May 31, 1966 H. N. K. PATON 3,253,750

GAS-FLUIDIZING CONTAINER-EMPTYING CAP

Original Filed March 23, 1962 2 Sheets-Sheet 1

Fig. 1.

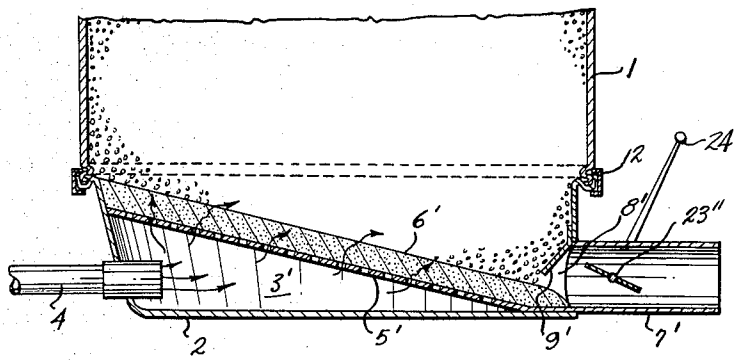


Fig. 2.

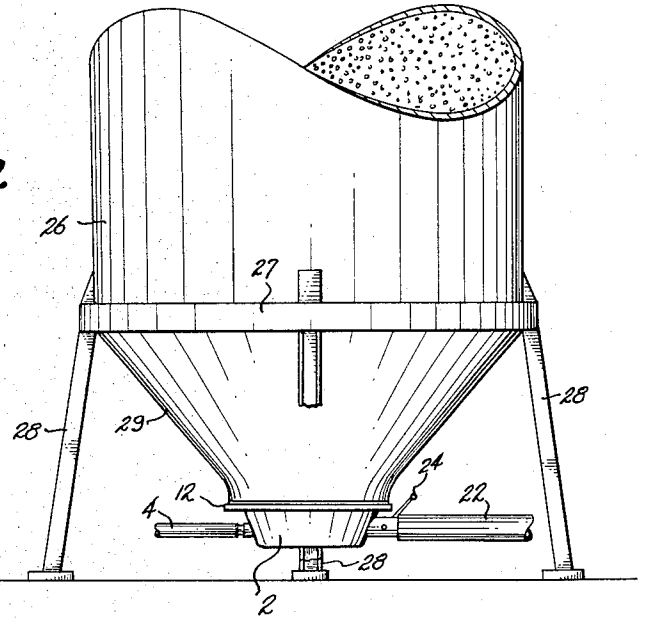
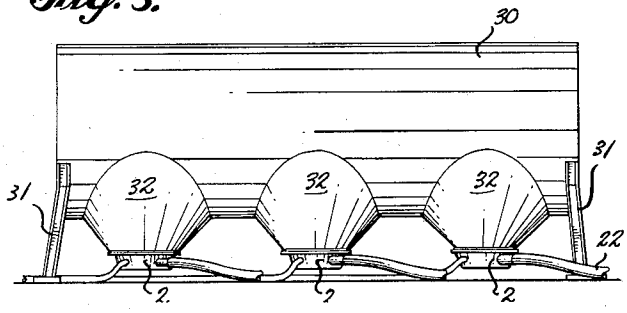


Fig. 3.



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Fig. 5.

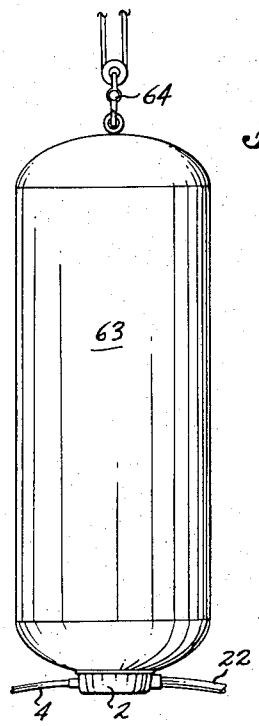


Fig. 4.

