June 19, 1962 W. N. POUNDSTONE ETAL 3,039,827

ROCK DUSTER

Filed Sept. 22, 1959 3 Sheets-Sheet 1

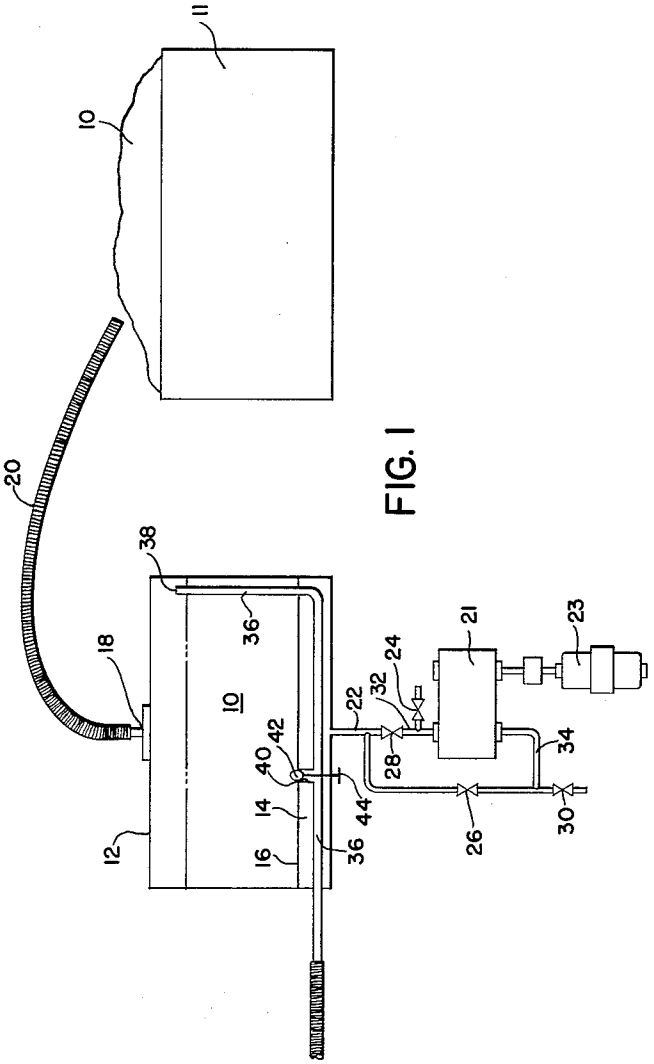


FIG. 1

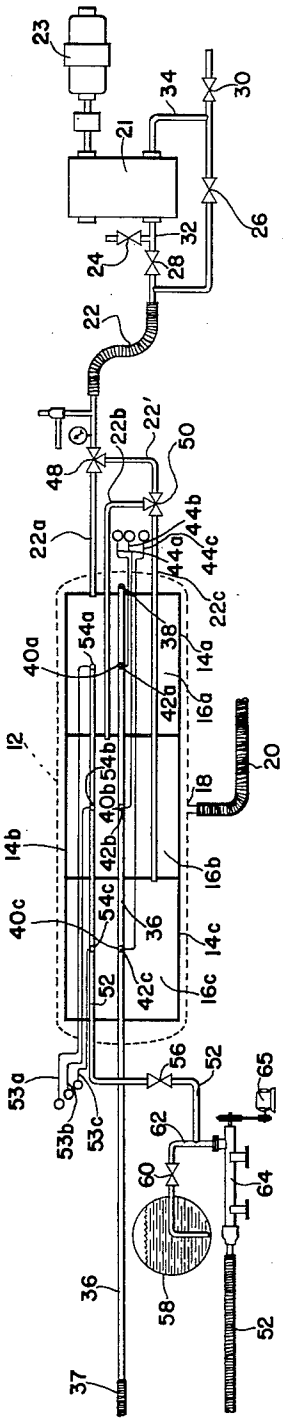


FIG. 2

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ROCK DUSTER

Filed Sept. 22, 1959 3 Sheets-Sheet 2

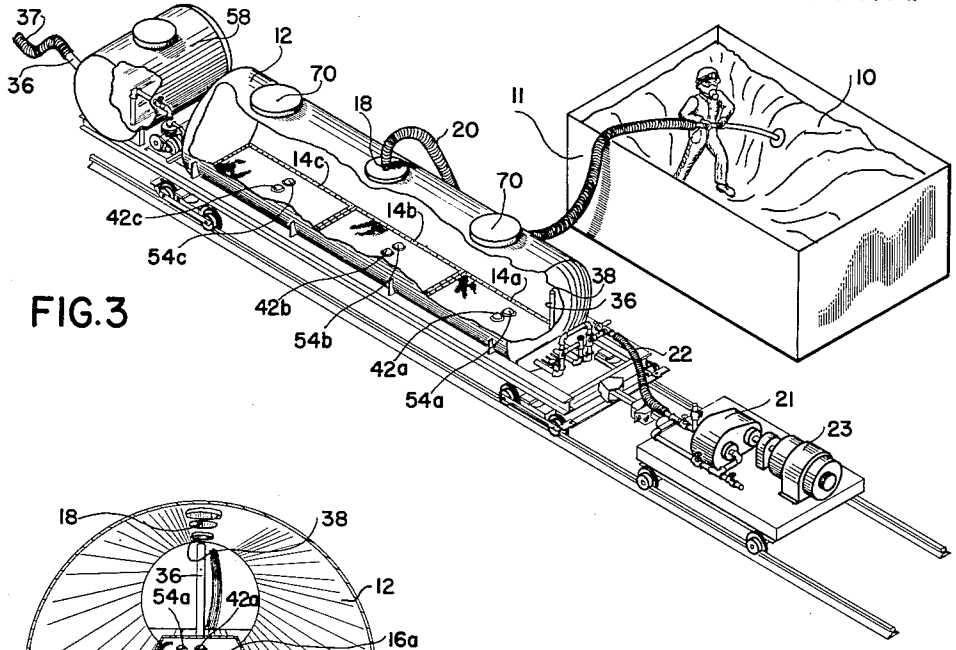


FIG.3

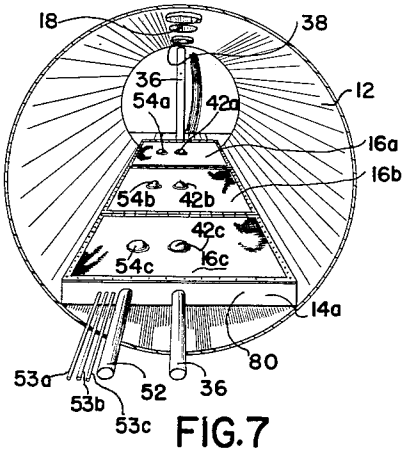


FIG.7

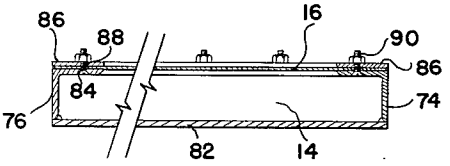


FIG.9

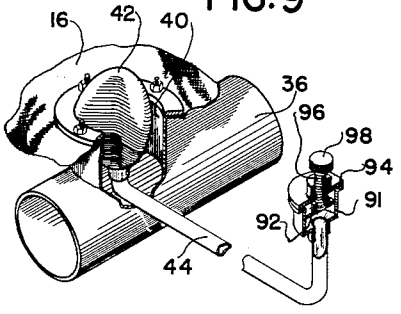


FIG.10

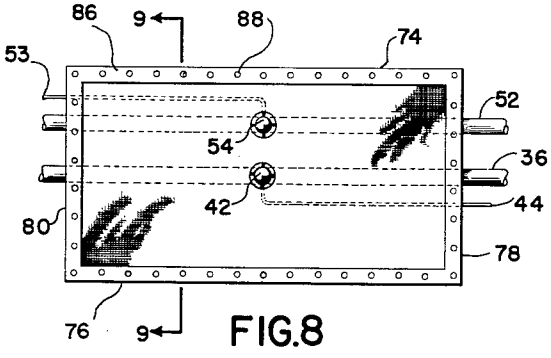


FIG.8

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ROCK DUSTER

Filed Sept. 22, 1959 3 Sheets-Sheet 3

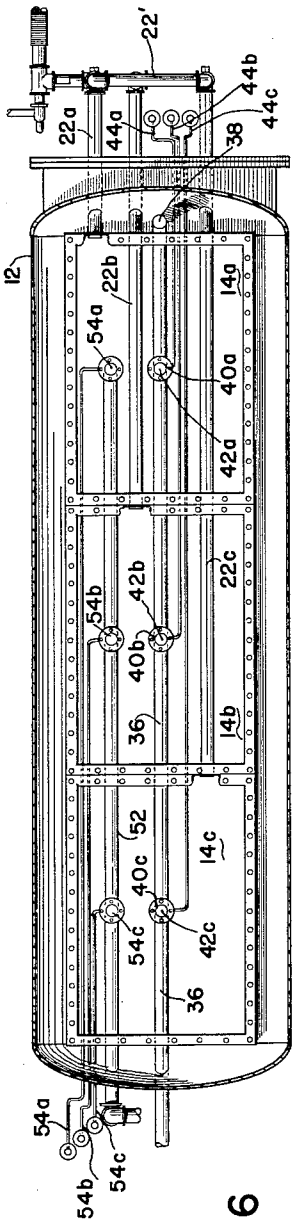


FIG. 6

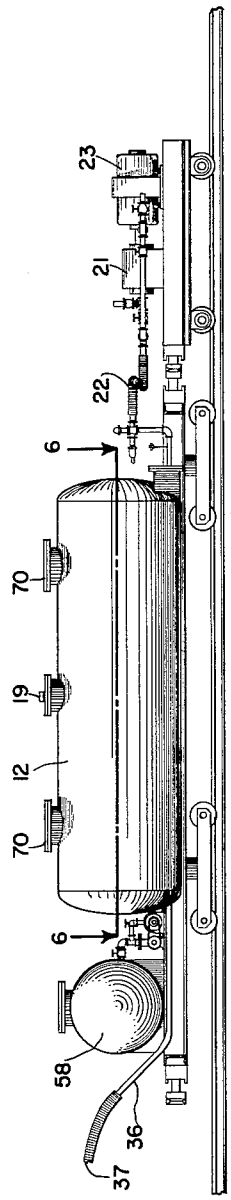


FIG. 4

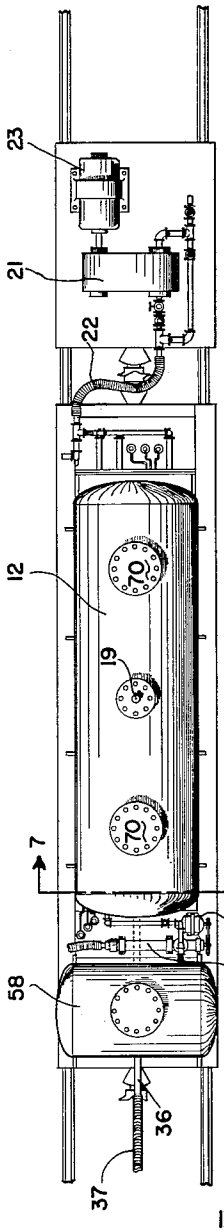


FIG. 5

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United States Patent Office 3,039,827 Patented June 19, 1962

3,039,827

ROCK DUSTER

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Filed Sept. 22, 1959, Ser. No. 841,556
3 Claims. (Cl. 302—52)

This invention relates to a system for handling particulate solid material in bulk lots. The invention more particularly relates to the handling and diffusion of rock dust in coal mines. It is common practice to spray the interior of coal mines with rock dust; this rock dust mixes with the coal dust in the coal mines, diluting the coal dust and reducing the chance of explosion caused by a spark igniting the coal dust within the coal mine. The rock dust also serves to confine any explosion which might occur since the rock dust will not propagate the explosion as coal dust does.

