Sept. 20, 1971 C. F. CARTER 3,605,826

METHOD AND APPARATUS FOR FILLING CONTAINERS

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FIG. 1

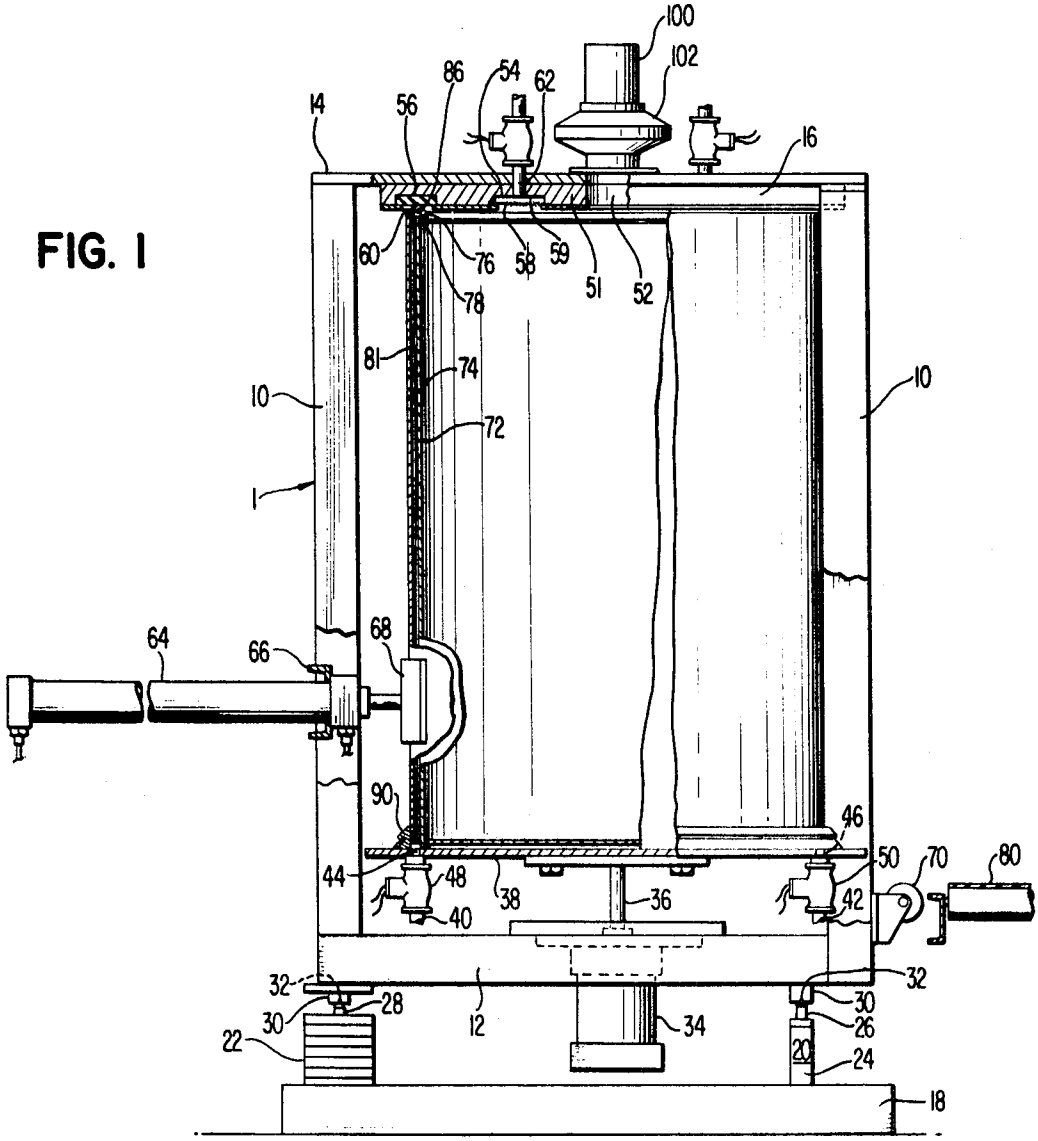
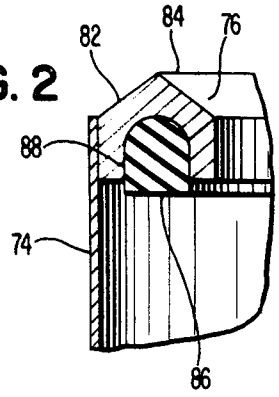


FIG. 2



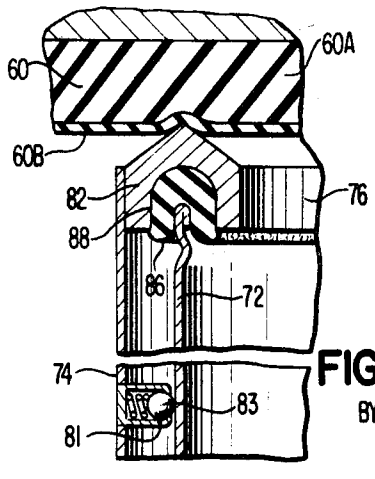


FIG. 3

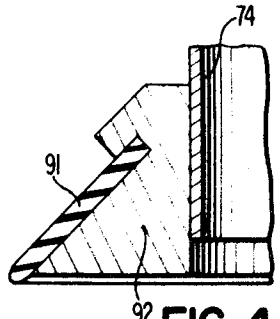


FIG. 4

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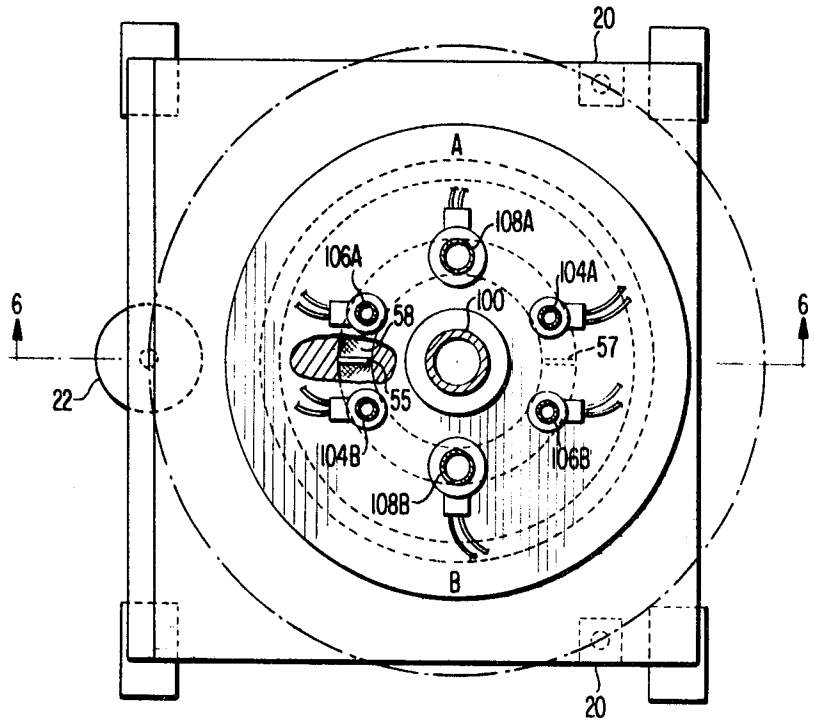
FIG. 5



