PARTICULATE TRANSFER SYSTEM FOR TRANSFERRING PARTICULATE AND A METHOD OF USE

A particulate transfer system (6) comprising: a particulate transfer device (6) capable of fluidizing (10) and transferring (70) particulate and a container (2) in which it fits. The device (6) can be placed on a top surface of particulate (4) in the container (2) and operated such that it travels towards the bottom of the container (2) as it fluidizes at least about 50 percent of the area of the top surface of the particulate (4) and removes (24) particulate. A method of using the system is provided.
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PARTICULATE TRANSFER SYSTEM FOR TRANSFERRING
PARTICULATE AND A METHOD OF USE

FIELD OF THE INVENTION

This invention relates to a particulate transfer system which can be used to
transfer particulate from one location to another quickly, with improved
homogeneity, and with a minimum of operator involvement. The invention also
relates to a method of using the particulate transfer system.

BACKGROUND OF THE INVENTION

One frequently desires to move fairly large quantities of particulate from one
location to another. For example, one may wish to unload a box, drum, etc.,
containing particulate for transfer to a use site or another container. Unpackaged
particulate can be difficult to transfer without incurring significant amounts of
dusting and/or particulate loss. Depending on the method of transfer utilized, the
particulate can potentially become airborne, resulting in loss or inefficient transfer of
material. In addition, known methods of transfer can be rather time consuming and
can involve a large amount of operator time and attention. For example, when a
conventional vacuum or suction wand, tube, pipe, or hose is used to empty a fairly
large container of particulate, the operator would typically stand and move the
appurtenance around within the container during the entire container emptying
procedure.

SUMMARY OF THE INVENTION

A need exists for an article (system) which can be used to transfer
particulate both quickly and homogeneously with minimal or no dusting and/or
particulate loss.

We have discovered a system for use in transporting particulate material
efficiently. The system can be used to transfer the material in such a manner that
loss of material and generation of dust from the material, and operator attention is
minimized.
The present invention provides a particulate transfer system comprising:

(a) a particulate transfer device comprising:

(i) a means for fluidizing particulate, upon operation of the particulate transfer device;

(ii) a means for transferring particulate, upon operation of the particulate transfer device;

wherein the means for transferring particulate is associated with the means for fluidizing particulate; and

(b) a container, the container having a bottom, wherein the particulate transfer device is capable of being inserted into the container;

wherein when the container contains particulate, the particulate transfer device is capable of being placed on a top surface of the particulate in the container and operated such that the particulate transfer device travels towards the bottom of the container as at least some particulate is fluidized and transferred from the container by the particulate transfer device; and

wherein the particulate transfer device is of such a design that at least about 50 percent of the area of the top surface of the particulate is fluidized by the means for fluidizing particulate, during operation of the particulate transfer device.

With respect to the particulate transfer device of the particulate transfer system, in a preferred embodiment, the means for fluidizing particulate comprises an apparatus, wherein at least a portion of at least one surface of the apparatus is capable of fluidizing via gas at least some particulate upon which the apparatus may be placed during the operation of the particulate transfer device; and

the means for transferring particulate comprises at least one conduit,

wherein at least one conduit upon application of sufficient pressure differential to the conduit is capable of transferring at least some particulate fluidized by the means for fluidizing particulate from the container.

In another preferred embodiment the particulate transfer system of the invention comprises:

(a) a particulate transfer device comprising:
(i) a means for fluidizing particulate, upon operation of the particulate transfer device;

(ii) a means for transferring particulate, upon operation of the particulate transfer device;

wherein the means for transferring particulate is joined to the means for fluidizing particulate; and