The rock dust used for spraying in the coal mine is usually crushed limestone. Until the present time, no efficient system has been developed for handling and diffusing this rock dust in bulk lots. The term bulk lots is used to distinguish from packaged lots which may be lifted and transported by one man and as used herein designates lots of a truckload, a railroad carload, or larger. It is common practice to prepare rock dust and package it in bags containing from 85 to 100 pounds of the dust. These bags are then carried by car into the mine passages. Upon reaching the face of the mine where the dust is to be sprayed, the bags are broken and their contents deposited into some form of rock duster. This relatively small capacity rock duster is then utilized by the miners at the face to spray rock dust over the area of the face.

This invention obviates the need for packaging of rock dust. It provides a system whereby a large quantity of rock dust may be delivered to the mine entry, and quickly and efficiently loaded into a rock duster which is then transported to the mine face. By eliminating the packaging and individual handling of each bag of rock dust, the savings in time and labor will be appreciated. Further, this invention allows large quantities of rock dust to be diffused in relatively short periods of time if desired. Since it contemplates the handling of rock dust in bulk lots, the diffusion need not await manual loading of the apparatus from bags.

The system of this invention utilizes a "fluidized bed" to allow bulk handling of particulate solid material. The rock dust is placed within the storage receptacle of a rock duster, and while within this receptacle gas under pressure is passed through the rock dust to fluidize it. This invention also contemplates a novel means for loading the rock dust into the storage receptacle of the rock duster. Thus, the over-all system provides means by which a quantity of rock dust in bulk lots may be delivered to the entry of a mine, the bulk rock dust may be loaded into the rock duster, the rock duster may be taken to the face of the mine, the rock dust may be there diffused by the miners as needed until the rock duster is empty, the rock duster may then be returned to the entry for reloading, and the operation repeated as required.

At the present time rock dust is sprayed within mines either "wet or "dry." That is, the rock dust may be mixed with some liquid, usually water, to provide a wet solution and then this solution is sprayed upon the face of the mine. The rock dust may also be sprayed in dry form. It is easier to spray the rock dust in dry form, however, when sprayed dry, the rock dust creates a dust cloud which presents respiration difficulties to workers at the face of the mine. Accordingly, the rock dust is usually sprayed dry only when no miners are working in the vicinity. When it becomes necessary to spray rock dust while miners are working at the face of the mine, a wet solution of rock dust is used. The present invention also contemplates a system whereby the rock dust may be sprayed "wet" or "dry" as required by working conditions at the face of the mine.

With the foregoing considerations in mind, it is the major object of the present invention to provide a novel system for the handling of particulate solid material in bulk lots.

It is another object of the present invention to provide a novel system whereby solid particulate material in bulk lots may be conveniently loaded into a receptacle and then withdrawn from that receptacle at some later time.

It is still another object of the present invention to provide a system in which the same gas that is utilized to fluidize the solid particulate material is also utilized as a carrier medium to conduct the material out of the receptacle to its final location.

It is a further object of the present invention to provide a system whereby rock dust may be sprayed "wet" or "dry" as required by working conditions at the face of the mine.

Another object of the present invention is to provide a novel loading system for loading rock dust in bulk quantities into a rock duster.

It is still another object of the present invention to provide a system of diffusing rock dust whereby a relatively small capacity air compressor may be utilized as the motive force for the rock duster.

Other and more specific objects of the present invention will become apparent from the following description taken in connection with the accompanying drawings.

In the drawings:

FIGURE 1 is a schematic representation of a single-cell system built in accordance with the present invention.

FIGURE 2 is a multiple-cell system similar to that of FIGURE 1, shown schematically.

FIGURE 3 is an over-all perspective view of an actual unit built in accordance with the schematic drawing of FIGURE 2, shown adjacent to a source of rock dust for loading.

FIGURE 4 is a side elevation of the unit shown in FIGURE 3.

FIGURE 5 is a top plan view of the unit shown in FIGURES 3 and 4.

FIGURE 6 is a horizontal section, with certain parts removed, of the tank shown in FIGURE 4, the section being taken along line 6—6 of FIGURE 4.

FIGURE 7 is a vertical section, taken on line 7—7 of FIGURE 5 of the tank of the unit shown in FIGURES 3, 4, 5 and 6.

FIGURE 8 is a top view of an individual gas conducting cell or chamber.

FIGURE 9 is a vertical section taken on line 9—9 of FIGURE 8 showing certain details of construction of the cell of FIGURE 8.

FIGURE 10 is a perspective drawing partially in section showing details of a preferred valve arrangement.

Referring to the drawings and particularly to FIGURE 1, a single-cell unit as shown schematically in FIGURE 1 will be described in detail. The remaining configurations to be described are variations of this basic single-cell unit. Throughout this specification, like reference numbers are given to like parts of all configurations insofar as those reference numbers refer to the same or equivalent parts in the configurations. While the description herein will be primarily directed to the preferred embodiment of the invention which is a rock duster for the diffusion of rock dust within coal mines,

the system may be utilized with equal facility for the loading, storage and unloading of other solid particulate material such as, for example, cement, fertilizer and grain. These materials are typical of the type that may be utilized in the system of the present invention, but these examples are not to be considered as limiting since other materials may also be utilized.

As shown in FIGURE 1, the basic system consists of a source of particulate solid material 10 such as rock dust in a bulk lot. This source of material 10 may be partially enclosed in a bin 11 or other suitable container. A storage receptacle 12 forms a primary component of the present rock dust system. This receptacle 12 may be stationary or it may be transportable as required by the use to which the system will be put. Formed below the storage receptacle 12 is a gas conducting chamber 14. This chamber 14 is separated from the interior of the storage receptacle 12 by a gas permeable member 16 which extends horizontally between the interiors of receptacle 12 and chamber 14. It has been found that gas permeable member 16 may be constructed of heavy canvas or the like. The storage receptacle 12 has an inlet aperture 18 which opens it to the atmosphere. An inlet conduit 20 may be fixed to this inlet aperture 18 to provide for incoming material. A compressor 21 is provided to create a source of gas under pressure and also to create a vacuum as desired. It will be appreciated that compressor 21 may be replaced by any equivalent structure which will pressurize gas.

