cause any environment problems or concerns within the manufacturing facility.

[0017] During the transferring of the powdery substance to the applicator 30 from the feed transporter 24, the pressure in the feed transporter 24 is maintained and controlled to a generally constant pressure. At least one the applicator 30 is fluidly connected to the feed transporter 24 by the applicator line 38. If additional applicators 30 are connected to the feed transporter 24 each of the applicators 30 are individually fluidly connected to the feed transporter 24 by additional applicator lines 38. Therefore as known in the art the feed transporter 24 typically will supply and transfer the powdery substance to a plurality of applicators 30. Each applicator line 38 includes an applicator valve 48 for turning on and off the transfer of the powdery substance. A push air device 50 is connected between the applicator valve 48 and the applicator 30 which allows for the complete removal of the powdery substance from the applicator line 38. In addition, the push air device 50 can be adjusted to additionally provide control of the flow of the powdery substance as known in the art. The push air device 50 is connected downstream of the applicator valve 48.

[0018] The powder transporter system 20 includes the source 22, the feed transporter 24 and the powder applicator 30. The source 22 as known in the art is typically located a distance from the booth or the point of application of the powdery substance to the article. Therefore, the powdery substance is transferred between several hoppers 52, 54 before reaching the applicator 30. The source 22 is further defined as a primary hopper 52 and a receiver hopper 54 for transporting the powdery substance from the source 22 to the applicator 30.

[0019] The primary hopper 52 is typically located in a paint mix room, which is usually located in a remote area of the manufacturing plant. The receiver hopper

54 is fluidly connected to the primary hopper 52 and the receiver hopper 54 transports a quantity of the powdery substance to the feed transporter 24 with each fill cycle. The primary hopper 52 further includes a primary fluidizer 56 that has a fluidizing air 36 supply and a fluidizing plate as known in the art for fluidizing the powdery substance, which is typically powder paint. The receiver hopper 54 includes a receiver fluidizer 58 that has a fluidizer air supply and a fluidizer plate as known in the art for fluidizing the powdery substance. As known in the art, fluidizing the powdery substance involves the mixing of air with the powdery substance to give the powdery substance liquid properties allowing for easier transfer of the powdery substance. The primary and receiver fluidizers 56, 58 provide the air supply that pressurizes each of the hoppers 52, 54 and maintain each generally at the same pressure, approximately 15 psig. As known in the art the pressure within the primary and receiver hopper 52, 54 is generally at a level that is less than 20 psig however the pressure may be increased depending on the design of each of the hoppers 52, 54 and the transport system 20.

[0020] The receiver hopper 54 is located near the primary hopper 52, such that in the preferred embodiment the transfer of powdery substance is generally done by gravitational force. As one skilled in the art the use of gravitational force requires that the primary hopper 52 is placed at a height above the receiver hopper 54 such that the potential energy due to the gravitational forces aids and substantially provides the force to transfer the powdery substance from the primary hopper 52 to the receiver hopper 54. However, as one skilled in the art would recognize the transfer of the powdery substance does not require the use of gravitational force, and optionally could be done utilizing the difference of positive pressure between the primary and receiver hopper 52, 54.

However, the pressure between the primary and receiver hopper **52**, **54** are generally equal due to a vent line **46** disposed between and fluidly connecting the receiver hopper **54** and the primary hopper **52**. The vent line **46** includes a vent valve **60** that is operably connected to the vent line **46**. The vent valve **60** defines an open and closed state as known in the art and is opened during the transfer of powdery substance from the primary hopper **52** to the receiver hopper **54** to allow the flow of the powdery substance into the receiver hopper **54** and equalizing of the pressure between the primary and receiver hoppers **52**, **54**. After the transfer of the powdery substance the receiver vent **44** is closed allowing the powdery substance in each of the hoppers **52**, **54** to be pressurized and fluidized by the respective fluidizer.

[0021] The receiver hopper **54** has a capacity of powdery substance less than the primary hopper **52**. Therefore the transfer of the powdery substance is controlled by a load sensor **62** connected to the primary hopper **52**. The load sensor **62** sends a signal to the controller indicating the weight of the primary hopper **52** and the controller controls a primary valve **64** on the primary hopper **52** and the vent valve **60**, to limit the amount of powdery substance transferred from the primary hopper **52** to the receiver hopper **54** to an amount less than the full capacity of the receiver hopper **54**. The receiver hopper **54** has a capacity that is approximately 10 lbs. However, the filling and the detection of the amount of powdery substance transferred could be optionally done by a level sensor or a load sensor connected to the receiver hopper **54**.