(b) a container, the container having a bottom, wherein the particulate transfer device is capable of being inserted into the container;

wherein when the container contains particulate, the particulate transfer device is capable of being placed on a top surface of the particulate in the container and operated such that the particulate transfer device travels towards the bottom of the container as at least some particulate is fluidized and transferred from the container by the particulate transfer device; and

wherein the particulate transfer device is of such a design that at least about 50 percent of the area of the top surface of the particulate is fluidized by the means for fluidizing particulate, during operation of the particulate transfer device;

wherein the means for fluidizing particulate comprises an enclosed vessel wherein the vessel has a top surface and a bottom surface, wherein at least a portion of the bottom surface of the vessel is gas permeable;

wherein the vessel has at least one gas inlet port;

wherein the means for fluidizing particulate is designed such that during operation, gas is charged into the vessel through the gas inlet port(s) and at least some of the gas exits the vessel through the bottom surface of the vessel in a manner such that the exiting gas is capable of fluidizing at least some particulate which the particulate transfer device may be placed on during operation;

wherein the means for transferring particulate comprises at least one conduit, wherein at least one conduit upon application of a sufficient pressure differential is capable of transferring at least some particulate fluidized by gas exiting through the bottom surface of the vessel, when particulate is present in the container, from the container.
The present invention also provides a method of transferring particulate comprised of the steps of:

(a) providing the particulate transfer system of the invention, wherein the transfer system further comprises particulate which is present in the container;

(b) placing the particulate transfer device of the particulate transfer system of the invention on top of particulate contained in the container; and

(c) operating the particulate transfer device such that at least some particulate is transferred out of the container.

Definition of Terms

The term “self supporting” as used herein is defined as follows. A particulate transfer device which can be placed upon a level or substantially level volume of particulate (such as glass microspheres, for example) in a rigid container (such as a box) such that the surface of the particulate transfer device in contact with the particulate is the same surface which would be in contact with the particulate during the use of the particulate transfer device and can remain substantially upright (positioned to function as intended) without additional support (i.e., a person holding the particulate transfer device, a separate mechanical support, or the walls of the container, etc.) and without physically pushing the particulate transfer device into the particulate in order to try to stabilize it is considered to be self supporting. Thus, a self-supporting particulate device should remain substantially upright upon operation to transfer at least some particulate from a container and not fall against the sides of the container. Preferably the device remains completely upright.

Preferably, the particulate transfer device of the particulate transfer system of the present invention is self supporting as that term is defined above.

The term “associated with” with respect to the means for fluidizing particulate and the means for transferring particulate includes the following: connected, joined, positioned adjacent to, positioned within the other.
BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates a top view of an embodiment of the particulate transfer system of the invention.

Fig. 2 illustrates a side view of the particulate transfer system of Fig. 1 taken along line 2-2.

Fig. 3 illustrates a partially broken away bottom view of the particulate transfer device of the particulate transfer system of Fig. 1.

Fig. 4 illustrates an expanded view of the conduit of the particulate transfer device of the particulate transfer system of Fig. 2 and the surrounding area.

DETAILED DESCRIPTION OF THE INVENTION

Particulate to be Transferred

Useful particulate according to the invention may be, for example, solid, hollow, porous, resilient, rigid, deformable, fragile, formed, ground, milled, attrited, and/or naturally occurring. Examples of particulate materials which can be transferred using the invention include but are not limited to those selected from the group consisting of bubbles, beads, powders, granules, fibers, flakes, pellets, microspheres [including, for example, solid (non-hollow) and hollow microspheres], generally ellipsoidal particles, and mixtures thereof. The composition of the particulate to be transferred can vary. Preferably the particulate is selected from the group consisting of glass, ceramic materials, polymeric materials, and mineral materials (including for example, expanded perlite). This invention is particularly useful for transferring particulate with an average diameter of about 0.01 to about 4000 microns, more particularly those of about 1 to about 1,000 microns. The particulate transfer system of the present invention is particularly useful for transferring particulate with a bulk density of about 0.01 to about 1.5 gram(s) per cubic centimeter. The particulate transfer system is especially useful for transferring hollow glass microspheres.
Containers

The particulate transfer device can be used to remove material from a variety of containers including but not limited to the following: boxes, barrels, drums, bags, crates, tubs, and bins. The particulate transfer device may optionally be used in a container which is lined. For example, it may be used in a container which has a plastic bag liner. The container with which the particulate transfer device is used is preferably a rigid container.