A main receptacle pressure-suction conduit 22 extends generally between compressor 21 and gas conducting trough or chamber 14. Associated with conduit 22 and compressor 21 are pressure valves 24 and 26, suction valves 28 and 30, and conduits 32 and 34 to form a conduit system by which the compressor may be placed in fluid communication with the gas conducting chamber 14, to provide either pressure or vacuum to gas conducting chamber 14. When it is desired to create pressure within chamber 14, pressure valves 24 and 26 are closed and suction valves 28 and 30 are opened. Thus, air is drawn in through valve 30, conduit 34, acted upon and pressurized by compressor 21, passes through valve 28, into conduit 22, and pressurizes chamber 14. When it is desired to create a vacuum in chamber 14, suction valves 28 and 30 are closed, and pressure valves 24 and 26 are opened. Air is then drawn from chamber 14, through conduit 22, through valve 26, through conduit 34, acted upon and pressurized by compressor 21, and vented to atmosphere through conduit 32 and valve 24. It will be appreciated that by properly positioning the valves 24, 26, 28 and 30, the compressor 21 may, in effect, be reversed so that pressure or vacuum will be created within chamber 14 as desired.

Disposed within receptacle 12, a conduit 36 is the outlet conduit by which the rock dust and the fluidizing gas may be withdrawn from receptacle 12 and carried to the area of diffusion. Outlet conduit 36 has a vertical portion terminating in an inlet 38. This inlet 38 is disposed near the top of the space within receptacle 12. Outlet conduit 36 passes beneath the permeable member 16 as shown in FIGURE 1 and extends beyond receptacle 12 to the area where the rock dust is to be delivered and diffused. Conduit 36 also has another fluidized solid inlet 40. This inlet 40 is created at the permeable member 16 so that the solid material supported by permeable member 16 may be taken into the outlet conduit 36 at that point. Fluidized solid inlet 40 is controlled by a valve 42 which has an external control member 44. The valve 42 is utilized to regulate the amount of material 10 entering the outlet conduit 36 for optimum withdrawal and diffusion of the material at the area of diffusion.

Utilizing the parts enumerated in the foregoing paragraphs, the operation of the schematic single-cell unit shown in FIGURE 1 may be described. The inlet conduit 20 is placed so that its inlet end is very near the surface of the source of particulate solid material 10.

With the inlet conduit in that position, valves 28 and 30 are closed and valves 24 and 26 are opened to thereby cause compressor 21 to create vacuum within chamber 14. Valve 42 is positioned to completely close inlet 40. The force of this vacuum is such that it evacuates the interior of receptacle 12 by drawing air from within receptacle 12 through the permeable member 16. When receptacle 12 is thus evacuated, the particulate solid material 10 is drawn through inlet conduit 20 into receptacle 12. This material 10 is drawn to the permeable member 16 and creates a bed of material 10 on permeable member 16. The height of this bed is shown in phantom lines on FIGURE 1.

When a bed of sufficient depth has been created in receptacle 12, the compressor is shut off. At that time inlet conduit 20 is removed and inlet aperture 18 is sealed by suitable means to make receptacle 12 gas tight. When it is desired to withdraw the rock dust or material 10 to the area at the end of outlet conduit 36 and there diffuse it, the following steps are taken. Pressure valves 24 and 26 are closed and suction valves 28 and 30 are opened so that when compressor 21 is started, gas under pressure will be forced into chamber 14. The compressor 21 is then started to create this pressure in chamber 14. The gas under pressure in chamber 14 passes upwardly through permeable member 16 into the bed above. This gas has the effect of fluidizing the bed above member 16. The term "fluidized bed" as used in this specification means any bed of solid particulate material which has gas passing upwardly through it, whereby the density of the original bed is reduced due to the upward velocity of gas through the original bed. When a bed is fluidized, the solid particulate material takes on many of the characteristics of a fluid. Most particularly, the bed will then flow as fluid flows.

It will be noted that the entire output of compressor 21 is directed to chamber 14 from whence it passes upwardly through the gas permeable member 16 and the bed of particulate material 10 and fluidizes the bed. Once the gas reaches the top of the bed, it fills the space above the bed within the receptacle 12. The gas above the bed then enters outlet conduit 36 through inlet 38 and is conducted through conduit 36 to the area of diffusion. The valve 42 is opened to allow the fluidized particulate material 10 to enter the same conduit 36 through inlet 40. Since the bed of material 10 has been fluidized, the material 10 literally flows into the inlet 40. The primary purpose of providing a fluidized bed is to facilitate this flow by the particulate solid material into the inlet to conduit 36.

The gas passing into inlet 38 and on through conduit 36 has a velocity which depends upon the pressure above the bed within receptacle 12. However, the velocity of the gas within conduit 36 will be relatively high. When the gas in the conduit 36 passes through conduit 36, the valve 42 may be opened to allow the proper amount of the solid material from the bed to pass into conduit 36. The gas which has already passed upwardly through the bed to fluidize it and which now is moving at some velocity through conduit 36 acts as a carrier medium for the fluidized material from the bed above. Thus, the material of the fluidized bed flows past valve 42 into inlet 40 and is carried to the area of dispersion by the gas in conduit 36.

A review of the foregoing description of the system shown schematically in FIGURE 1 will reveal certain features of that system which provide novel and highly useful results. The system first provides a method of drawing bulk material 10 into a storage receptacle, whereby the bulk material 10 need not be packed and handled in small quantities. Secondly, once the material 10 is in storage receptacle 12 in the form of a bed, this bed may be easily fluidized utilizing a pressure source such as compressor 21. Thus, the single compressor may be used, first, as a source of vacuum to draw material into receptacle 12, and second, as a source of pressure to fluidize

the bed of material which has been drawn in. In the system of FIGURE 1, the gas under pressure created by compressor **21**, after it has fluidized the bed of material **10**, then passes into outlet conduit **36** where it also becomes the carrier gas for the particulate material which has been fluidized. While the gas pressure created by compressor **21** need not always provide the carrier medium in the outlet conduit, as will be described in connection with other configurations of this general system, it is a useful feature of this system which may be so utilized.