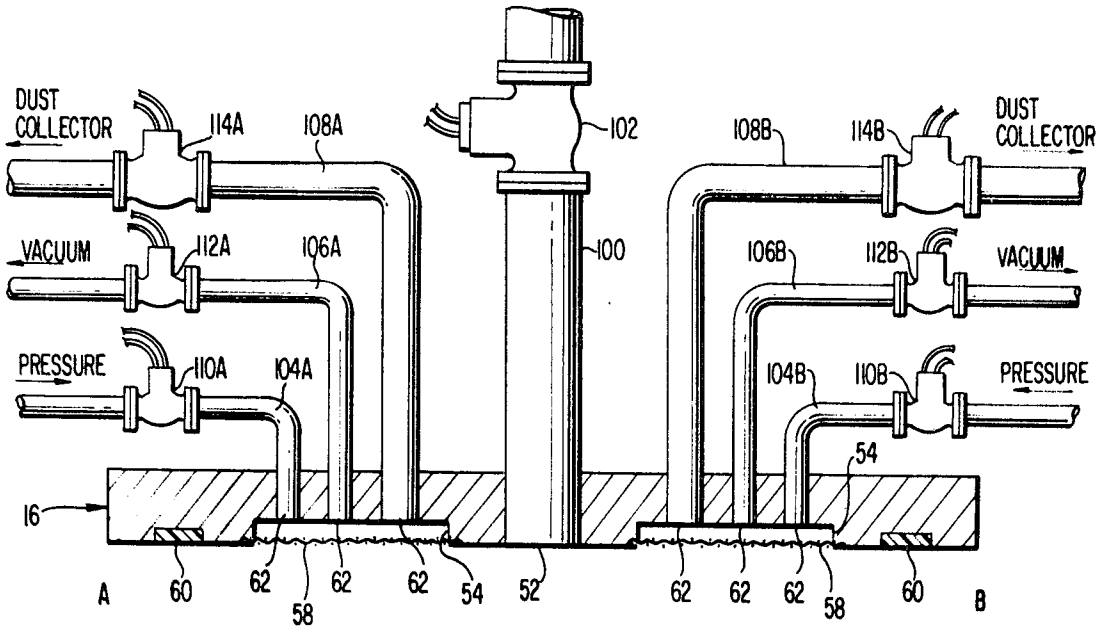


FIG. 6

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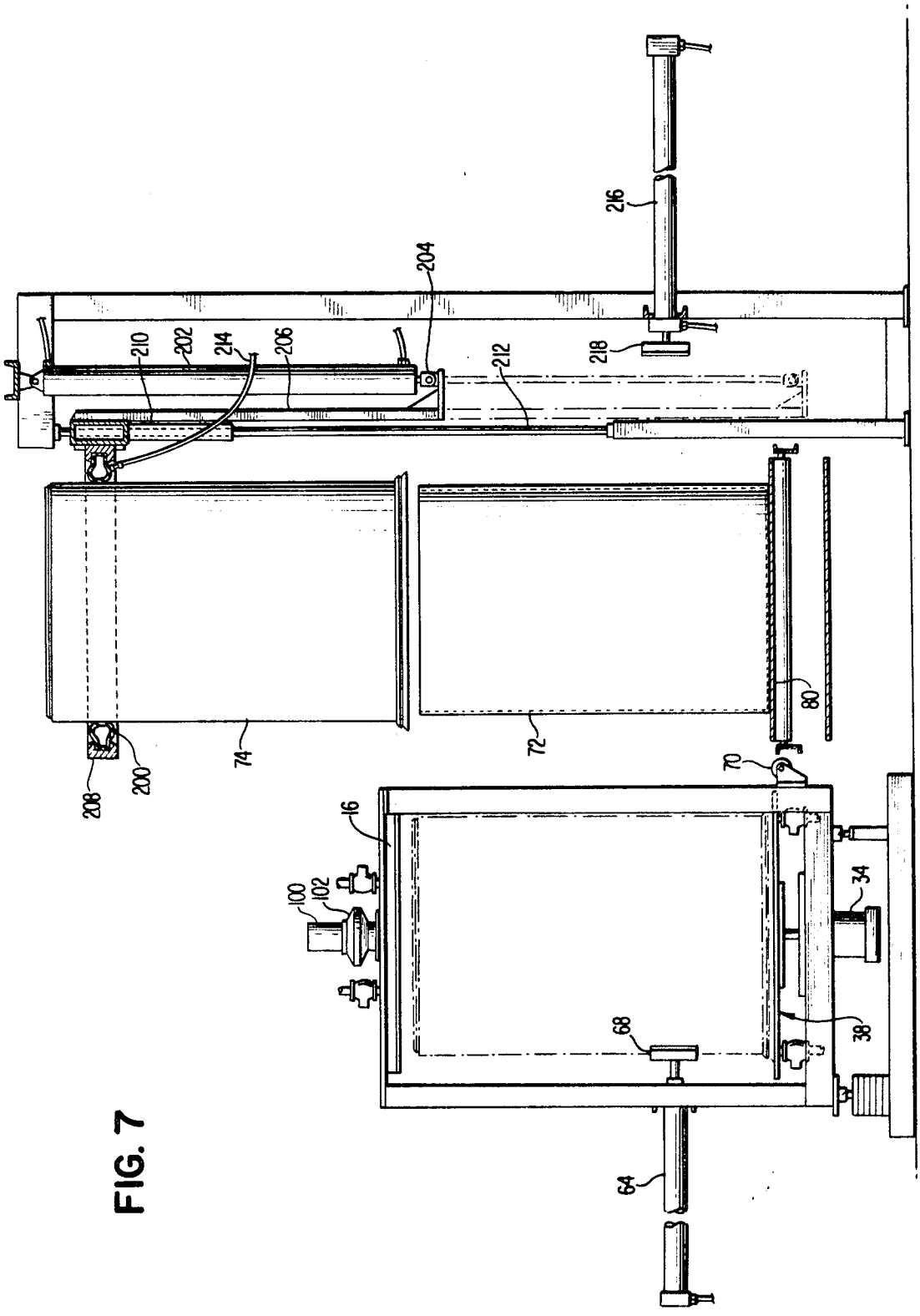

FIG. 7

United States Patent Office 3,605,826
Patented Sept. 20, 1971

3,605,826

METHOD AND APPARATUS FOR FILLING CONTAINERS

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Filed May 1, 1970, Ser. No. 33,775
Int. Cl. B65b 1/04, 3/04
U.S. Cl. 141—5 19 Claims

ABSTRACT OF THE DISCLOSURE

The disclosure relates to a method and apparatus for filling containers with particulate material by at least partially surrounding the container with a shroud which sealingly engages the container to provide a barrier between the shroud and the mouth of the container. The container is loaded into a container filling zone, filled, and unloaded from the container filling zone with the barrier between the shroud and the container, thereby preventing contamination of the shroud interior and the container exterior. A dust collecting system is operable to prevent contamination by particle dust and particulate material while loading and unloading containers into and out of the filling zone.