The dimensions of the container can vary. The container should be of such dimensions that the particulate transfer device can readily fit therein. The closer the dimensions of length and width or diameter of the particulate transfer device to those of the container, the more efficient the particulate transfer device since the particulate transfer device will be in contact with a greater amount of particulate which it may fluidize (if the fluidizing surface of the particulate transfer device increases in dimension correspondingly). However, the dimensions of the particulate transfer device should not be so great that the device cannot travel smoothly towards the container bottom as particulate is removed therefrom.

For example, the dimensions of a device should not be so great that the device can become stuck within the container. Preferably the dimensions of the device should not be so great that an external force applied by an operator, for example, is needed to actually push the device down into the container.

Typically the maximum (largest) horizontal cross-sectional area of the particulate transfer device is at least about 50 percent of the minimum (smallest) horizontal cross-sectional area of the container, preferably at least about 60 percent, more preferably at least about 70 percent, and most preferably at least about 90 percent. The maximum horizontal cross-sectional area of the particulate transfer device could theoretically be up to about 100 percent of the minimum horizontal cross-sectional area of the container as long as the particulate transfer device can travel in a direction towards the bottom of the container as the particulate is removed such that the particulate transfer device can continue to fluidize and remove the particulate. Typically, the horizontal cross-sectional area of a container such as a box or barrel is substantially constant, more typically constant.
The volume of the container typically ranges from about 0.05 cubic meters to about 6 cubic meters. Some containers which are useful herein have, for example, a volume of about 0.05 cubic meters to about 4 cubic meters. Other useful containers, for example, may have a volume of about 0.7 cubic meters to about 1.5 cubic meters or about 1 cubic meter to about 3 cubic meters.

In one preferred embodiment the container bottom and the bottom surface of the particulate transfer device are both rectangular. In another preferred embodiment the container bottom and the bottom surface of the particulate transfer device are both circular.

Depending on the intended application, the dimensions of the area of the top surface of the particulate which is fluidized during operation of the particulate transfer device can vary. For certain applications it may be at least about 0.1 square meter, in other applications at least about 1 square meter, and in even other applications at least about 2 square meters, for example, depending on the container size in order to more rapidly transfer particulate.

**Particulate Transfer Device**

Preferably the particulate transfer device of a preferred embodiment of the particulate transfer system is designed such that the means for fluidizing particulate comprises an enclosed vessel wherein the vessel has a top surface and a bottom surface, wherein at least about 50 percent, more preferably at least about 75 percent, and most preferably at least about 90 percent, of the bottom surface of the vessel is gas permeable and/or a fluidizing surface.

Preferably the particulate transfer device is of such a design that at least about 70 percent, more preferably at least 80 percent, and most preferably at least 90 percent of the area of the top surface of the particulate which may be present in the container is fluidized by the means for fluidizing particulate, during operation of the particulate transfer device.
Gas Inlet Port(s)

Frequently, according to the present invention, the means for fluidizing particulate makes use of a gas inlet port(s) therein. In a preferred embodiment, the gas inlet port(s) are present in a top surface of a vessel. In some embodiments the vessel might have 2 to 4 gas inlet ports, although the number can vary.

In some situations it may be preferred that at least one gas inlet port has a diffuser situated in the vicinity of the gas inlet port on the inside of the vessel, in such a manner as to at least partially diffuse gas entering though the gas inlet port.

Gas can be provided through the gas inlet port(s) by gas lines (or tubes or conduits) which are positioned adjacent or through the gas inlet ports. Except for its ends, a gas line is typically an airtight passageway. It may be of one-piece construction or it may comprise two or more components joined together such as a hose, coupling agent, etc.

Shape

The bottom surface of the particulate transfer device and/or the vessel may be, for example, substantially flat or flat, sloped, convex, concave, etc. and combinations thereof (e.g., flat and concave and convex) as long as the particulate can be adequately fluidized. In a preferred embodiment the bottom surface of the particulate transfer device and/or vessel is flat or substantially flat and preferably is additionally slightly angled or inclined in a slightly downward angle from a centrally located conduit as shown in Fig. 2 to facilitate transfer of fluidized particulate from the container.