A further important feature of the schematically drawn system of FIGURE 1 is the provision of a gas permeable member **16** upon which the bed is supported. It has been found that if a simple standpipe or other concentrated source of gas pressure is placed beneath a horizontally disposed bed, the gas does not fluidize the bed, but rather channels its way to the surface of the bed and thereby most of the fluidizing pressure is wasted. Thus the gas permeable member **16** of the present system has the effect of spreading the gas under pressure and evenly distributing that gas over the entire lower surface of the bed of particulate material **10**. With the gas pressure so distributed, the entire bed is fluidized and is put in a condition to flow into conduit **36**.

Turning now to FIGURE 2, a schematic diagram of a system similar to that of FIGURE 1 but with multiple cells is shown there. In order to obtain capacity for the quantities of rock dust desired to be carried into the mine on a single trip into the mine, it was determined that the single-cell system shown schematically in FIGURE 1 required a compressor of such size and capacity as to be prohibitive economically. Thus, in order to use a reasonably sized compressor, the multiple-cell system of FIGURE 2 was designed. Further, the system of FIGURE 2 provides means for "dry" dusting or for "wet" dusting, as desired.

The system of FIGURE 2 will be described insofar as it differs from the previously described system of FIGURE 1. To the right of FIGURE 1 the compressor **21** driven by motor **23** and the associated conduit means which allows the compressor to serve as either a source of pressure or vacuum will be recognized as similar to that of previously described FIGURE 1. The common elements of conduits **22**, **34** and **32**, as well as valves **26**, **28**, **30** and **24**, will be recognized in FIGURE 2. In the system of FIGURE 2, however, the conduit **22** is connected to a four-way valve **48**. This four-way valve **48** allows alternate distribution of the entire input from conduit **22** to conduit **22***a* or conduit **22'**. The valve **48** may also be utilized to connect conduit **22** with conduits **22***a* and **22'** simultaneously or to close conduit **22** completely. Conduit **22'** leads to another four-way valve **50**. Four-way valves **48** and **50** are similar to each other and may be of any desired construction, their exact construction not being critical to the present invention. The entire input from conduit **22'** to four-way valve **50** may alternately be distributed by four-way valve **50** to conduits **22***b* or **22***c*. The valve **50** may also be utilized to connect conduit **22'** with conduits **22***b* and **22***c* simultaneously or to close conduit **22'** completely. Thus conduits **22***a*, **22***b* and **22***c* represent the pressure-suction lines into the individual gas conducting cells **14***a*, **14***b* and **14***c* of the multiple cell unit of FIGURE 2. While cells **14***a*, **14***b* and **14***c* have gas permeable tops **16***a*, **16***b* and **16***c* respectively, they are otherwise isolated from each other so that gas does not pass readily from one to the other. A common output conduit **36** passes longitudinally through the gas conducting cells **14***a*, **14***b* and **14***c* of FIGURE 2. This common conduit **36** has inlets **40***a*, **40***b* and **40***c* respectively which correspond to the inlet **40** of FIGURE 1. The conduit **36** terminates in an inlet **38** within the receptacle **12** as shown in FIGURE 2.

As described thus far, the unit of FIGURE 2 has three gas conducting cells similar to that of the single cell unit described in conjunction with FIGURE 1. It has been found that with the three cell unit the size of the bed of particulate material **10** may be increased so that the capacity of the rock duster becomes highly practical while at the same time the size of the compressor required is not prohibitive. The three cells, in effect, divide the bed of particulate material **10** into three parts for fluidizing purposes. It is during the fluidizing and withdrawal portion of the operating cycle that the greatest load is placed upon the compressor **21**.

With the three cell unit, the entire output of gas under pressure from the compressor **21** may be directed to one of the cells **14***a*, **14***b* or **14***c*. Thus, only that portion of the bed of particulate material **10** which is supported over the particular energized cell is fluidized and the output of compressor **21** is concentrated upon one third of the bed, where it is effective, rather than being dissipated ineffectively over the entire bed. In the present invention, the individual cells **14***a*, **14***b* and **14***c* are maintained separately insofar as gas communication between them is concerned. The bed of particulate material **10** need not be separated at the boundaries of cells **14***a*, **14***b* and **14***c*. Nevertheless, the gas under pressure from compressor **21**, when directed to one of the cells, has the effect of fluidizing only a portion of the bed.

During the loading cycle of the rock duster, the load on compressor **21** is not so great. Thus in operation the solid particulate material **10** may be drawn into receptacle **12** in the following manner. Valves **24**, **26**, **28** and **30** are positioned so that compressor **21** creates a vacuum in conduit **22**, four-way valve **48** is positioned so that conduit **22** communicates simultaneously with conduit **22***a* and conduit **22'**, and four-way valve **50** is positioned so that conduit **22'** communicates simultaneously with conduits **22***b* and **22***c*. The end of inlet conduit **20** is placed closely adjacent to the source of particulate material **10**. The particulate material is drawn through inlet conduit **20** into receptacle **12** and toward permeable members **16***a*, **16***b* and **16***c* since vacuum is created within the cells **14***a*, **14***b* and **14***c* by the simultaneous communication of conduit **22** with all of the cells **14***a*, **14***b* and **14***c*. After the particulate material has accumulated upon permeable members **16***a*, **16***b* and **16***c* to sufficient depth, the load upon compressor **21** may become excessive since the vacuum created within the gas conducting cells must act through the bed of particulate material **10** to draw in additional material **10**.