BACKGROUND OF THE INVENTION

The present invention relates to a method and apparatus for filling containers with particulate material and more specifically relates to a method and apparatus for filling all types and sizes of containers with particulate material utilizing vacuum filling techniques.

The filling of containers with finely divided particulate material utilizing vacuum filling techniques presents a number of problems. Among the more serious problems encountered are the contamination of the air in the area by particle dust and the accumulation of particulate material on the filling apparatus and containers. Such contamination affects the equipment reliability, the container appearance and the health of those operating the equipment, particularly when filling containers with toxic materials.

Contamination may occur if the seal between the container and the filling apparatus or "head" is broken while particulate material is being dispensed, particularly when a vacuum exists around the exterior of the container and is greater than a vacuum in the interior of the container as is sometimes the case. Contamination may also occur because of inadequate sealing between the container and the filling head which may be caused by slight dents in the lip of the open mouth of the container.

An additional problem encountered in the vacuum filling of containers is the buckling of containers due to the axial load to which the container must be subjected to prevent the seal between the container and the filling head from breaking while filling the container. This is a particular problem where "back flushing" is used to clean the screens in the filling head as in the United States Carter Patent 2,815,621. The fluctuations in pressure within the container interior, caused by back flushing the screens, tend to break the seal between the container and the filling head which, if allowed to occur, would cause a loss of material as well as contamination of the exterior of the container and the interior of the shroud. To prevent the breaking of this seal and the resultant contamination, the container walls must be subjected to substantial axial loading, sometimes resulting in the buckling of the container walls.

It is therefore an object of the present invention to provide a novel method and apparatus for filling containers with particulate material with a minimum of contamination thereby resulting in a cleaner, more efficient filling operation.

It is a further object of the present invention to provide a novel method and apparatus for filling containers with particulate material with a minimal loss of material.

It is another object of the present invention to provide a novel method and apparatus for preventing the escape of particle dust into the air into the vicinity of the apparatus while loading and unloading containers.

It is yet another object of the present invention to provide a novel method and apparatus for filling slightly damaged containers with particulate material, without the loss of material and the contamination of the area and the equipment.

It is still a further object of the present invention to provide a novel method and apparatus for filling containers wherein improved airtight seals may be easily provided.

It is yet a further object of the present invention to provide a novel method and apparatus for filling containers with particulate material which minimize the buckling of the container during the filling operation.

It is still another object of the present invention to provide a novel method and apparatus for filling containers of a variety of types and sizes, including solid and flexible walled containers, with particulate material.

These and other objects and advantages of the present invention will become apparent from a perusal of the detailed description read in conjunction with the accompanying drawings.

SUMMARY OF THE INVENTION

A first significant method aspect of the present invention involves at least partially surrounding a container with a shroud which cooperates with the container to provide a barrier between the shroud and the open mouth of the container, moving the shroud, while retaining the surrounding relationship and the barrier between the shroud and the container into sealing engagement with a filling head, filling the container with particulate material and, while retaining the surrounding relationship and the barrier between the shroud and the container, removing the shroud and the container from engagement from the filling head.

Another significant aspect of the present invention is the provision of a novel combination of apparatus means to accomplish, in coordinated relation, the various steps of the first method above described.

A second significant method aspect of the present invention involves at least partially surrounding the exterior periphery of a container with a generally open-ended shroud having a member at one end thereof to sealingly engage the open mouth of the container thereby providing a barrier between the shroud and the open mouth of the container, moving the shroud and container into a container filling zone, moving the shroud into sealing engagement with the filling head while retaining the surrounding relationship and the sealing engagement between the shroud and the container, filling the container with particulate material, removing the shroud and container from the container filling zone, and removing the shroud from surrounding relationship and sealing engagement with the container.

A further significant aspect of the present invention is the provision of a novel combination of apparatus means to accomplish, in coordinated relation, the various steps of the second method above described.

A third significant method aspect of the present invention involves creating a vacuum in the interior of a container filling zone through a screen means and admitting particulate material into the interior of the container, intermittently admitting a limited quantity of air through

the screen means into the interior of the container to clean the screen means, interrupting the creation of the vacuum in the container interior, admitting air into the container through the screen means until the interior of the container is at atmospheric pressure, interrupting the admission of air through the screen means, and, while unloading the container from the container filling zone and while loading a different container into the container filling zone, applying a relatively low vacuum to the screen means to remove particle dust from the container filling zone and to hold accumulated particulate material on the screen means.

A further aspect of the present invention is the provision of a novel combination of apparatus means to accomplish, in coordinated relation, the various steps of the third method above described.

A fourth significant method aspect of the present invention involves various novel combinations, in coordinated relation, of the steps of the methods previously described.

Yet another significant aspect of the present invention is the provision of a novel combination of apparatus means to accomplish, in coordinated relation, the various steps of the novel combinations of the methods above described.

THE DRAWINGS

FIG. 1 is an elevation in partial section of the container filling apparatus of the present invention showing a shroud and a container in the filling position;

FIG. 2 is an enlarged view of a portion of the top of the shroud in the apparatus of FIG. 1;

FIG. 3 is an enlarged view of a portion of the top of the shroud in the apparatus of FIG. 1 shown in surrounding relationship and sealing engagement with a container and in sealing engagement with a filling head;

FIG. 4 is an enlarged view of a portion of the bottom of the shroud in the apparatus of FIG. 1;

FIG. 5 is a plan view of the filling apparatus of FIG. 1;

FIG. 6 is a schematic representation of an elevation of the filling head utilized in the apparatus of FIG. 1; and,

FIG. 7 is an elevation of a container filling system employing the container filling apparatus of FIG. 1 and operable in accordance with the methods of the present invention.

DETAILED DESCRIPTION

Filling apparatus

Referring now to the drawings, and specifically to FIG. 1, the filling apparatus of the present invention comprises a support frame **1** having a plurality of vertical members **10** which are interconnected by a plurality of transverse members **12** at the lower ends thereof. At the upper ends of the vertical members **10**, a support plate **14** is provided to interconnect the upper ends of the vertical members **10** and to provide a support for a filling head **16**.

The support frame is preferably mounted on a weight responsive base comprising a horizontally disposed frame **18** having two vertically disposed frame support members **20** and a vertically disposed weight responsive element **22**. The frame support members **20** preferably include a vertical beam **24** at the top of which is provided a solid cylindrical member **26**, the upper end of which is semi-spherical in shape. The weight responsive element **22** may comprise a conventional load cell having a load receiving member **28** which supports the load and causes the load cell to produce an output signal proportional to the weight of the load applied thereto. The end of the load receiving member **28** is likewise semi-spherical in shape.