[0022] The feed transporter **24** is filled by the receiver hopper **54** and that transfer is determined by the full state and the refill state of the feed transporter **24**. Once the feed transporter **24** is in the refill state the controller will begin a fill cycle of the feed

transporter 24. The feed transporter 24 pressure must still be maintained a positive pressure since the applicator 30 and painting in the booth will not stop during the fill cycle. This is done through the fluidizing air 36, the air flow from the transferring powdery substance and the continuous pressurized air 42.

[0023] The feed transporter 24 when in the refill state the controller will open a feed valve 66 fluidly connecting the feed transporter 24 to the receiver hopper 54 through the feed line 26. The transfer of the powdery substance will continue until the feed transporter 24 is at the full state and the controller closes the feed valve 66. The amount of powdery substance transferred will generally be equal to the complete capacity of the receiver hopper 54 therefore emptying the receiver hopper 54 with each fill cycle. The powdery substance is then transferred to the receiver hopper 54 as described above, and the primary valve 64 and vent valve 60 are closed. The receiver hopper 54 will pressurize by the fluidizing air 36 and be ready for transfer to the feed transporter 24 upon the next refill state of the feed transporter 24.

[0024] The feed transporter 24 is continuously supplying the powdery substance to the applicator 30, when the applicator valve 48 is open and therefore the level of the feed transporter 24 will continuously change due to the supply of the applicators 30 while the system 20 is in operation. The transporting of the powdery substance and the continuous pressurized air 42 to the feed transporter 24 results in a fill cycle of the feed transporter 24 with minimal fluctuations of the air pressure and therefore a substantially constant flow rate of powdery substance to the applicator 30 for continuous application on the article. Optionally, as shown in Figure 1 the feed line 26

can further include a restrictor **28** for restricting the flow of the powdery substance and pressure from the receiver hopper **54** to the feed transporter **24**.

[0025] In this system, it may be advantageous to restrict the flow rate of the powdery substance from the receiver hopper **54**. This is important because the pressure drop in the feed line **26** is sensitive to the flow rate of powdery substance in the feed line **26**. If the powdery substance flow rate is unrestricted, the pressure drop through the feed line **26** will increase greatly when the feed line **26** is full of powdery substance as compared to when it is empty. For the typical flow rates given in this disclosure, the pressure drop in through an feed line **26** may be ~ 1 psig and the pressure drop through a powdery substance feed line **26** will be ~ 9 psig.

[0026] This pressure change can be a problem because of the compressible nature of air. If the pressurized air **42** flow rate is constant, but the pressure drop in the feed line **26** is increasing, the net flow into the feed transporter **24** will drop while the pressure is increasing in the feed line **26**. Once the pressure drop stabilizes at the higher value, the flow rate to the feed transporter **24** will stabilize. The reason for this is that while the pressure in the feed line **26** is increasing, the air in the feed line **26** is being compressed and in essence, some air is being stored in the feed line **26** instead of being delivered to the feed transporter **24**. The opposite effect occurs when the pressure is relieved; some compressed air that is stored in the feed line **26** is released into the feed transporter **24** and the flow to the transporter increases while the pressure is decreasing.

[0027] The restrictor **28** for the powdery substance flow out of the receiver hopper **54** may be accomplished in a number of ways. The feed valve **66** may be sized smaller than the feed line **26** connecting to the feed transporter **24**. For example, if

the feed line 26 is 5/8" inside diameter, the feed valve 66 may be 1/4" diameter. Alternatively, an adjustable valve may be included in the feed line 26 between the receiver hopper 54 and the point where the pressurized air 42 connects to the feed line 26. This adjustable valve restrictor 28 may be either upstream or downstream of the feed valve 66, however it is downstream in the illustrated system 20.

[0028] One of the novel features of this invention is that the pressurized air 42 flows into the feed transporter 24 continuously. Because the flow is large in relation to the other variable flows (see Table 1 for typical flow ranges), making this flow continuous greatly improves the pressure control of the feed transporter 24.