The means for fluidizing particulate and/or the vessel may optionally have a shape selected from the group consisting of pillow shapes, cylindrical shapes, and polyhedron shapes (for example, a six-, seven-, eight-, nine- or ten-sided polyhedron). In a particularly preferred embodiment the shape of the vessel is that of a six-, seven-, eight-, nine- or ten-sided polyhedron, wherein one side of the polyhedron exterior comprises air-permeable material and the other sides of the polyhedron comprise air-impermeable material. In another preferred embodiment the shape of the vessel is that of a pillow wherein one side of the pillow exterior
comprises air-permeable material and the other side of the pillow comprise air-impermeable material. In another preferred embodiment the shape of the vessel is that of a cylinder, wherein one side of the cylinder exterior comprises air-permeable material and the other sides of the cylinder comprise air-impermeable material.

In a preferred embodiment the horizontal dimensions of the top of the particulate transfer device and/or means for fluidizing particulate and/or vessel is less than the horizontal dimension of the bottom of the particulate transfer device and/or means for fluidizing particulate and/or vessel. This helps to aid in returning the small amount of particulate which may potentially become airborne during operation or creep around the particulate transfer device during use to slide back into the container.

In an even more preferred embodiment the side of the polyhedron opposite the side comprising air-permeable material is smaller in length and width or diameter than the side comprising air-permeable material. Typically only one side of the vessel is air permeable, and that side is typically substantially flat. Typically at least a portion of the interior of the vessel is hollow.

Conduit(s)

Frequently, according to the invention, fluidized particulate is transferred from the container by means of a conduit(s) present in the particulate transfer device. Except for its ends, the conduit is typically an airtight particulate passageway. It may be of one-piece construction such as a hose or tube, or it may, for example, comprise two or more components joined together such as hoses, couplings, etc. In a preferred embodiment the conduits(s) extend from the vicinity of the bottom surface of the vessel and/or transfer device and away from the bottom of the container when the particulate transfer device is positioned within the container such that the bottom surface of the vessel and/or transfer device is closest to the bottom of the container. Preferably the conduit(s) extends through both the top surface and the bottom surface of the vessel. In a preferred embodiment the conduit extends through approximately the center of the air-permeable section of the vessel.
In a preferred embodiment, wherein one conduit is present in the particulate transfer device for transferring fluidized particulate from the container, the area of the conduit opening typically ranges from about 0.1 to about 5 percent of the area of the fluidizing surface of the means for fluidizing particulate, preferably about 0.2 to about 2 percent, and most preferably about 0.3 to about 0.5 percent. Typically one conduit is present in the particulate transfer device, which is typically centrally positioned within the fluidizing area, although it could optionally be located elsewhere such as on the side of the means for fluidizing particulate (which may, for example, be a vessel). Also it is possible to have more than one conduit present as part of a means for transferring particulate.

Gas-Permeable Material(s)

Useful gas-permeable materials may be, for example, flexible or rigid. Examples of useful gas-permeable flexible or rigid materials which can be used to fluidize gas as part of the means for fluidizing particulate include, for example, those which may inherently be gas permeable by nature such as fabric, foam, cloth, certain papers and certain plastics and/or those which may not be inherently gas permeable but which may be provided with openings and/or pores and/or perforations to be gas permeable such as composite materials, metals, paper, rubber, glass, plastics, ceramics, etc., and combinations thereof. For example, the material may potentially be a (metal, for example) grill, grid, or screen. In a preferred embodiment, the gas-permeable material would have a pore size of less than about 35 microns.

Gas-Impermeable Material(s)

Examples of useful gas-impermeable materials which can be used as part of the particulate transfer device include but are not limited to those selected from the group consisting of wood, metal, certain plastics, composite materials, rubbers, ceramics, coated fabrics, and combinations thereof.
Optional Components

The particulate transfer system may optionally further comprise a dust cover extending over the particulate transfer system or just over and as part of the particulate transfer device. In addition, the particulate transfer device may optionally further comprise a flexible member around the edge, of the device, such as a rubber edge, which enables the device to maintain closer contact with the container to further avoid dusting of particulate.

This invention will be better understood by referring to the following Figures 1-4.