Three pads **30** are provided on the underside of the transverse members **12** to pivotally engage the ends of the cylindrical members **26** and the load receiving member **28**. Each of the pads **30** is provided with a semi-spherical depression **32** to receive the similarly shaped ends of the cylindrical member **26** and the load receiving member **28**. The entire filling apparatus is thus supported on a three point, ball-in-socket type suspension, thus allowing non-restricted pivotal movement of the apparatus as the load cell is depressed in response to an increase in weight during filling.

Further, as illustrated in FIG. 5, the three pivot points provided by the frame support members **20** and the weight responsive element **22** are radially equidistant from a vertical line passing through the approximate center of gravity of a loaded container filling apparatus, i.e. the container filling apparatus with a container positioned for filling as shown in FIG. 1. Due to the relatinship, approximately one third of the total weight of the apparatus is felt at the load receiving member **28** of the weight responsive element or load cell **22**.

Referring once again to FIG. 1, an air cylinder **34**, supported by the transverse members **12**, is connected by way of a piston rod **36** to a substantially flat, horizontally disposed support member or platform **38** which is free to reciprocate vertically in response to the application of air pressure to the cylinder **34**.

A vacuum conduit **40** and a pressurized air conduit **42**, connected to the underside of the platform **38**, communicate, by way of openings **44** and **46**, respectively, with the upper side of the platform **38**. The conduits **40** and **42** are connected, respectively, to a suitable means for creating a vacuum, e.g. a vacuum pump, and a suitable supply of air pressure, e.g. the atmosphere (not shown). Suitable remotely controlled valves **48** and **50** are provided in the conduits **40** and **42** respectively to control the flow of air therethrough in response to appropriate control signals.

The filling head **16** is mounted above the platform **38** and preferably includes a generally flat, circular plate **51** having a centrally disposed opening **52** extending axially therethrough, i.e. along the axis of the plate **51** normal to the surface thereof, and first and second annular concentric grooves **54** and **56**, respectively, disposed in the underside of the plate **51**. An annular screen **58**, generally parallel to the lower surface of the plate, is secured across the first annular groove **54** in a suitable, conventional manner. Disposed in the second annular groove **56** is a generally flat annular sealing gasket **60**, the outer surface of which is generally parallel to and flush with the lower surface of the plate **51**.

The annular screen **58** may be any suitable screen which permits the passage of air while preventing the passage of particulate materials. Such screens are entirely conventional and are well known in the art to which the present invention relates.

The sealing gasket **60** preferably has a sponge rubber base **60A** covered by a relatively thin layer of gum rubber **60B** on the outwardly facing surface thereof, as illustrated in FIG. 3. This arrangement provides the necessary resilience as well as a durable sealing surface. Additionally, the sealing gasket **60** preferably provides a sufficiently wide sealing surface in the underside of the filling head **16** to accommodate a wide range of shroud and therefore container sizes.

A plurality of openings **62** are provided through the plate **51** of the filling head **16** to provide communication between the upper surface of the plate **51** and the first annular groove **54**. Each opening **62** is connected to an associated conduit which will hereinafter be described in connection with the operation of the filling head **16**. In addition, since the openings **62** communicate with the first annular groove **54** which is covered by the annular screen **58**, the openings **62** will hereinafter be referred to as screened openings.

It should be understood that the filling head **16** as described above is a preferred embodiment of the filling head of the present invention and is adapted to be used in connection with the filling of generally cylindrical con-

tainers. The head and groove shapes may, of course, be varied to allow the filling of other container shapes without departing from the spirit of the present invention.

As illustrated in FIG. 1, the filling apparatus also includes an air cylinder **64** connected to a transverse brace **66** and having a curved plate **68** connected to the piston rod thereof. The cylinder **64** is mounted so that the direction of the stroke of the piston is substantially perpendicular to the vertical axis of the filling apparatus. On the opposite side of the filling apparatus, a horizontally disposed roller **70** is provided to facilitate the loading and unloading of the filling apparatus.

Referring now to FIGS. 1 through 4, a container **72**, surrounded by and in sealing engagement with a shroud **74**, as will hereinafter be described, may be positioned within the filling apparatus in a filling zone generally defined by the filling head **16**, the platform **38** and the vertical member **10**, as illustrated.

The shroud **74** is preferably a substantially open-ended cylinder, having a slightly larger diameter than the container **72** and generally conforming in shape to the shape of the exterior periphery of the container **72**. The shape of the shroud may, of course, be varied to permit the filling of a variety of container shapes without departing from the spirit of the present invention.

An inner sealing member **76**, preferably carried by the shroud **74**, is provided between the interior periphery of the upper end of the shroud **74** and a peripherally extending edge **78** defining an open mouth of the container **72**.

As shown in FIG. 3, the inner sealing member **76** is operable to resiliently deform so as to conform to the shape of the peripherally extending edge **78** and is thus adapted to engage the edge **78** of the container **72** to provide a substantially airtight seal between the top of the shroud **74** and the edge **78** defining the open mouth of the container **72**. This seal provides a barrier between the upper portion of the shroud **74** and the edge **78** of the container **72**, thereby preventing the contamination of the interior of the shroud and the exterior of the container by particulate material.

As will subsequently be described, the shroud **74** and the container **72** are loaded together into the filling zone, while in surrounding relationship and sealing engagement, from a conveyor **80** adjacent the platform **38** of the container filling apparatus. Since the shroud **74** and the container **72** remain in surrounding relationship and sealing engagement during the filling of the container **72** and during the unloading of the shroud **74** and the filled container **72** from the filling zone onto the conveyor **80** after the filling operation, the protective barrier formed by the inner sealing member **76** is operable to prevent the contamination of the interior of the shroud **74** and the exterior of the container **72** while loading, filling, and unloading the container **72**. The importance of the prevention of contamination is quite apparent from the standpoint of appearance of the container **72** after filling and the continued efficient operation of the filling apparatus. However, it becomes extremely important to prevent such contamination when handling particulate materials which are toxic.

While the inner sealing member **76** could be provided on the edge **78** of the container **72**, the inner sealing member **76** is preferably carried by the shroud **74**, as previously described and as illustrated in FIGS. 2 and 3. This arrangement allows the filling apparatus of the present invention to be utilized with commercially available containers.