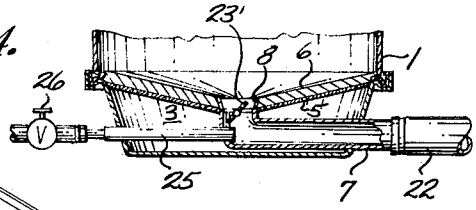


Fig. 6.

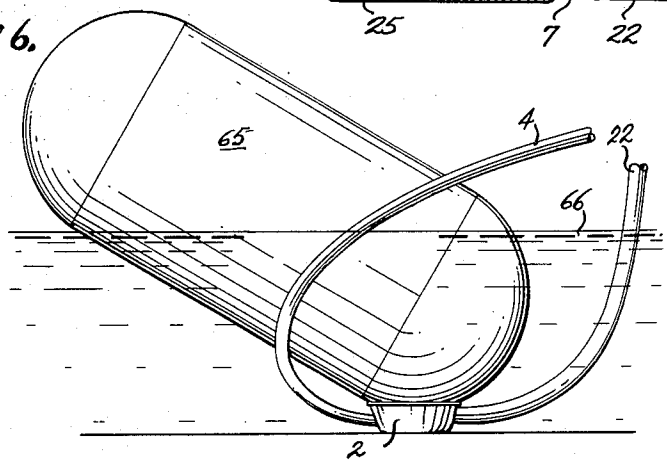
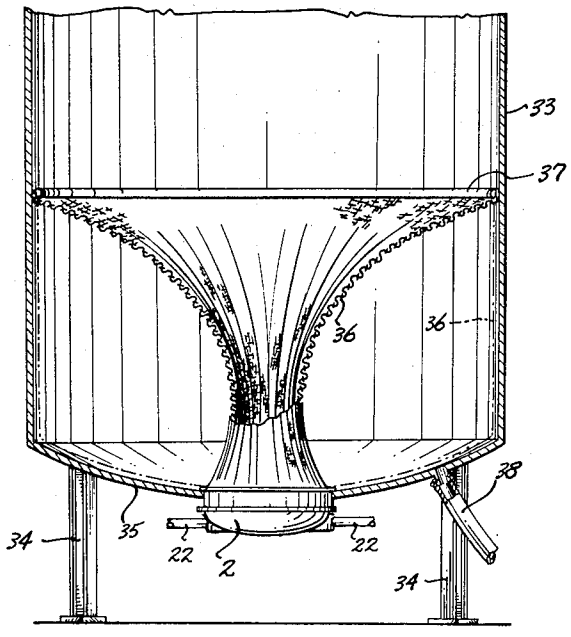


Fig. 7.



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GAS-FLUIDIZING CONTAINER-EMPTYING CAP

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Original application Mar. 23, 1962, Ser. No. 181,981. Divided and this application Oct. 8, 1964, Ser. No. 402,583

10 Claims. (Cl. 222—195)

The present invention relates to a cap for a container by which gas is supplied to fluidize granular material or powder in the container for the purpose of emptying it through a discharge aperture in the cap. Such container-emptying cap is attachable to a container at a destination in place of its usual lid. This application is a division of my application Serial No. 181,981, filed March 23, 1962, for Gas-Fluidizing Container-Emptying Cap, now abandoned.

It is a principal object of this invention to provide a cap which will expedite emptying granular material or powder from containers without the necessity of providing any other opening in the container. Such caps can be provided in several sizes to fit different standard containers, so that such a fluidizing cap can readily replace a conventional lid.

It is a further object to provide container-handling mechanism associated with such a gas-fluidizing cap which will enable the cap to be applied to a container and thereafter enable the container to be positioned easily with the cap beneath the container for supporting the contents of the container.