Fig. 1 illustrates a top view of an embodiment of the particulate transfer system of the invention which includes a particulate transfer device 6 and container 2. In Fig. 1 the means for fluidizing particulate comprises an enclosed vessel 9. The top surface layer of the vessel 9 is shown as 20. In this embodiment the top surface 20 is a gas-impermeable material such as metal. Attachment points 49 such as lifting hooks are present in the top surface 20. These attachment points 49 are designed such that they do not penetrate top surface 20. A tool can be inserted in the attachment points 49 to aid in moving the particulate transfer device 6. This may occur when positioning the device on particulate 4 in the container 2 prior to operation or removing the particulate transfer device 6 from the container 2 once the particulate has been transferred therefrom. A gas-impermeable member or layer 31 divides the interior of the vessel into two chambers to help better direct the gas for fluidizing the particulate 4. Slanted rigid particle impermeable shields 8 are attached to and extend above the top surface 20 of the vessel 9. The shields 8 help direct particulate 4 which may fall thereupon due to dusting and/or particulate 4 or what may creep through space 13 to slide back into the container 2, and thus aid in preventing particulate 4 from collecting on top surface 20. Optionally a dust cover (not shown) can extend over the vessel 9. The dust cover could, for example, include the shields 8 joined at their uppermost surface by a layer of particulate impermeable material. The space between the edge of the vessel 9 and the container 2 is identified as 13. A dust cover serves to prevent particulate 4 which may travel through space 13 or that which may become airborne from falling onto
top vessel surface 20 during the particulate transfer operation. During operation, gas is charged into the vessel 9 through the gas inlet lines 12, 16, 50 and 52 which extend through the gas inlet ports 15, 17, 19, and 21, respectively, in the top surface 20 of the vessel 9. Diffusers, which are not visible from this top view, are positioned beneath the gas inlet ports 15, 17, 19 and 21, respectively, and are identified as 14, 54, 56, and 18. The means for transferring fluidized particulate 4 out of the container 2 includes hose 24 which forms part of the conduit for removing material. A pressure differential can be formed across the conduit by a device such as a vacuum conveying system. The maximum (largest) horizontal cross-sectional area of particulate transfer device 6 is defined by $x$ times $y$. The minimum (smallest) horizontal cross-sectional area of the container 2 is defined by $x_1$ times $y_1$. For the container 2 in this embodiment the horizontal cross-sectional area is constant.

Fig. 2 illustrates a side view of the particulate transfer system of Fig. 1 taken along line 2-2. In Fig. 2 it can be seen that the particulate transfer device 6 has been placed on particulate 4. Also visible is horizontal gas-impermeable top surface 20 which is joined with rigid particle shields 8. The vessel 9 exterior is defined by this gas-impermeable layer 20, gas-impermeable side layers 22, and gas-permeable layer 10. Gas which enters this vessel 9 exits through gas-permeable layer 10 in a manner which fluidizes at least a portion of the top surface of particulate 4. Items 48 are cleats which function along with attachment devices, such as screws 39 (not shown in Fig. 2, which are inserted therethrough), to secure the gas-permeable layer 10 in place. Item 46 is a quick connect hose coupler which attaches hose 24 to a quick connect adapter 28. Number 70 indicates the conduit opening.

Fig. 3 illustrates a partially broken away bottom view of the particulate transfer device of the particulate transfer system of Fig. 1. Fig. 3 shows grate 44 positioned over coupling tube 26. The grate 44 prevents the conduit from becoming plugged with a container plastic liner, for example. It also prevents direct contact of the conduit with the container bottom and serves to prevent large-size debris from entering into the conduit opening 70. Gas-permeable layer 10 is partially broken away to show gas diffusers 18, 54, and 56 and gas-impermeable
layer 20. Diffusers 56 and 14 are vibrating elastic pads. (Diffuser 14 is not visible in Fig. 3). Diffusers 18 and 54 are flat plates spaced away from gas inlet ports 21 and 17. A gas-impermeable layer 31 along with gas-impermeable plate 32 (identified in Fig. 4) divides the vessel into two chambers is shown as 31. Gas-permeable layer 10 is secured via screws 39 through cleats 48 and 29 to gas-impermeable side layers 22 and gas-impermeable dividing member 31.