[0029] Table 1, Typical Flow Ranges to Feed Transporter

Flow Title	Typical Range	Variability
Receiver Hopper Fluidizing Air	20-50 scfh	Only on during transport of powder into feed transporter
Pressurized Air (into the feed line)	100-300 scfh	Continuous
Feed Transporter Fluidizing Air	120-240 scfh	Continuous
Air to Applicators	20-40scfh per applicator	Only on during application

[0030] To understand this more fully, the minimum and maximum flow rate through the regulator 40 are calculated with and without the pressurized air 42 in Table 2. As can be observed from the Table 2, the regulator 40 flow has a 3.41:1 range without continuous pressurized air 42 and a 1.28:1 range with continuous pressurized air 42. Therefore a narrow flow out of the vent 44 is resulted by utilizing the continuous pressurized air 42.

[0031] Table 2, Regulator Flow Range With and Without Continuous

Pressurized Air (CPA)

Flow Title Nom. Volume	Min. Flow Without CPA	Max. Flow Without CPA	Min. Flow With CPA	Max. Flow With CPA
Receiver Hopper Fluidizing Air 30 scfh	0	+30 scfh	0	+30 scfh
Pressurized Air 200 scfh	0	+200 scfh	+200 scfh	+200 scfh
Feed Transporter Fluidizing Air 180 scfh	+180 scfh	+180 scfh	+180 scfh	+180 scfh
Air to 3 Applicators 20 scfh / applicator	-60 scfh	0	-60 scfh	0
Vent Flow of Regulator	120 scfh	410 scfh	320 scfh	410 scfh

[0032] Another advantage of the continuous pressurized air **42** is that it allows feeding a greater number of applicators **30** from a given feed transporter **24**. Using the nominal figures from Table 2, without CPA, the system would be limited to 9 applicators **30** (180 scfh / 20 scfh). If a greater number of applicators **30** were used, the flow out of the feed transporter **24** would exceed the flow into the transporter and pressurization could not be sustained. However, with CPA, the theoretical upper limit on number of applicators **30** is 16 (320 scfh / 20 scfh). Clearly, these limits could be increased in other ways, such as making the transporter larger (which would increase the feed transporter **24** fluidizing air **36** flow). However, there is a cost associated with any such changes.

[0033] Obviously, many modifications and variations of the present invention are possible in light of the above teachings. The invention may be practiced otherwise than as specifically described within the scope of the appended claims. It is anticipated that air will be the preferred gas in most applications because air under pressure is generally available at most paint application sites, particularly automotive paint facilities. However, other gases under pressure may also be utilized.

CLAIMS

What is claimed is:

1. A method of transporting a powdery substance from a source to a feed transporter for supplying an applicator for application of the powdery substance to an article with the feed transporter having a full state and a refill state, said method comprising the steps of:

transferring the powdery substance under pressure from the source to the feed transporter until the feed transporter reaches the full state;

transferring the powdery substance under pressure from the feed transporter to the applicator during operation of the applicator;

transferring the powdery substance under pressure from the source to the feed transporter when the feed transporter reaches the refill state; and

continuously supplying pressurized air between the source and the feed transporter thereby maintaining a substantially constant pressure in the feed transporter and a substantially constant flow rate of powdery substance from the feed transporter to the applicator.

2. A method as set forth in claim 1 further including the step of regulating the feed transporter to maintain a substantially constant pressure.

3. A method as set forth in claim 2 wherein the regulating the feed transporter is further defined as venting the feed transporter to atmosphere to maintain a substantially constant pressure.

4. A method as set forth in claim 1 further including step of fluidizing the powdery substance in the feed transporter to mix pressurized air with the powdery substance for the powdery substance to have material properties similar to a liquid.

5. A method as set forth in claim 1 further including the step of supplying pressurized air between the feed transporter and the applicator for assisting the transport of the powdery substance out of the applicator to the article.

6. A method as set forth in claim 1 wherein the source is further defined as a primary hopper and a receiver hopper and further including the step of transferring the powdery substance under pressure from the primary hopper to the receiver hopper.