It is also an object to provide a gas-fluidizing cap of a single size which can be applied to containers of various sizes, shapes and types, such as metal, wood or cardboard drums, metal storage or transportation tanks, storage or transportation receptacles and containers which are portable or in stationary installations. Moreover, the caps may be of a size to cover the entire end of a container or hopper bottom on a container, or the cap can cover a part of the bottom and provision be made for dumping material from the remainder of the bottom onto the gas-fluidizing cap. Also, such a cap can be applied to an opening in the side, end or quarter of a container.

Another object of the present invention is to provide securing mechanism for an attachable gas-fluidizing cap which will enable such a cap to be secured quickly and easily to the end of, or an opening in, a container so that the complete emptying operation can be accomplished very expeditiously. Control valves can be provided for controlling the rate at which material is discharged from the container by use of the gas-fluidizing cap.

It is also an object to provide a gas-fluidizing cap of the type mentioned which will be very effective in effecting fluidizing of granular material or flour in a container, which will not be contaminated or clogged readily by such material and which can be cleaned easily when necessary.

The foregoing objects can be accomplished by an attachable gas-fluidizing cap composed of a pan having in it spaced from its bottom a porous partition through which a discharge duct opens toward the top of the pan. Preferably such partition is inclined toward the discharge opening, the partition either being dished with the discharge opening in its central portion, or the partition sloping sidewise and the discharge duct being connected to the lower portion of the partition. A plenum chamber is formed between the partition and the bottom of the pan and a fluidizing gas supply pipe is connected to the plenum chamber for supplying gas under pressure which will permeate the partition to fluidize the material in the container above it. The lip of the cap may have in it a groove to fit an end or opening in the container, both to locate the cap in proper position relative to the container and to provide a seal between the cap and the container, and the cap can be secured in such position by a clamping band. The cap can also be secured to the container by additional clamping mechanism which may be applied to the container while the opening in the container to which the cap is applied is in upwardly opening position, and after the cap has been secured in place the container can be inverted to locate the cap at the bottom of the container.

FIGURE 1 is a vertical section through a container-emptying cap of the present invention and the adjacent portion of a container.

FIGURE 2 is an elevation of the lower portion of a larger container to which the container-emptying cap is applied.

FIGURE 3 is an elevation of a horizontally elongated tank having a plurality of bottom hoppers to which container-emptying caps are applied.

FIGURE 4 is a vertical section through a modified container-emptying cap and the adjacent portion of a container.

FIGURE 5 is an elevation of another container to which the container-emptying cap has been applied.

FIGURE 6 is an elevation of a different type of container to which the container-emptying cap is applied.

FIGURE 7 is a vertical section through still a further type of container to which the container-emptying cap is applied.

Provision has been made heretofore to fluidize granular or powdered material in special containers for the purpose of emptying such material from the container, but no equipment has been provided to enable this process of material handling to be utilized for emptying material from containers of conventional type. Moreover, the fluidizing equipment has been constructed as an integral part of the container so that it was necessary to employ the fluidizing procedure in every instance in which material was removed from the container. The present invention provides a gas-fluidizing container-emptying cap attachable to containers of various standard types without modification of such containers. Alternatively, such a container-emptying cap can be secured detachably to various types of containers, or can be mounted permanently on containers with minimum modification of them being required.

A typical application for such a container-emptying cap is a conventional small, cylindrical drum made of metal, plywood, or paperboard, one entire end of which may be closed by a lid. The container-emptying cap of the present invention can be of a size, shape and construction to be substituted for the lid of such a container when it is desired to empty it. In FIGURE 1 such a container **1** is shown as having attached to it a gas-fluidizing container-emptying cap of the present invention. The cap is composed of a pan **2** of sheet material, such as plastic or noncorrodible metal, for example, aluminum alloy or stainless steel.