Referring now to FIGS. 2 and 3, the preferred inner sealing member **76** comprises an annular ring-like member **82** connected to the interior of the shroud **74** to form an inwardly projecting shoulder around the interior periphery of the top of the shroud **74**. As illustrated, the uppermost portion of the annular ring-like member **82** is provided with a sharp corner or edge **84** to provide an airtight seal when the shroud **74** is raised to the filling position and the ring-like member **82** engages the sealing gasket **60** in the filling head **16**. An annular, resilient inner sealing gasket **86**, operable to deform from the flat face configuration of FIG. 2 to conform to the shape of the edge **78** defining the open mouth of the container **72** as shown in FIG. 3, is carried by the ring-like member **82** in an annular groove **88** in the lower surface thereof. The inner sealing gasket **86** is preferably made of soft sponge rubber to permit vertical movement of the container **72** without causing excessive stress in the walls thereof, and to make allowance for slight variations in container height. As illustrated in FIG. 3, the inner sealing gasket **86** also provides a seal which extends around the sides of the edge **78** to protect against air leaks between the interior and exterior of the container **72** due to the irregular shape or damage to the top of the edge **78** defining the open mouth of the container **72**.

Referring now to FIGS. 1 and 4, the shroud **74**, in surrounding relationship with the container **72** and in sealing engagement with the edge **78** defining the open mouth thereof, is carried by the platform **38** while filling the container **72**. Since a vacuum must be created in the space between the interior of the shroud **74** and the exterior of the container **72** to prevent the inward collapse of the wall of the container **72** when a vacuum is created in the interior of the container **72** during the filling operation, an outer sealing member **90** is provided between the bottom of the shroud **74** and the upper surface of the platform **38**. The outer sealing member **90** cooperates with the inner sealing member **76** to provide a substantially airtight chamber between the interior periphery of the shroud **74** and the exterior periphery of the container **72** as illustrated in FIG. 1.

The outer sealing member **90** may be carried by either the platform **38** or the shroud **74**. However, in the preferred embodiment of the present invention, the outer sealing member **90** is carried by the shroud **74** and comprises a resilient outer sealing gasket **91** carried by a flange **92** on the bottom exterior periphery of the shroud **74**. The outer sealing gasket **91** extends slightly below the flange **92** and is angled outwardly and downwardly from the wall of the shroud **74** to provide airtight engagement with the platform **38**. In addition, the portion of the outer sealing gasket **91** abutting the platform **38** may be rounded as illustrated to prevent the outer sealing gasket **91** from scuffing against obstacles which may be encountered during the loading and unloading of containers.

Filling head

As previously described in connection with FIG. 1, the filling head **16** is provided with a centrally disposed opening **52** providing communication between the top and the underside of the filling head **16**, and a plurality of openings **62** providing communication between the top of the filling head and the first annular groove **54** in the bottom surface of the filling head **16**.

Referring now to FIGS. 5 and 6, the filling head **16** may be a split filling head of the type disclosed in U.S. Patent No. 2,954,203, assigned to the assignee of the present invention and may be divided into two substantially identical halves A and B along a line **6—6** for the purpose of description. Screen frame members **55** and **57** extending between the screen **58** and an inner surface **59** of the groove **54** may be provided across the groove **54** to divide the groove **54** into two separate compartments, one in each half of the filling head **16**. A material supply conduit **100**, in fluid communication with the opening **52** which is common to both the A and B halves of the filling head **16**, is connected to a supply of particulate material. A suitable valve **102** is provided in the material supply conduit **100** to control the flow of particulate material through the conduit. The valve **102** may be any commercially available valve suitable for controlling the flow

of particulate material in response to electrical, pneumatic or hydraulic signals.

As shown in FIG. 6, pressure conduits **104**A and **104**B vacuum conduits **106**A and **106**B and dust collector conduits **108**A and **108**B, each in fluid communication with an associated one of the screened openings **62** in the respective halves of the filling head **16**, are provided. The pressure conduits **104**A and **104**B may be connected to a suitable source of pressure, e.g. atmospheric pressure, the vacuum conduits **106**A and **106**B may be connected to a conventional means for creating a vacuum, e.g. a vacuum pump, and the dust collector conduits **108**A and **108**B may be connected to a conventional dust collector such as a cyclone dust collector or other low vacuum source. Flow through each of the conduits **104**A through **108**A and **104**B through **108**B may be selectively controlled by suitable conventional valves **110**A through **114**A and **110**B through **114**B, respectively, although it should be noted that flow through the dust collector conduits **108**A and **108**B may be controlled by a single valve since flow through both dust collector conduits **108**A and **108**B will be initiated and interrupted simultaneously during a filling operation.

Overall filling system

Before describing the cycling sequence of the control valves associated with the filling head **16**, the overall container filling system will be generally described in connection with FIG. 7, wherein the same numbers have been given to previously described elements.

Referring now to FIG. 7, the container filling apparatus is illustrated with the platform **38** in the "down" position, ready to be loaded with a container **72** for filling, as shown in phantom. However, prior to moving a container onto the platform **38**, a shroud **74** must be moved into surrounding relationship and sealing engagement with the container **72**. This may be accomplished either manually or automatically by a hoist or other lifting device capable of moving the shroud **74** along a vertical path with substantial accuracy.

The preferred device for accomplishing this movement is illustrated in FIG. 7 and comprises an inflatable member **200** generally conforming to the shape of the outer periphery of the shroud **74** and an air cylinder **202**, the piston rod **204** of which is connected through a suitable linkage **206** and a guide member **208** to a retaining member **210** to which the inflatable member **200** is secured.

The guide member **210** slidably engages a vertically disposed rod **212**, secured to a suitable framework, and is driven by the air cylinder **202** along a vertical path defined by the rod **212**. An air line **214** provides communication between a high pressure air source (not shown) and the inflatable member **200**. The application of high pressure air to the inflatable member **200** may be controlled either manually or automatically by a suitable conventional valve (not shown) to thereby selectively control the clamping of the shroud **74** by the inflatable member **200**.

In operation, air pressure may be continuously applied, by way of the air line **214**, to the inflatable member **200** to provide continuous clamping of the shroud **74** when the hoist is in the "up" position. When the container **72** is in position, the air cylinder **202** may be manually or automatically actuated to lower the shroud **74** over the container **72**. The air pressure applied to the inflatable member **200** may then be released to thereby release the shroud, and the air cylinder **202** may be actuated to raise the hoist from the vicinity of the shroud.

After the container **72** has been filled and the container **72** and shroud **74** are again on the conveyor **80**, the inflatable member **200** may be lowered over the shroud **74** by actuating the air cylinder **202**. The inflatable member **200** may then be inflated to clamp the shroud exterior, and the shroud **74** may be raised from surrounding relationship and sealing engagement with the container **72** by actuating the air cylinder **202**.

Other mechanically or electromagnetically operated hoists may be utilized to provide a means for moving the shroud **74** into and out of surrounding relationship and sealing engagement with the container **72**. However, the preferred lifting device will accommodate shrouds of various sizes since the inflatable member **200** can be expanded and contracted over a considerable range, thereby providing flexibility in the container sizes which may be accommodated utilizing the filling system of the present invention.

Operation

The operation of the filling system of the present invention will be described in connection with FIGS. 1 and 5 through 7. Referring first to FIG. 7, the container **72** is conveyed to a predetermined position adjacent the filling apparatus and beneath the shroud **74**. The air cylinder **202** is actuated to lower the shroud into surrounding relationship with the container **72** and also into sealing engagement with the edge **78** defining the open mouth of the container **72** as illustrated in FIG. 1.