In this event a more concentrated vacuum may be created by restricting the fluid communication with compressor **21** to a single cell **14***a*, **14***b* or **14***c*. For example, suppose that cell **14***b* is chosen. Four-way valve **48** is then positioned so that conduit **22** communicates with only conduit **22'**. The four-way valve **50** is positioned so that conduit **22'** communicates with only conduit **22***b*. Thus, a vacuum is created within gas conducting chamber or cell **14***b* and the solid particulate material is drawn in through conduit **20** and is deposited upon the bed above gas permeable member **16***b*. When the material further accumulates to the desired depth upon permeable member **16***b*, the four-way valves **48** and **50** are positioned so that the compressor is alternately placed in communication with the cells **14***a* and **14***c* to gather additional material **10** above the permeable members **16***a* and **16***c*. The bulk material **10** may, thus, be drawn into receptacle **12** by creating vacuum within cells **14***a*, **14***b* and **14***c* simultaneously or alternately, depending upon the size of the compressor utilized and the depth of the bed which is desired. In the foregoing manner the bulk particulate material may be drawn from its source and a bed of the material may be created within receptacle **12** and supported by the gas permeable members **16***a*, **16***b* and **16***c*.

When it is desired to withdraw the particulate material such as rock dust to diffuse it at the face within the mine, the end of outlet conduit **36** is placed at the area of desired diffusion. Lengths of conduit such as flexible hose

37 may be added to lengthen conduit 36 as necessary. By proper positioning of the control valves 24, 26, 28 and 30 as described in connection with the schematic representation of FIGURE 1, the compressor 21 is connected to create a source of gas under pressure in conduit 22. The four-way valves 48 and 50 are then positioned to conduct this source of gas under pressure from conduit 22 to any one of the desired air cells 14*a*, 14*b* or 14*c*. Whichever cell is put into communication with conduit 22, the portion of the bed immediately above that cell becomes fluidized by the action of the gas under pressure passing upwardly through the gas permeable member 16 and into that portion of the bed. Thus, approximately one-third of the entire bed within receptacle 12 is fluidized at any one time.

For example, let us assume that the valves 48 and 50 have been positioned so that conduit 22 communicates with conduit 22*b* thus creating a source of gas under pressure within gas conducting cell 14*b*. In this event, the center portion of the bed will become fluidized. The gas having fluidized the bed above the chamber 14*b* will then pass into the inlet 38 to conduit 36. At that time, the valve 42*b* is opened so that the fluidized particulate material may flow into conduit 36 and be carried through conduit 36 to the area of diffusion as explained in connection with the system of FIGURE 1. In the foregoing manner the four-way valves 48 and 50 may be repositioned, thereby alternately actuating cells 14*a*, 14*b* and 14*c* until the entire quantity of material 10 in the bed is fluidized and passed into conduit 36 for withdrawal.

In some instances after a large quantity of the material 10 has been withdrawn and the depth of the bed of remaining material is relatively shallow, the output of compressor 21 may be sufficient to fluidize the entire remaining bed. In such an instance, four-way valves 48 and 50 are positioned so that cells 14*a*, 14*b* and 14*c* are all put into fluid communication with conduit 22 simultaneously. In that case, valves 42*a*, 42*b* and 42*c* are all opened to allow flow of material 10 into conduit 36. It will be appreciated that the necessity for utilizing three individual cells 14*a*, 14*b* and 14*c* arises from the fact that the capacity of the compressor is not sufficient to fluidize the entire bed of material at one time. When, however, the depth of the bed is so diminished, or the size of the compressor is so increased, that the pressure output of the compressor is sufficient to fluidize the entire bed at one time, all cells 14*a*, 14*b* and 14*c* may be pressurized simultaneously, and all valves 42*a*, 42*b* and 42*c* may be opened to increase the rate of withdrawal of the material.

As shown in FIGURE 2, an alternate outlet conduit 52 is provided to carry the solid particulate material under certain specified conditions. This alternate outlet conduit 52 runs generally parallel to outlet conduit 36. Alternate conduit 52 has three inlet valves 54*a*, 54*b* and 54*c* each of which is similar in construction to valves 42*a*, 42*b* and 42*c* (this construction to be described in detail later in this specification) and is located in proximity to the respective valves 42*a*, 42*b* and 42*c*. It will be noted that alternate conduit 52 has no inlet which communicates with the interior of receptacle 12 above the bed as has outlet conduit 36.

The primary purpose of outlet conduit 52 is to provide an outlet for the solid particulate material when that material is to be mixed with a liquid before dispersion. Thus alternate outlet conduit 52 is primarily a component of the "wet" dusting system. The alternate outlet conduit 52 has an alternate control valve 56 as shown in FIGURE 2. Beyond the control valve 56 the conduit 52 communicates with a conduit 62. The conduit 62 is a liquid conduit from liquid tank 58. A tank valve 60 is provided in conduit 62 to control the flow of liquid from tank 58. Downstream of the juncture of conduits 52 and 62 a positive displacement pump 64 is placed in conduit 52. This positive displacement pump 64 is utilized to provide the force to carry the solid particulate material and the water through line 52 when the system is utilized for wet dusting. The pump 64 is driven by some auxiliary power unit such as an electric motor 65.

When the system of FIGURE 2 is utilized for wet dusting, the following procedure is utilized. The bed of material to be diffused is drawn in through the inlet conduit 20 as has already been described in connection with the dry dusting system of FIGURE 2. After the bed is in place upon the permeable members 16*a*, 16*b* and 16*c*, the bed is then fluidized as previously described in connection with the dry dusting system of FIGURE 2. That is, one section of the bed is fluidized by admitting gas under pressure to one of the cells 14*a*, 14*b* and 14*c*. When the portion of the bed above the selected cell or chamber is fluidized, the air passing through that section of the bed once more enters conduit 36. During the wet dusting process, conduit 36 conducts only the fluidizing gas out of the receptacle 12. The inlet valves 42*a*, 42*b* and 42*c* to conduit 36 are all maintained in the closed position during the wet dusting process. The alternate outlet conduit 52 is utilized to convey the fluidized material to the area of dispersion.