In FIGURE 4 a partition is spaced from the bottom of the pan to form a plenum chamber **3** to which gas under pressure is supplied by a gas supply pipe **4**. The partition is gas permeable, being composed of a perforate plate **5** supporting a porous mat **6** which preferably is of cellular urethane material or fabricated from bonded fine rubber particles, the cells of which are interconnected to enable gas to pass through the mat and emanate substantially uniformly from its surface.

An outlet duct **7** is connected to the partition in which the discharge opening **8** communicating with such outlet duct is provided. In the cap shown in FIGURE 4 the pan **2** and the partition within it are circular and the outlet

duct is located in the center of the partition. Such partition is dished so that the fluidizing surface slopes slightly toward the discharge opening to facilitate flow of the fluidized material to such opening.

The cap can be secured on the container **1** in various ways. In the particular instance illustrated it is assumed that the gas-fluidizing cap will be attached to the container **1** in place of the conventional lid which normally closes the entire end of the drum shown. The rim **10** of the pan is shaped to form a groove of a size and shape to receive the lip of the container wall. Such engagement between the pan and the container will establish proper registry of the cap with the container opening and will prevent the cap from sliding sidewise relative to the opening. The container lip may be bent to provide a seat for the lid and the groove **11** in the rim of the pan **2** should be shaped to received the lip of the container. When the cap has thus been fitted to the lip of the container, such lip and the rim of the pan **2** can be secured together by a clamping band **12** of channel cross section, which will embrace the container lip and pan rim and this band can be contracted circumferentially and its ends secured to bind it in place.

The gas supply pipe **4** and the material discharge duct **7** are connected to the pan **2** at an angle of less than 180 degrees. The portion **7** of the outlet duct carried by the cap need extend only from the discharge opening **8** through the wall of the pan **2**, at which location it can be connected by a coupling **21** to a conveyor pipe **22** of either flexible or rigid type extending to a location at which it is desired to deposit the contents of the container. The flow of material through the outlet duct and conveyor pipe can be controlled by a butterfly valve **23'** swingable to a desired regulating position by a handle connected to the valve shaft.

To apply the gas-fluidizing cap to the drum **1** of FIGURE 4 the lid will first be removed from the drum. Next, the cap is placed on the drum full of material with the lip of the drum lodged in the groove **11** of the cap. The cap is then secured to the drum by the clamping band **12**. To facilitate handling, the conveyor pipe **22** should not be connected to the outlet duct at this time and the valve **23'** should be in closed position so as to prevent any accidental discharge of material from the drum through the outlet duct.

The gas-fluidizing cap should thus be attached to the container when such container is in a position with the opening to which the cap is thus applied at the top of the container. The container can then be upended so that the pan **2** will be in a lower position, as shown in FIGURE 4. Immediate emptying of the container during inversion of it will be prevented by having valve **23'** in the closed position during this operation.

When the container has been inverted so that the cap is in a lower position the conveying pipe **22** is connected by the coupling **21** to the outlet duct **7** and air or other suitable gas under pressure is supplied by the gas supply pipe **4** to the plenum chamber **3** for permeating the partition **5, 6** to fluidize the material in the drum. If the valve **23'** is now opened by swinging its handle the fluidized material will flow out of the drum through the discharge opening **8** and into the conveying pipe **22**. The rate of material discharge can be regulated both by controlling the amount of fluidizing gas supplied by the pipe **4** and by adjusting the position of the control valve **23'** in the outlet duct. Even the slight slope of the upper surface of the cap's partition will be sufficient to cause all of the material in the drum to be emptied from it through the discharge opening **8** because of the fluidizing action of the gas supplied to the material in the container through the partition **5, 6** of the cap.