Suitable, conventional inwardly biased guides **81** may be provided in at least three places around the interior periphery of the shroud **74** to insure proper engagement between the edge **78** of the container **72** and the inner sealing member **76** when the shroud **74** is lowered. For example, as illustrated in FIG. 3, three spring biased buttons **83** connected to the interior periphery of the shroud **74** at approximately 120° intervals may be provided. These guides tend to center the container **72** within the shroud **74** thereby insuring proper engagement.

The air pressure applied to the inflatable member **200** is released and the cylinder **202** is actuated to remove the hoist from the vicinity of the shroud **74**. The curved plate **68** connected to the air cylinder **64** may then be extended into contact with the exterior surface of the shroud **74** and coupled thereto, utilizing a vacuum or other suitable coupling means. The shroud **74**, while in surrounding relationship and in sealing engagement with the container **72**, may then be pulled onto the platform **38**, as illustrated in phantom, through retraction of the piston of the cylinder **64**.

Alternatively, an air cylinder **216**, having a curved, piston rod carried plate **218** generally conforming to the shape of the exterior periphery of the shroud **74**, may be utilized to push the shroud and container onto the platform **38**. The roller **70**, the surface of which preferably extends slightly above the surface of the conveyor **80** and the surface of the platform **38**, aids in transferring the shroud and container from the conveyor **80** onto the platform **38**.

When the shroud and container are positioned within the container filling zone on the platform **38**, the coupling force between the curved plate **68** and the shroud **74** is released, and the air cylinder **34** is actuated to raise the shroud **74**, surrounding the container **72**, into sealing engagement with the sealing gasket **60** in the filling head **16** as previously described. The air cylinder **34** applies a continuously upward bias to the shroud **74** to ensure proper sealing between the shroud **74** and the filling head **16**. Since the shroud **74** is interposed between the platform **38** and the filling head **16** and the container **72** is interposed between the resilient, sponge rubber inner sealing gasket **86** and the platform **38**, the shroud **74** accepts substantially all of the axial stress produced between the platform **38** and the filling head **16**.

After the shroud **74** is sealed against the filling head **16**, the dust collector valves **114**A and **114**B, which are open from the previous filling cycle, are closed, and a vacuum is created in the container **72** by opening the valve **112**A and in the space between the interior periphery of the shroud **74** and the exterior periphery of the container **72** by opening the valve **48** in the vacuum conduit **40** beneath the platform **38**.

When the vacuum in and around the container **72** has reached a predetermined value, preferably between 10 and 25 inches of mercury, the fill valve **102** in the material supply conduit **100** opens for a predetermined and controlled period, and a first predetermined amount of particulate material is dispensed into the container **72**. The vacuum valve **112A** closes and the vacuum valve **112B** opens. The pressure valve **110A** then opens for a period of time sufficient to drop the vacuum in the container interior about 5 to 10 inches of mercury, thereby causing a flow of air into the container through the screen **58** on the A side of the filling head **16**, removing particulate material which has accumulated thereon. This momentary flow of air through the screen **58** for cleaning purposes is preferably always insufficient to drop the vacuum in the container **72** to zero vacuum, i.e. at atmospheric pressure.

After the pressure valve **110A** has been closed for a sufficient time to permit recovery of the vacuum in the container interior to the predetermined value between 10 and 25 inches of mercury, the fill valve **102** is again opened to dispense a predetermined amount of material into the container **72**. When the first predetermined amount of material has been dispensed, the fill valve **102** is again closed as is the vacuum valve **112B**. The vacuum valve **112A** is then opened and the pressure valve **110B** is opened long enough to drop the vacuum in the container about 5 to 10 inches of mercury to clean the screen **58** on the B side of the head in the manner previously described.

This alternate operation of the A and B sides of the head **16** is continued until a predetermined weight of material, as determined by the weight responsive element or load cell **22**, has been dispensed, at which time all valves are closed. The pressure valves **110A** and **110B** in the filling head **16** and the valve **50** in the pressure conduit **42** beneath the platform **38** are opened to relieve the vacuum in and around the container **72**. The cylinder **34** is actuated to lower the shroud **74** and the container **72** and, just as the seal between the shroud **74** and the filling head **16** is broken, the pressure valves **110A** and **110B** and the pressure valve **50** are closed and the dust collector valves **114A** and **114B** in the dust collector conduits **108A** and **108B** are opened providing a relatively low suction in the vicinity of the underside of the filling head **16** and the top of the container **72** and the shroud **74**. Since the pressure valves **110A** and **110B** are closed to prevent the flow of air through the pressure conduits **104A** and **104B**, the suction tends to collect any dust in the air exteriorly of the groove **54** and tends to either hold the dust against the screen **58** or transmit the dust to a suitable conventional dust collector. The suction additionally prevents material which has accumulated on the screen **58** during the filling operation from dropping onto the platform **38** and into the filling zone when the shroud **74** and container **72** are removed therefrom.

When the platform **38** reaches the "down" position, the air cylinder **64** is actuated and the shroud, still in surrounding relationship and in sealing engagement with the container **72**, is pushed onto the conveyor **80**. The inflatable member **200** is then lowered over the shroud **74** and is inflated to engage the exterior periphery of the shroud **74**. The shroud is then raised clear of the container **72** and the conveyor **80** transports the full container away while simultaneously transporting an empty container to the predetermined position adjacent the filling apparatus and beneath the shroud **74**.

The dust collector valves **114A** and **114B** remain open until a container and shroud have been moved into the filling apparatus and have been raised into sealing engagement with the filling head **16**. These valves are then closed prior to the commencement of the creation of a vacuum in the space in and around the container **72**. Thus, any material which has been held against the screen **58** by the flow of air through the dust collector conduits **108A** and **108B** is retained against the screen **58** at all times during the loading and unloading of the filling apparatus and is allowed to drop until the shroud **74** is sealed against the filling head **16**. In addition, the suction created by the dust collector aids the cylinder **34** in sealing the shroud **74** against the filling head **16** thereby permitting the use of a smaller cylinder **34** than would otherwise be required.