As in the case of the dry dust process the valve 54*a*, 54*b* or 54*c* that is located below the portion of the bed then being fluidized is opened to admit the fluidized particulate material to the conduit 52. When the system is used for wet dusting, valve 56 is opened so that conduit 52 communicates with the inlet to pump 64. Valve 60 is opened to allow a proper amount of liquid from tank 58 to enter conduit 52. The proper amount of liquid from tank 58 is regulated by a valve 60 and the mixture from tank 58 and conduit 52 is drawn through pump 64. Pump 64 supplies the necessary force to draw the mixture of liquid and fluidized particulate material through conduit 52 to the area of diffusion. It will be appreciated that during the wet dusting process the gas under pressure from compressor 21 serves only to force gas through the bed and fluidize the bed of particulate material 10 thus facilitating flow of the particulate material into conduit 52.

In some instances, it may be desirable to utilize the alternate outlet conduit 52 and positive displacement pump 64 during the dry dusting process. In this event valve 60 is closed to prevent liquid from tank 58 from entering conduit 52. If so utilized, these components, consisting of outlet conduit 52 and pump 64, are substitutes for the outlet conduit 36 and the gas pressure produced by compressor 21 for the purpose of withdrawing the fluidized particulate material to the area of dispersion.

The operation and general arrangement of the novel diffusion system having been described with reference to schematic representations FIGURE 1 and FIGURE 2, a preferred embodiment of this system will now be described with reference to FIGURES 3–10. As seen in FIGURE 3, the storage receptacle 12 of the preferred embodiment takes the form of a tank mounted upon a railway or mine car. This tank has two manholes at the top, which manholes are hermetically sealed by manhole covers 70. The manholes may be utilized for access to the interior of receptacle 12; however, in normal operation, the manholes are sealed and are not utilized. An inlet aperture 18 is provided at the top of receptacle 12 and an inlet conduit 20 may be removably attached to inlet aperture 18 to provide fluid communication between conduit 20 and the interior of storage receptacle 12. The inlet conduit 20 may be threadingly engaged into inlet aperture 18. The threaded cap 19 (FIGURE 4) may be utilized to close inlet aperture 18 and hermetically seal the interior of storage receptacle 12, when the inlet conduit 20 is removed. Within storage receptacle 12 are placed the gas conducting chambers or cells 14*a*, 14*b* and 14*c*. As best shown in FIGURES 7–9, these cells are simply boxes with the gas permeable members 16 forming the top of the box.

Gas conducting cells or chambers 14 are conveniently formed of angle iron stock and relatively small gauge

sheetmetal. As shown in FIGURES 8 and 9, a rectangular frame is formed of angle iron portions **74**, **76**, **78** and **80**. A rectangular, small gauge piece of sheetmetal **82** is then welded to the bottom of the rectangular frame to form a box member with an open top. The angle iron frame portions **74**, **76**, **78** and **80** are drilled as shown in FIGURE 9 with holes **84** around the periphery of the top of the box. A piece of heavy six-ply canvas **16**, with holes in its periphery that align with holes **84** around the top of the box, is placed across the top of the box formed from the angles and sheetmetal. A rectangular frame **86** is placed above canvas **16**, and the holes **88** in frame **86** are aligned with holes **84** in the angle iron sections **74**, **76**, **78** and **80**. The frame **86** is then bolted by means of bolts **90** to the box-like chamber, thus clamping canvas **16** and retaining it as the top of the gas conducting chamber or cell **14**. As best shown in FIGURE 7, holes are formed in the angle stock **80** to provide for passage of the outlet conduits **38** and **52** to the interior of the air conducting chambers or cells **14**. Holes are also formed in the angle stock **80** to permit passage of control lines **53***a*, **53***b* and **53***c* which are the external controls of inlet valves **54***a*, **54***b* and **54***c*, respectively, of the alternate outlet conduit **52**. As seen in FIGURES 3 and 6, control lines **44***a*, **44***b* and **44***c* pass through the angle stock **78** forming a portion of chambers **14** to the other end of the receptacle **12** so that valves **42***a* and **42***b* may be controlled by these lines.

FIGURE 6 presents a very clear view of the over-all valve and control arrangements for outlet conduits **36** and **52**. In FIGURE 6 the upper gas permeable members **16** have been removed from their respective chambers **14***a*, **14***b* and **14***c* so that the entire piping arrangement is exposed.

As may also be seen in FIGURES 3, 4 and 5, a water tank **58** is placed upon the railway car to provide a storage unit for liquid to be used during the wet dusting process. Mounted between the storage receptacle **12** and tank **58** (as is best seen in FIGURE 5) is a positive displacement pump **64** which is utilized during the wet dusting process as has been previously described. This pump **64** is driven by a motor **65** as shown in FIGURE 5. The exact construction of this positive displacement pump is not critical to the present invention, and any suitable, commercially available pump may be utilized for the purpose.

As shown in FIGURES 3, 4 and 5, the compressor **21** is located upon a separate small railway car which may be connected to the tank car and carried as a unit along with the tank car. The compressor **21** is driven by the motor **23** which is also mounted upon the separate small car. The compressor may be of any suitable form, its design not being a critical point of the present invention.

It will be appreciated that the compressor **21** and its driving motor **23**, along with the associated conduits and control valves for compressor **21**, may be mounted on the same railway car with the storage receptacle **12** so that all of the mobile elements of the system are located on a single railway car.

FIGURE 10 is a perspective view showing the construction of one of the outlet conduit inlet control valves **42** or **54**. As shown in FIGURE 10, the outlet conduit **36** runs in a generally horizontal manner. The inlet **40** to conduit **36** is generally vertical. Disposed within inlet **40** is a control valve bulb **42** which is formed of a soft pliable material such as rubber or the like. This control valve bulb **42** is hollow, and communicating with the interior of control valve bulb **42** is a control line **44**. Control line **44** is in fluid communication with a cylinder **91** as shown in FIGURE 10. Cylinder **91** has a piston **92** disposed therein. The cylinder **91** is closed by a closure member **94**, and threaded through closure member **94** is a threaded piston rod **96**. The threaded piston rod **96** is secured to piston **92** so that upon rotation of rod **96**, piston **92** moves upwardly and downwardly in cylinder **91**. The knurled knob **98** is non-rotatably fixed to piston rod **96** to facilitate rotation of the piston rod.