While the gas supplied to the material in the drum **1** through pipe **4** during an emptying operation will fluidize such material so that it will flow through the conveyor pipe **22** for a considerable distance without further assistance, it may be desirable to make provision for conveying the material through the pipe **22** over a greater distance. In that instance it may be desirable to provide supplemental air to the conveyor pipe **22** after the material has been discharged from the container. Through the additional pipe **25** gas under pressure can be supplied to the elbow of the outlet duct **7**. This pipe is in addition to the pipe **4** through which gas is supplied under pressure to the plenum chamber **3** for fluidizing the material in the container by passage through the partition **5, 6**. Pipe **25** may be a pipe branching from pipe **4**, or pipe **4** may be a branch of pipe **25**, but the flow of gas through these pipes should be controllable independently. For this purpose a valve **26** is shown diagrammatically in the pipe **25**.

By connecting the gas supply pipe **25** to the elbow of the outlet duct **7** it serves as an injector if the velocity of the gas discharged from the pipe **25** is sufficiently high, which will assist in withdrawing material from the container **1** through the discharge opening **8**. In such an installation it is desirable for the outlet control valve **23'** to be located in the discharge opening or pipe ahead of the pipe **25** in the direction of material movement from the container.

When the drum has thus been emptied the conveyor pipe **22** can be disconnected from the outlet duct **7**, the supply of gas under pressure through the pipe **4** can be shut off and such pipe may or may not be disconnected from the gas-fluidizing cap as desired. The drum may then be righted while the cap remains secured to the drum. Next, the clamping band **12** is loosened and removed from the assembly so that the cap can be lifted off the drum and stored or applied to another drum or other container.

In FIGURE 1 a somewhat modified type of gas-fluidizing cap is shown in which the partition is planar instead of being dished and includes a perforated plate **5'** sloping from one side of the pan **2** to its opposite side. A mat **6'** of resilient permeable material is supported on the plate **5'** and slopes correspondingly. Consequently, the plenum chamber **3'** tapers in depth from one side of the pan to the other. The supply pipe **4** for gas under pressure should be connected to a portion of the pan where the plenum chamber is comparatively deep, and such connection is shown as being diametrically opposite the outlet duct **7**.

Since the partition is shown as being located in the cap converging to the bottom of the pan **2**, it is not practical to provide the discharge opening through the partition. Instead, in this instance, the discharge opening **8'** is located adjacent to the lower portion of the partition and immediately above it. The size of the discharge opening can be established by the baffle **9'**, or the size of the discharge opening can be regulated if such baffle is movable. Flow of material through the outlet duct can, however, be controlled by a butterfly valve **23''** mounted in the outlet duct. The remainder of the construction of the gas-fluidizing cap shown in this figure is similar to that described in connection with the cap shown in FIGURE 4.

The operation of the apparatus disclosed in FIGURE 1 will be similar to that described with relation to FIGURE 4, except that when the material in the drum **1** is fluidized it will flow all in one direction over the partition to the side outlet opening **9'**.

The gas-fluidizing cap shown in FIGURE 2 may be of the same type as that of FIGURE 1 or FIGURE 4 and even of the same size. Consequently, it is not necessary to describe again the parts of the cap or its operation. In this instance, however, the container **26** is much larger than the drum **1** shown in FIGURES 1 and 4 and is illustrated as being a stationary storage type of container supported by the frame **27** mounted on legs **28**. In this instance, therefore, the cross-sectional area of the principal portion of the tank is much larger than the area of the

open end of the cap. To enable the cap to be fitted to the container, therefore, and to insure that the entire contents of the container can be emptied through the discharge outlet of the cap, the lower portion of the container is formed as a hopper bottom **29** tapered downwardly at an angle steeper than the angle of repose of the material in the hopper. The fluidizing of the container contents by air emitted from the cap **2** will effect discharge of the material from the large container in the same manner as explained previously in connection with FIGURES 1 and 4.

In FIGURE 3 the container **30** is also illustrated as being of the stationary storage type, but it is elongated horizontally and supported by legs **31**. In order to effect emptying of such a container a plurality of hoppers **32** are provided along the length of the container located sufficiently close together so that material from the container when fluidized will drain through one or the other of such hoppers. To the bottom opening of each of these hoppers is applied a gas-fluidizing cap of the type previously described in connection with FIGURE 1 or FIGURE 4.