In summary, the sequence for filling containers with the system of the present invention is as follows:

Sequence

(1) Convey an empty container **72** to a predetermined position adjacent the filling apparatus and beneath the shroud **74**;
(2) Lower the shroud **74** into surrounding relationship and sealing engagement with the container **72**;
(3) Push (or pull) the shroud **74** surrounding the container **72** onto the platform **38** of the filling apparatus;
(4) Raise the platform **38** until the top of the shroud **74** is in sealing engagement with the filling head **16**;
(5) Open the vacuum valve **112A** in the filling head **16** and the vacuum valve **48** in the platform **38** to create a vacuum of between 10 and 25 inches Hg in the interior of the container **72** by drawing air out of the container through the screen **58** and in the space between the shroud and the container by drawing air through the opening **44** in the platform **38**;
(6) Open the material supply valve **102** in the filling head **16** to admit particulate material into the container **72**;
(7) Interrupt the material supply after a first predetermined amount of material has been dispensed;
(8) Close the vacuum valve **112A** and open the vacuum valve **112B** in the filling head **16**;
(9) Open a pressure valve **110A** in the filling head to admit a limited quantity of air, insufficient to drop the vacuum in the container interior to zero, into the container interior through the screen **58** to clean material off the screen;
(10) Repeat steps (6) through (9) alternating from the A to the B side of the filling head **16** until a predetermined total amount of material has been dispensed;
(11) Close the vacuum valves **112** and **48** in the filling head **16** and in the platform **38**, respectively
(12) Open the pressure valve **110A** or **110B** in the filling head and the pressure valve **50** in the platform **38** to admit air into the container interior and into the space between the shroud **74** and the container **72** to relieve the vacuum in and around the container;
(13) Break the seal between the shroud **74** and the filling head **16**;
(14) Close the pressure valves **110** and **50** in the filling head and in the platform respectively and open the dust collector valves **114A** and **114B** in the filling head **16** just as the seal between the shroud **74** and the filling head **16** is broken to collect dust and to hold material against the screen **58**;
(15) Push (or pull) the shroud **74** still surrounding the full container **72** onto the conveyor belt **80**;
(16) Raise the shroud **74** from surrounding relationship and sealing engagement with the container **72**;
(17) Convey the full container **72** away from the filling apparatus while simultaneously conveying an empty container **72** to the position adjacent the filling apparatus;
(18) Lower the shroud **74** over the empty container **72**;
(19) Push (or pull) the shroud **74** and the container **72** onto the platform **38**;
(20) Raise the platform **38** to seal the shroud **74** against the filling head **16**;
(21) Close dust collector valves **114A** and **114B** and repeat steps (5)–(21), inclusive.

While the system of the present invention has been described in connection with the filling of solid-walled containers, such as pressed paper or plastic containers, without the use of an impervious bag liner, a liner may be inserted if desired. For example, after the shroud **74** has

been lowered into surrounding relationship and sealing engagement with the container **72**, an impervious bag liner may be inserted into the interior of the container **72** with the top of the liner drawn over the top edge of the shroud **74** as illustrated in phantom in FIG. 3. Air may be removed between the liner and the interior of the container **72** utilizing a system such as that described in the previously referenced United States patent. Additionally, the shape of the inner sealing member **76** may be altered in a manner well known in the art to prevent air leakage around the top of the shroud **74** when filling lined containers with the system of the present invention.

The present invention may also be employed to fill containers such as plastic bags without the use of a solid-walled container. As shown in phantom in FIG. 3, the bag may be inserted into the shroud **74** with the open mouth thereof drawn over the top edge of the sealing member **76**. The container **72** need not be utilized, in which case the bag may be filled in the same manner in which a solid container is filled. The previously described barrier between the shroud **74** and the container is provided, when filling bags, by the cooperation between the open mouth of the bag container and the edge **84** of the sealing member **76**.

It is apparent from the above description of the filling system of the present invention that the exterior of the container **72** and the interior of the shroud **74** are always shielded from contamination by particulate material during the loading, filling and unloading of the container **72**, resulting in a minimal loss of material and a cleaner more efficient and other improved container filling system. Contamination of the equipment and the space in the vicinity thereof is also prevented by the method and apparatus of the present invention.

It is further apparent that the present invention allows a great variety of types and sizes of containers to be filled, even where slight container irregularity or damage has occurred.

In addition, the present invention provides improved sealing with a minimum of container buckling in a relatively simple manner. The improved sealing is aided by suction created by the dust collector and by the vacuum between the shroud and the container during filling since both the suction and the vacuum tend to raise the upwardly biased platform **38** which in turn increases the sealing force between the shroud **74** and the filling head **16**. Container buckling is minimized since the shroud accepts most of the axial load between the platform **38** and the filling head **16**. Also, since the vacuum around the outside of the container is always equal or exceeds the vacuum in the interior of the container, inward container buckling due to pressure differentials is eliminated.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims, rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. Apparatus for filling open mouth containers with particulate material comprising:

a filling head;

a support member for carrying a container during a filling operation;

a substantially open-ended shroud carried by said support member and at least partially surrounding the exterior periphery of the container;

first sealing means carried by one of said shroud and the container;

second sealing means carried by one of said shroud and said support member;

said first sealing means cooperating with the container to provide a barrier between said shroud and the container to prevent the contamination of the interior of said shroud and the exterior of the container during filling, loading and unloading;

said first sealing means cooperating with said filling head to provide a substantially airtight seal between the exterior of said shroud and the interior of the container; and,

said first and second sealing means cooperating to provide a substantially airtight chamber between the interior of said shroud and the exterior periphery of the container.

2. The apparatus of claim **1** wherein said filling head comprises:

a generally flat plate having a centrally disposed aperture extending axially therethrough;

a first groove outwardly displaced from said aperture in one surface of said plate;

a plurality of openings communicating with said first groove from the other surface of said plate;

a screen disposed generally parallel to said one surface of said plate and extending across said groove; and,

in said one surface of said plate, a second groove substantially concentric with and outwardly displaced from said first groove, said second groove containing a resilient sealing member generally conforming to the shape of the top edge of said shroud.

3. The apparatus of claim **1** further comprising:

means carried by said filling head for creating a vacuum in the container; and

means carried by said support member for creating a vacuum in said substantially airtight chamber.

4. The apparatus of claim **1** wherein said first sealing means is carried by said shroud and includes:

a resilient gasket deformable to conform to the shape of the peripherally extending edge defining the open mouth of the container and to sealingly engage the top and the sides of said edge; and,

means for sealingly engaging said filling head.

5. The apparatus of claim **2** further including:

a material supply conduit in fluid communication with said centrally disposed aperture;

a vacuum conduit, a pressure conduit, and a dust collector conduit, each in fluid communication with an associated one of said plurality of openings; and,

means for selectively controlling flow through said conduits.

6. The apparatus of claim **4** including a resilient sealing member carried by said filling head and generally conforming to the shape of the top peripheral edge of said shroud, said sealing member being less resilient than said resilient gasket to allow said shroud to accept substantially all of the axial load produced between said support member and said filling head during a filling operation.

7. Apparatus for filling, with particulate material, containers having a peripherally extending edge defining an open mouth, the apparatus comprising:

a filling head;

a support member for carrying a container during a filling operation;

an open-ended shroud carried by said support member and surrounding the exterior periphery of the container;

first sealing means carried by one of said shroud and the container;

said first sealing means being operable to provide a barrier between said shroud and the peripherally extending edge of the container to prevent the contamination of the interior of said shroud and the exterior of the container by particulate material while filling, loading and unloading the container;

second sealing means carried by one of said shroud and said support member;

said first and second sealing means cooperating to pro-

vide a substantially airtight chamber between the interior of said shroud and the exterior periphery of the container; and ,

means for moving said shroud, while in surrounding relationship and sealing engagement with the container, into substantially airtight sealing engagement with said filling head.