7. A method as set forth in claim 6 further including the step of fluidizing the powdery substance in the receiver hopper to mix pressurized air with the powdery substance for the powdery substance to have material properties similar to a liquid.

8. A method as set forth in claim 6 further including the step of fluidizing the powdery substance in the primary hopper to mix pressurized air with the powdery substance for the powdery substance to have material properties similar to a liquid.

9. A method as set forth in claim 6 further including the step of venting the receiver hopper during transferring the powdery substance from the primary hopper to the receiver hopper.

10. A method as set forth in claim 9 further including the step of transferring the powdery substance from the primary hopper substantially by gravitational force to the receiver hopper.

11. A method as set forth in claim 10 further including the step of terminating the venting of the receiver hopper after the transfer of the powdery substance of an amount less than the capacity of the receiver hopper.

12. A method as set forth in claim 1 further including the step of restricting the flow of the powdery substance and pressure from the source to the feed transporter.

13. A system for applying a powdery substance to an article, said system comprising:

a source for supplying the powdery substance;

a feed line having a first end fluidly connected to said source and a second end;

a feed transporter having a full state and a refill state fluidly connected to said second end of said feed line for receiving the powdery substance under pressure from said source through said feed line when said feed transporter is in said refill state until said feed transporter is in said full state;

an applicator fluidly connected to said feed transporter for receiving the powdery substance under pressure and applying the powdery substance to the article; and

an air line connected to said feed line continuously applying pressurized air to said feed transporter to maintain a substantially constant pressure in said feed transporter and a substantially constant flow rate of powdery substance from said feed transporter to said applicator thereby enabling continuous application of the powdery substance to the article.

14. A system as set forth in claim 13 further including a regulator connected to said feed transporter for maintaining the pressure in said feed transporter a substantially constant pressure.

15. A system as set forth in claim 14 wherein said regulator further includes a vent for releasing excess pressure out of said feed transporter to maintain a substantially constant pressure in said feed transporter.

16. A system as set forth in claim 13 further including a transporter fluidizer for maintaining the powdery substance in a fluidized state mixing air into the powdery substance to have material properties similar to a liquid material.

17. A system as set forth in claim 13 further including a push air device disposed between said feed transporter and said applicator for assisting the transport of the powdery substance out of said applicator to the article.

18. A system as set forth in claim 13 wherein said source is further defined as a primary hopper and a receiver hopper for transferring the powdery substance under pressure from said primary hopper to said receiver hopper and to said feed transporter.

19. A system as set forth in claim 18 further including a receiver fluidizer for maintaining the powdery substance in a fluidized state mixing air into the powdery substance to have material properties similar to a liquid material.

20. A system as set forth in claim 18 further including a primary fluidizer for maintaining the powdery substance in a fluidized state mixing air into the powdery substance to have material properties similar to a liquid material.

21. A system as set forth in claim 18 further including a vent line having a vent valve disposed between said receiver hopper and said primary hopper for venting gas from said receiver hopper to said primary hopper while transferring the powdery substance from the primary hopper to the receiver hopper.

22. A system as set forth in claim 21 wherein said primary hopper is place at a height above said receiver hopper for transferring the powdery substance substantially by gravitational force from said primary hopper to said receiver hopper.

23. A system as set forth in claim 22 further including a load sensor under said primary hopper for signaling the transfer of an amount of the powdery substance to said receiver hopper.

24. A system as set forth in claim 13 further including a restrictor on said feed line for restricting the flow of the powdery substance and pressure from said source to said feed transporter.