The bulb **42**, line **44**, and cylinder **91** below piston **92** are filled with fluid so that the three elements when taken together form a closed hydraulic circuit. When the knurled knob **98** is rotated in a clockwise direction (when viewed from the top of FIGURE 10), the piston **92** is forced downwardly within cylinder **91**. This action causes the fluid within cylinder **91** and line **44** to be displaced into bulb **42** so that it totally expands bulb **42** and thereby causes bulb **42** to completley fill the inlet passage **40**. When the knurled knob **98** is moved in a counterclockwise direction, the piston **92** moves upwardly in a cylinder **91** and the hydraulic fluid is displaced by atmospheric pressure (or by the pressure of the particulate material **10** on the bulb **42**), thereby causing bulb **42** to partially collapse to partially open passage **40** and forcing the fluid up into cylinder **91**. While this control valve is particularly effective to perform the function of adjustably restricting or throttling conduit **40**, its specific construction is not one of the features of this invention. Other valve means can be utilized with equal facility to throttle and close off the flow of fluidized particulate material **10** through passage **40** into the outlet conduit **36**.

A preferred embodiment of the present invention has been disclosed in particular detail in the foregoing description. It will be appreciated that certain of these features of the foregoing preferred embodiment may be altered without departing from the spirit of the present invention. For example, the preferred embodiment has been disclosed as a mobile unit which may take on the particulate material at a certain location and transport it to a remote location to be diffused. While this embodiment is particularly adaptable for the rock dusting of coal mines, many other applications in which particulate material is to be handled might allow for a stationary storage receptacle **12**.

Further, it will be appreciated that while a compressor **21** and driving motor **23** have been disclosed as providing the source of gas under pressure and the source of vacuum for loading the storage receptacle **12**, the compressor is intended to illustrate only the preferred embodiment. In many instances, particularly in factories and within mines, sources of gas under pressure such as compressed air are piped to various locations within the factories or mines. Under such circumstances these sources of compressed air might be used to activate the fluidization and diffusion of the particulate solid material. Further, sources of vacuum are often available in factories and mines. These sources of vacuum may be utilized to load the storage receptacle **12**.

The invention in its preferred embodiment has been described in detail as a three cell unit. This is not a limiting number, and a greater or fewer number of cells may be utilized as dictated by the size of the bed of material desired and by the capacity of the source of gas under pressure that is available.

With the foregoing considerations in mind, it would be possible to utilize the tank car shown in FIGURE 3 or a similar car with a greater or fewer number of cells without the additional auxiliary compressor car. In such an instance the source of vacuum might be made available adjacent to the source of particulate material **10**. Thus the source of vacuum could be connected directly to the conduit **22** to provide loading of the receptacle **12**. Then, after the receptacle **12** was loaded and the tank car was moved to the face of the mine near to where the material was to be diffused, a source of compressed air or the like could be directly connected to conduit **22** to provide for fluidization, withdrawal and diffusion of the particulate material.

According to the provisions of the patent statutes, we have explained the principle, preferred construction, and mode of operation of our invention and have illustrated and described what we now consider to represent its best

embodiment. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. A method for handling particulate solid material in bulk lots for initial storage in a storage receptacle having a gas permeable member therein and ultimate use at some point remote from said storage receptacle, said remote point connected to said storage receptacle by an elongated conduit, said method comprising the steps of creating a vacuum within said storage receptacle below said gas permeable member to draw an inventory of said particulate solid material onto said gas permeable member within said receptacle, passing gas under pressure upwardly through said storage receptacle from below said gas permeable member at a velocity sufficient to maintain said particulate material in a fluidized condition so that said particles comprise a fluidized bed, withdrawing said gas from said receptacle at a point above said fluidized bed, separately withdrawing said particulate solid material from said fluidized bed, admitting said separately withdrawn material into said elongated conduit, and providing means to convey said material through said conduit.

2. A method for handling particulate solid material in bulk lots for initial storage in a storage receptacle having a gas permeable member therein and ultimate use at some point remote from said storage receptacle, said remote point connected to said storage receptacle by an elongated conduit, said method comprising the steps of creating a vacuum within said storage receptacle below said gas permeable member to draw an inventory of said particulate solid material onto said gas permeable member within said receptacle, passing gas under pressure upwardly through said storage receptacle from below said gas permeable member at a velocity sufficient to maintain said particulate material in a fluidized condition so that said particles comprise a fluidized bed, withdrawing said gas from said receptacle at a point above said fluidized bed, introducing said gas into said elongated conduit, separately withdrawing said particulate material from said fluidized bed, and introducing said withdrawn particulate material into said conduit so that said gas serves as a carrier medium for said withdrawn particulate material.

3. A method for handling particulate solid material in bulk lots for initial storage in a storage receptacle having a gas permeable member therein and ultimate use at some point remote from said storage receptacle, said remote point connected to said storage receptacle by an elongated conduit, said method comprising the steps of creating a vacuum within said storage receptacle below said gas permeable member to draw an inventory of said particulate solid material onto said gas permeable member within said receptacle, passing gas under pressure upwardly through said storage receptacle from below said gas permeable member at a velocity sufficient to maintain said particulate material in a fluidized condition so that said particles comprise a fluidized bed, withdrawing said gas from said receptacle at a point above said fluidized bed, introducing said withdrawn particulate material into said elongated conduit, mixing liquid with said withdrawn particulate material while in said conduit, and pumping said mixture of said material and said liquid through said conduit.

References Cited in the file of this patent

UNITED STATES PATENTS

2,116,603	Holly	May 10, 1938
2,527,455	Schemm	Oct. 24, 1950
2,565,835	Adams	Aug. 28, 1951
2,723,054	Londen	Nov. 8, 1955
2,734,782	Galle	Feb. 14, 1956
2,735,725	Galle	Feb. 21, 1956
2,781,234	Boisture	Feb. 12, 1957
2,791,472	Barthauer	May 7, 1957
2,813,702	Thomas	Nov. 19, 1957
2,915,337	Loomis	Dec. 1, 1959