If the cap is removable, a gate valve or iris valve should be provided at the lower end of the hopper which can be closed if it is desired to remove the cap from such a hopper when it contains material. If desired, the cap can be left permanently on the hopper and the container filled with material through a suitable filling opening in its top. In order to insure that the cap will be properly supported a suitable prop may be placed between the floor and the bottom of the cap.

The container **63** of FIGURE 5 represents one type of large transportable container, which may be either collapsible, being made of limp material, or may be rigid, and can be handled by suitable crane equipment **64**. A gas-fluidizing cap may be provided on an opening in its lower end as a permanent part of the container or may be applied as an attachment if it is convenient for this end of the container to be turned upward. If the cap is applied as an attachment the container can be filled through the opening to which the cap is applied or, if the cap is attached permanently, the opposite end of the container can be made removable or a filler opening can be provided in such opposite end through which the container can be filled. When the container has reached its destination the pressure gas supply pipe **4** and conveyor pipe **22** are connected to the gas-fluidizing cap and the container emptied in the manner previously described.

In FIGURE 6 the container **65**, which may be either of the collapsible type or the rigid type, may be towed to its destination or it may simply be placed in a body of water **66** for the purpose of supporting the container while it is being emptied. The container can be positioned with its opening to which the gas-fluidizing cap is secured facing upward and after the cap has been fixed in place the container can be turned into the position shown in FIGURE 6 so that air supplied through the pipe **4** will effect discharge of the material through the conveyor pipe **22** in the manner explained above.

FIGURE 7 shows another type of stationary storage container **33** supported by legs **34**, but in this instance the container does not have a hopper bottom which would insure flow of fluidized material to the cap to effect complete emptying of the container. The container bottom **35** is shown as being somewhat dished but its slope toward the central cap would be much flatter than the angle of repose of unfluidized material and no provision is made for fluidizing the material between the cap and the side wall of the container.

In order to effect complete emptying of this container an internal flexible dump wall **36** is provided in the lower portion of the container. The upper edge of this dump wall is secured to the container wall by a clamping band **37** and the lower edge of this wall is secured around the rim of the cap. When as much of the powdered or granular material has been emptied from the container as will flow by gravity to the gas-fluidizing cap, supplemental gas under pressure is introduced into the container through the supplemental gas supply pipe **38** opening through the wall of the container between the flexible dump wall **36** when it is in the broken line position forming a lining for the lower portion of the container and the container wall itself. Such gas under pressure will belly the dump wall inward toward the position illustrated in full lines in FIGURE 7 in which the central portion of the dump wall is gathered and it forms generally a flexible funnel leading into the gas-fluidizing cap. Preferably the dump wall **36** is impervious to gas, although it might be pervious. Such wall should not, however, allow even powdered material to pass through it from the container to the space between the dump wall **36** and the container wall. The dump wall will move the last portion of the powdered or granular material in the bottom of the container to the center onto the gas-fluidizing cap so that such material remainder can be emptied from the container by the cap in the same way that it effects removal of the rest of the material from the container, as described previously.

In the containers of FIGURES 5, 6 and 7 it will be noted that all of the container ends are domed and the ends of the containers shown in FIGURES 5 and 6 are domed to a more pronounced degree than the bottom of the container shown in FIGURE 7. In fact, the ends of the container shown in FIGURE 6 are almost hemispherical. The degree of convexity selected for the container ends will depend upon the amount of internal pressure in the container anticipated. The greater the internal pressure which is expected, the more pronounced will be the curvature of the container end.

In FIGURE 6 the discharge opening in the lower end of the container **65**, to which the cap means is applied, is offset from the center of the domed lower end and the length of the elongated container slopes relative to horizontal downward toward the cap means **2** when the container is in position for unloading, as shown in FIGURE 6.