8. The apparatus of claim **7** wherein said filling head comprises:

a generally flat plate having a centrally disposed aperture extending axially therethrough;

a first groove outwardly disposed from said aperture in one surface of said plate;

a plurality of openings communicating wth said first groove from the other surface of said plate;

a screen disposed generally parallel to said one surface of said plate and extending across said groove; and,

in said one surface of said plate, a second groove substantially concentric with and outwardly displaced from said first groove, said second groove containing a resilient sealing member generally conforming to the shape of the top edge of said shroud.

9. The apparatus of claim **7** further comprising:

means carried by said filling head for creating a vacuum in the container; and,

means carried by said support member for creating a vacuum in said substantially airtight chamber.

10. The apparatus of claim **7** wherein said first sealing means is carried by said shroud and includes:

a resilient gasket deformable to conform to the shape of the peripherally extending edge defining the open mouth of the container and to sealingly engage the top and the sides of said edge; and,

means for sealingly engaging said filling head.

11. The apparatus of claim **8** further including:

a material supply conduit in fluid communication with said centrally disposed aperture;

a vacuum conduit, a pressure conduit, and a dust collector conduit, each in fluid communication with an associated one of said plurality of openings; and

means for selectively controlling flow through said conduits.

12. The apparatus of claim **10** including a resilient sealing member carried by said filling head and generally conforming to the shape of the top peripheral edge of said shroud, said sealing member being less resilient than said resilient gasket to allow said shroud to accept substantially all of the axial load produced between said support member and said filling head during a filling operation.

13. Apparatus for filling with particulate material, containers having an upper portion defining an open mouth, the apparatus comprising:

filling means operable to transmit particulate material;

support means adapted to support a container beneath said filling means;

a substantially open-ended shroud adapted to at least partially surround the exterior periphery of the container, said shroud being adapted to be carried by said support means;

sealing means adapted to be connected between said shroud and an upper container portion defining an open mouth, said sealing means being operable to provide a barrier between said shroud and said container while filling, loading and unloading the container to prevent the contamination of the interior of said shroud and the exterior of the container by particulate material; and

means for raising said support means and said shroud, with said shroud being in at least partially surrounding relation to the exterior periphery of the container, to bring said container into filling cooperation with said filling means.

14. Apparatus for filling open mouth containers with particulate material comprising:

intermittently operable conveyor means for transporting a container to a predetermined position adjacent a filling apparatus;

a substantially open-ended shroud having a first resilient sealing means disposed around the interior periphery of one end thereof, and a second resilient sealing means disposed around the exterior periphery of the other end thereof, said shroud being operable to surround the exterior periphery of the container and said first sealing means being operable to provide a barrier between the interior periphery of said one end of said shroud and the edge of the open month of the container;

means for moving said shroud into surrounding and barrier providing relationship with the container;

means for moving said shroud, while in surrounding and barrier providing relationship with the container, onto a support member positioned beneath a filling head, said second sealing means cooperating with said support member and said first sealing means cooperating with said container to provide a substantially airtight chamber between said shroud and the container on the support member;

means for raising said shroud, while in surrounding and barrier providing relationship with the container, into airtight engagement with said filling head;

means carried by said support member for creating a vacuum in the space between said shroud and the container;

means carried by said filling head for creating a vacuum in the container;

means for filling the container with a predetermined amount of particulate material; and,

means for moving said shroud while in surrounding and barrier providing relationship with the container, onto said conveyor means after the container has been filled.

15. The apparatus of claim **14** wherein said filling head includes:

a centrally disposed material supply conduit;

a screened vacuum conduit;

a screened pressure conduit;

a screened dust collector conduit;

said conduits communicating with a filling zone beneath said filling head;

said screened conduits being radially displaced from said supply conduit; and,

means for selectively controlling flow through said conduits.

16. In a method of filling open mouth containers with particulate material within a vacuum filling apparatus including a filling head and a container filling zone between a support member and the filling head, the steps of:

(a) surrounding at least a portion of the exterior periphery of a container with a generally open-ended shroud having a member at one end thereof to sealingly engage the open mouth of the container thereby providing a barrier between the shroud and the open mouth of the container.

(b) moving the shroud, while in at least partially surrounding relationship and in sealing engagement with the container, into a container filling zone;

(c) moving the shroud, while in at least partially surrounding relationship and in sealing engagement with the container, into engagement with the filling head;

(d) filling the container with particulate material;

(e) removing the shroud, while in at least partially surrounding relationship and in sealing engagement with the container, from the container filling zone; and,

(f) removing the shroud from at least partially surrounding relationship and sealing engagement with the container.

17. The method of claim **16** wherein the step of filling the container with particulate material includes the step of: creating a vacuum in the interior of the container

and in the space between the container and the shroud to increase the effectiveness of the engagement between the filling head and the shroud and to allow the container to be filled by a vacuum filling technique without buckling the container walls.

18. The method of claim **16** wherein the step of removing the shroud, while in surrounding relationship and in sealing engagement with the container, from the container filling zone includes the steps of:

(1) breaking the engagement between the shroud and the filling head; and,

(2) immediately creating a flow of air through the filling zone to collect dust in the filling zone and to prevent particulate material from contaminating the filling apparatus while unloading the container from the filling zone and while loading a different container into the filling zone.

19. In a method of filling open mouth containers with particulate material within a vacuum filling apparatus including a support member for carrying containers during the filling operation disposed beneath a vacuum filling head, the steps of:

(a) positioning a generally open-ended shroud in surrounding relationship with the exterior periphery of an empty container and in sealing engagement with the open mouth of the container to provide a barrier between the shroud and the open mouth of the container;

(b) moving the shroud, while in surrounding relationship and in sealing engagement with the container, onto the support member;

(c) raising the support member, while in surrounding and sealing engagement with the container, until the shroud is in airtight sealing engagement with the filling head;

(d) creating a vacuum in both the container interior and a chamber defined by the interior periphery of the shroud and at least a portion of the exterior periphery of the container;

(e) admitting particulate material into the container while continuously maintaining the vacuum in the container and the chamber;

(f) interrupting the flow of material into the container when a predetermined amount of material has been dispensed;

(g) admitting a limited quantity of air into the container, the quantity of air being insufficient to increase the pressure in the container to atmospheric;

(h) repeating steps (e) through (g) until a predetermined amount of material has been dispensed;

(i) opening a valve in the filling head to entirely relieve the vacuum in the container interior and the chamber;

(j) closing the valve in the filling head;

(k) lowering the support member to break the seal between the shroud and the fililng head;

(l) creating a suction in the vicinity of the open mouth of the container and the underside of the filling head to collect dust created during the filling operation;

(m) removing the shroud, while in surrounding relaship and in sealing engagement with the container, from the support member onto the conveyor; and,

(n) removing the shroud from surrounding relationship and sealing engagement with the container.

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U.S. Cl. X.R.

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