Fig. 4 illustrates an expanded view of a portion of the conduit of Fig. 2 and the surrounding area. Item 28 is a quick connect adapter or coupling which serves to partially define the conduit. Item 26 is a tube which also serves to partially define the conduit. Item 40 is a bolt in communication with lock washer 60 which serves to secure gas-permeable layer 10 to gas-impermeable top layer 20. Item 42 is a plate which serves to distribute clamping forces evenly on layer 20. Item 32 is a spacer plate of a gas-impermeable material such as plywood which serves to provide a rigid support for the conduit. Item 36 is a pad keeper tension distributor and spreader plate which serves to uniformly impart draw down forces onto gas-permeable layer 10 over a larger area. Item 38 is a pad tension draw plate which serves to pull the sandwich layer consisting of items 38, 36, 10, 32, 20 and 42 tightly together through the bolt 40. Both items 26 and 44 are welded to item 38 via welds 51 and 45, respectively.

The particulate transfer device can be used, for example, to transfer particulate from a container either continuously or intermittently. In a preferred embodiment, the particulate transfer device is designed so that when placed on particulate which fills or substantially fills the container, the particulate transfer device can be operated such that it travels smoothly toward the bottom of the container while substantially or completely emptying the box of all of the particulate contents with a minimum of dusting and operator attention.

While this invention has been described in connection with specific embodiments, it should be understood that it is capable of further modification. The claims herein are intended to cover those variations which one skilled in the art would recognize as the equivalent of what has been described herein.
IT IS CLAIMED:

1. A particulate transfer system comprising:

   (a) a particulate transfer device comprising:

      (i) a means for fluidizing particulate, upon operation of the
          particulate transfer device;

      (ii) a means for transferring particulate, upon operation of the
           particulate transfer device;

   wherein the means for transferring particulate is associated with the means
   for fluidizing particulate; and

   (b) a container, the container having a bottom, wherein the particulate
       transfer device is capable of being inserted into the container,

   wherein when the container contains particulate, the particulate transfer
   device is capable of being placed on a top surface of the particulate in the container
   and operated such that the particulate transfer device travels towards the bottom of
   the container as at least some particulate is fluidized and transferred from the
   container by the particulate transfer device, and

   wherein the particulate transfer device is of such a design that at least about
   50 percent of the area of the top surface of the particulate is fluidized by the means
   for fluidizing particulate, during operation of the particulate transfer device.

2. The particulate transfer system of claim 1,

   wherein the means for fluidizing particulate comprises an apparatus, wherein
   at least a portion of at least one surface of the apparatus is capable of fluidizing via
   gas at least some particulate upon which the apparatus may be placed during the
   operation of the particulate transfer device; and

   wherein the means for transferring particulate comprises at least one
   conduit, wherein at least one conduit upon application of sufficient pressure
   differential to the conduit is capable of transferring at least some particulate
   fluidized by the means for fluidizing particulate from the container.
3. The particulate transfer system of claim 1 wherein the container is selected from the group consisting of barrels, boxes, drums, bags, crates, tubs and bins and wherein the volume of the container ranges from about 0.05 cubic meters to about 6 cubic meters.

4. The particulate transfer system of claim 1 wherein the particulate is selected from the group consisting of powders, granules, flakes, pellets, hollow microspheres, fibers, solid microspheres, generally ellipsoidal particles, and mixtures thereof and wherein the particulate is selected from the group consisting of glass, ceramic materials, polymeric materials, and mineral materials.

5. The particulate transfer system of claim 1 wherein the particulate transfer device is self supporting.

6. A particulate transfer system comprising:
   (a) a particulate transfer device comprising:
      (i) a means for fluidizing particulate, upon operation of the particulate transfer device;
      (ii) a means for transferring particulate, upon operation of the particulate transfer device;

       wherein the means for transferring particulate is joined to the means for fluidizing particulate; and