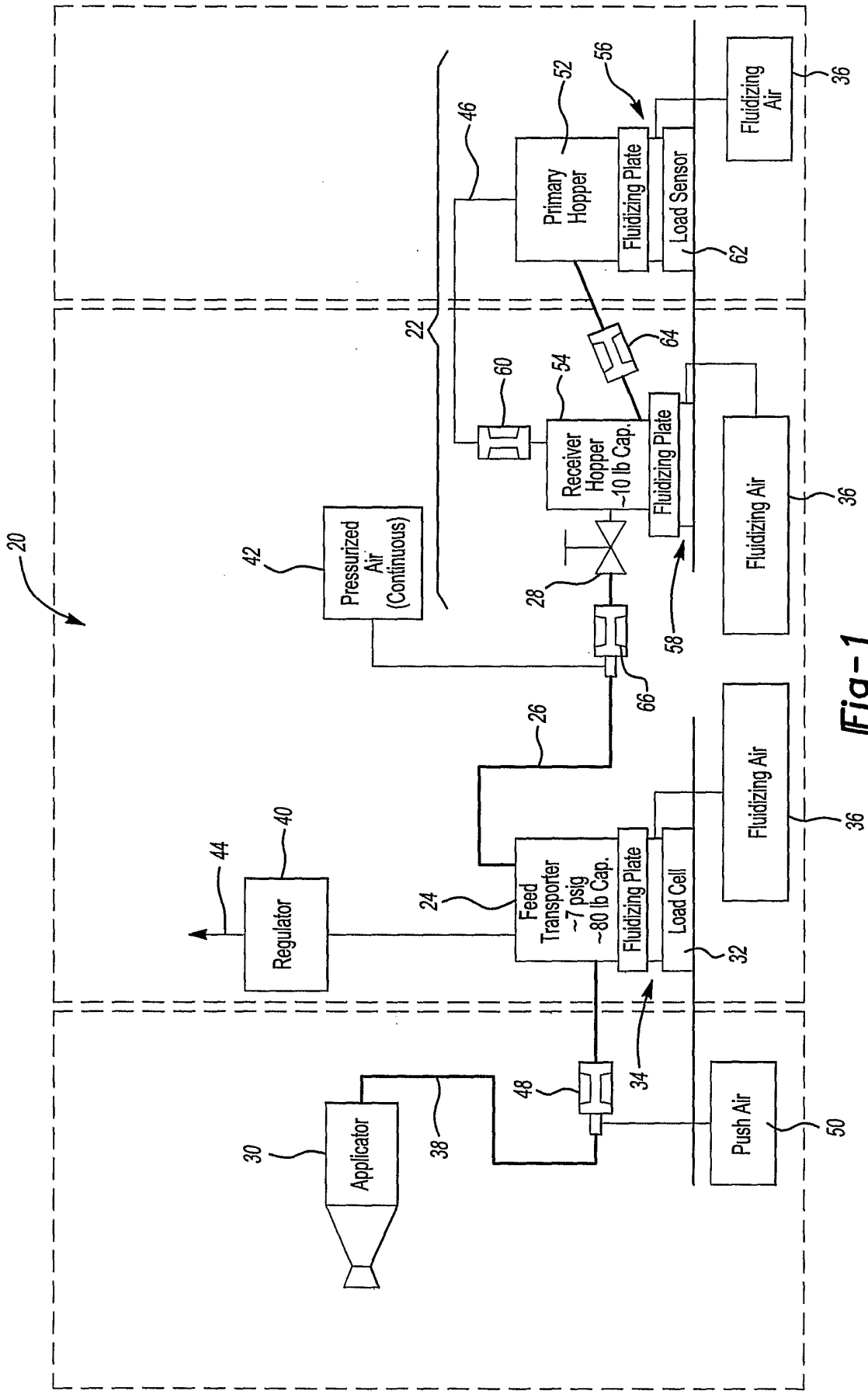


Fig-1

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US06/07779

A. CLASSIFICATION OF SUBJECT MATTER

IPC: **B65G 51/36(2006.01),B65G 53/66**

USPC: 406/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 406/25, 31, 32, 93, 94, 138

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,487,624 A (TOYOTA et al.) 30 January 1996 (30/06/1996), see entire document	1-23
A	US 6,830,414 B2 (KIA et al.) 14 December 2004 (14/12/2004), see entire document	1-23
A	US 4,005,908 A (FREEMAN) 1 February 1977 (01/02/1977), see entire document	1-23
A	US 4,367,987 A (WALTERS) 11 January 1983 (11/01/1983), see entire document	1-23
A	US 6,176,647 B1 (ITOH) 23 January 2001 (23/01/2001), see entire document	1-23
A	US 5,634,713 A (ABE) 03 June 1997 (03/06/1997), see entire document	1-23
A	US 5,615,980 A (MAUCHLE) 01 April 1997 (01/04/1997), see entire document	1-23



Further documents are listed in the continuation of Box C.



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