I claim:

1. A container-emptying device for emptying granular materials from a container, comprising cap means including a pan having a bottom and a peripheral wall with one edge encircling and joined to said bottom and its opposite edge defining an open side, the height of said peripheral wall being substantially less than the width of said pan bottom, nonrotative securing means detachably attaching said pan to the container with its open side in communication with the interior of the container, a gas-permeable mat of elastomeric foam material in said pan, supporting means underlying said gas-permeable mat and supporting said mat in a position inclined relative to and spaced from said pan bottom, gas-supply means operable to supply gas to the chamber between said pan bottom and said gas-permeable mat and outlet pipe means with an opening to the portion of said pan above said gas-permeable mat at the bottom of its incline and projecting from the peripheral wall of said pan for discharge from the container of material fluidized by gas emanating from said mat.

2. The container-emptying device defined in claim **1**, and hoist means attached to the upper end of the container for suspending the container with the cap means attached to its lower end.

3. The container-emptying device defined in claim **2**, in which the container has domed upper and lower ends, and the discharge opening is in the domed lower end.

4. The container-emptying device defined in claim **1**, in which the discharge opening is in the lower end of the container offset from its center and the container is elongated so that the length of the container will slope relative to horizontal downward toward the cap means

when the portion of the container lower end having in it the discharge opening is lowermost.

5. The container-emptying device defined in claim 1, in which the container has in it a flexible dump wall arranged around the discharge opening, and air supply means connected to the container for supplying air between the container wall and said dump wall for moving said dump wall away from the container wall to dump onto the cap means material in the container disposed in a location offset from, but adjacent to, the cap means.

6. The container-emptying device defined in claim 1, in which the outlet pipe means extends through the central portion of the gas-permeable mat and opens at its upper side, and the outlet pipe means has an angle passage confined between the bottom of the pan and the gas-permeable mat extending from the upper side of the gas-permeable mat to the peripheral wall of the pan.

7. The container-emptying device defined in claim 1, and a baffle within the pan masking a portion of the outlet pipe means opening and having an edge spaced from the gas-permeable mat a distance less than the width of the outlet pipe means opening and forming a slot of a width less than the corresponding width of the outlet pipe means opening for flow of material therethrough from the container to the outlet pipe means.

8. The container-emptying device defined in claim 1, in which the lower portion of the container is an upwardly flaring conical hopper and the discharge opening to which the pan is attached is at the bottom of said hopper.

9. The container-emptying device defined in claim 6, in which the gas-supply means includes a pipe connected to the angle passage of the outlet pipe means for supplying gas to the outlet pipe means for implementing flow of material therethrough.

10. A container-emptying device for emptying granular material, comprising a horizontally elongated container, a plurality of hoppers attached to the bottom of said container at locations spaced lengthwise thereof, each of said hoppers having a discharge opening in the lower portion thereof of a maximum horizontal width much less than the maximum horizontal width of said container, cap means including a pan attached to the discharge opening of each hopper, respectively, each of said cap means including a pan having a bottom and a peripheral wall with one edge encircling and joined to said bottom and its opposite edge defining an open side attached to the hopper discharge opening, a gas-permeable partition in said pan spaced from the bottom of said pan and gas-supply means operable to supply gas to the chamber between said pan bottom and said gas-permeable partition, and outlet pipe means projecting from the peripheral wall of the pan of each of said cap means for discharge from the container of material fluidized by gas emanating from said partitions of the respective cap means.

References Cited by the Examiner

UNITED STATES PATENTS

2,538,756	1/1951	Braswell	222—193
2,721,006	10/1955	Knutsen	222—195
2,723,054	11/1955	Louden et al.	222—195
2,755,143	7/1956	Cunningham	222—193 X
2,792,262	5/1957	Hathorn	222—195
2,968,425	1/1961	Paton	302—53
3,053,420	9/1962	Saint-Martin	222—195

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