   (b) a container, the container having a bottom, wherein the particulate transfer device is capable of being inserted into the container;

       wherein when the container contains particulate, the particulate transfer device is capable of being placed on a top surface of the particulate in the container and operated such that the particulate transfer device travels towards the bottom of the container as at least some particulate is fluidized and transferred from the container by the particulate transfer device; and
wherein the particulate transfer device is of such a design that at least about
50 percent of the area of the top surface of the particulate is fluidized by the means
for fluidizing particulate, during operation of the particulate transfer device;
wherein the means for fluidizing particulate comprises an enclosed vessel
wherein the vessel has a top surface and a bottom surface, wherein at least a portion
of the bottom surface of the vessel is gas permeable;
wherein the vessel has at least one gas inlet port;
wherein the means for fluidizing particulate is designed such that during
operation, gas is charged into the vessel through the gas inlet port(s) and at least
some of the gas exits the vessel through the bottom surface of the vessel in a
manner such that the exiting gas is capable of fluidizing at least some particulate
which the particulate transfer device may be placed on during operation;
wherein the means for transferring particulate comprises at least one
conduit, wherein at least one conduit upon application of a sufficient pressure
differential is capable of transferring at least some particulate fluidized by gas
exiting through the bottom surface of the vessel, when particulate is present in the
container, from the container.

7. The particulate transfer system of claim 6 wherein the means for fluidizing
particulate comprises an enclosed vessel wherein the vessel has a top surface and a
bottom surface, wherein at least about 50 percent of the bottom surface of the
vessel is gas permeable.

8. The particulate transfer system of claim 6,
wherein the conduits(s) extend from the vicinity of the bottom surface of the
vessel and away from the bottom of the container when the particulate transfer
device is positioned within the container such that the bottom surface of the vessel
is closest to the bottom of the container.

9. The particulate transfer system of claim 6 wherein the bottom surface of the
vessel is substantially flat.
10. A method of transferring particulate comprising the steps of:
   (a) providing the particulate transfer system of claim 1, wherein the transfer
   system further comprises particulate which is present in the container;
   (b) placing the particulate transfer device of claim 1 on top of the particulate
   contained in the container; and
   (c) operating the particulate transfer device such that at least some of the
   particulate is transferred out of the container.
**INTERNATIONAL SEARCH REPORT**

A. CLASSIFICATION OF SUBJECT MATTER

| IPC 6 | B65G53/42 |

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) |
| IPC 6 | B65G | B65B |

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

Electronic database consulted during the international search (name of database and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tbody>
<tr>
<td>Y</td>
<td>EP 0 452 635 A (GEMA VOLSTATIC AG) 23 October 1991</td>
<td>1,2,6,10</td>
</tr>
<tr>
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<td>see abstract; claims; figures</td>
<td>3,4,7,9</td>
</tr>
<tr>
<td>A</td>
<td>GB 2 056 932 A (ADAMS D) 25 March 1981</td>
<td>1,2,6,10</td>
</tr>
<tr>
<td></td>
<td>see abstract; claims; figures</td>
<td>3,4,7-9</td>
</tr>
<tr>
<td>A</td>
<td>DE 12 95 470 B (MASCHINENFABRIK HARTMANN AG) 14 May 1969</td>
<td>1,2,6-10</td>
</tr>
<tr>
<td></td>
<td>see column 3, line 10 - line 28; claims; figures</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>DE 196 28 429 A (WILHELM KLAUS) 16 January 1997</td>
<td>1,5,6,10</td>
</tr>
<tr>
<td></td>
<td>see abstract; claims; figures</td>
<td></td>
</tr>
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</table>

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

Date of the actual completion of the international search: 12 January 1999

Date of mailing of the international search report: 18/01/1999

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Van Rolleghem, F.
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CA 2040383 A</td>
<td>15-10-1991</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2040383 C</td>
<td>12-07-1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 59100709 D</td>
<td>27-01-1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES 2047350 T</td>
<td>16-02-1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 1977970 C</td>
<td>17-10-1995</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 4226217 A</td>
<td>14-08-1992</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 6091981 B</td>
<td>16-11-1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 5116321 A</td>
<td>26-05-1992</td>
</tr>
<tr>
<td>GB 2056932 A</td>
<td>25-03-1981</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>DE 1295470 B</td>
<td>NONE</td>
<td></td>
<td></td>
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</tbody>
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