July 12, 1938. P. G. MARR 2,123,537

METHOD AND APPARATUS FOR SPRAYING POWDER OR THE LIKE

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Fig. 1.

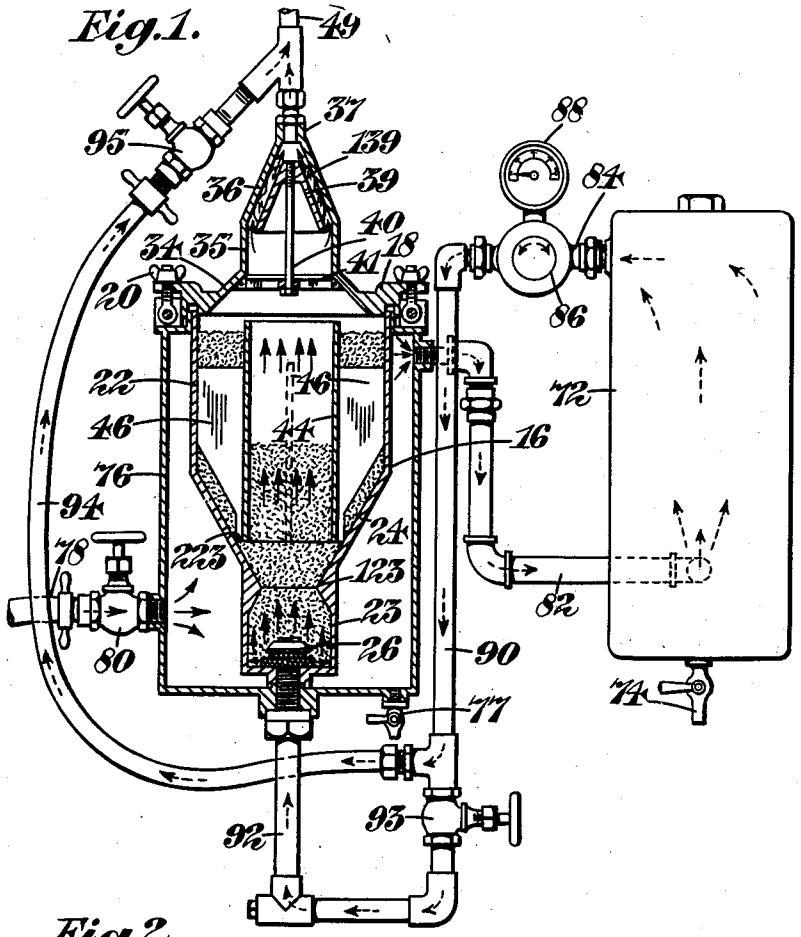


Fig. 2.

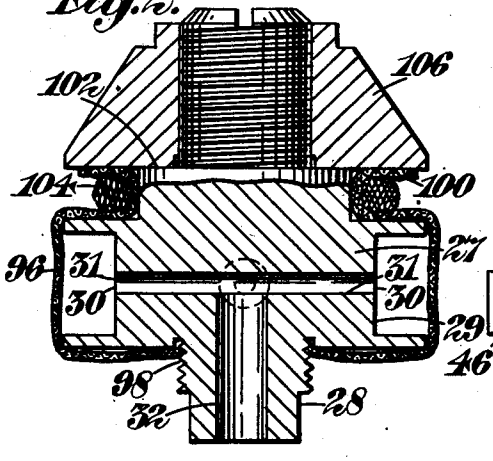
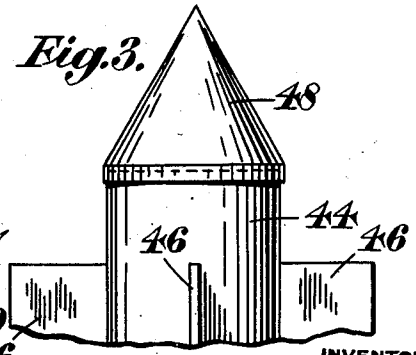


Fig. 3.



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METHOD AND APPARATUS FOR SPRAYING POWDER OR THE LIKE

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9 Claims. (Cl. 91—45)

This invention relates to a method for spraying powder, flock or other finely divided materials, hereinafter referred to generally as "powder", from a container by means of air under pressure admitted so as to agitate the powder within the container.

The invention also relates to powder-spraying apparatus of the type (hereinafter referred to as the type described) for carrying the said method into practice, in which apparatus a container for powder has an inlet for a supply of air at superatmospheric pressure below the free level of the powder, and an outlet spaced away above said free level for the discharge of the air having powder suspended therein.

The invention is particularly applicable to coating with a metallic powder, e. g. zinc or aluminium, a surface, such as structural steelwork, that has previously been rendered sticky or tacky by means of an adhesive material, such as wet paint, varnish, gum or the like.

The jet of powder which it is aimed to produce by the improved apparatus is not primarily a dense jet such as is used in a sand blasting process, as too dense a jet of powder may result in undue waste through only a small proportion of the powder adhering to the prepared surface; on the contrary, the jet to be produced is in the nature of a cloud of powder and air.

Powder spraying apparatus is known, in which the stopper of a powder container had an inlet for air under pressure, which was led by a tube to near the bottom of the container, and an outlet in the stopper allowed the air that had passed through the powder to escape in the form of a jet. When operated manually by means of a collapsible bulb puffs of powder can be produced, but they are not suitable for providing an even coating of powder on a painted structure, especially on a large scale such as for coating structural steelwork, whilst when used with a continuous supply of compressed air supplied by an air compressor at a pressure of several pounds or more per square inch, it is found that a vertical air passage is liable to form in the body of powder in the container, so that the emission of powder becomes very small or irregular, which renders the apparatus unsuitable for use in the manner referred to above.

The present invention has for its main object to overcome these and other drawbacks, and to enable a continuous steady jet of powder and air of substantially constant density to be emitted from a container for use in applying an even layer of the powder to a coating of paint or the like, and thereby provide improved results not hitherto obtainable.

According to an important feature of the invention there is provided a method of spraying powder from a container by means of air compressed to several atmospheres pressure admitted into the powder below its free level which always lies below the outlet of the container to provide a cloud space at the top of the container, consisting in subdividing a main current of highly compressed air within the body of the powder, near the bottom of the container, into streams of air bubbles or air pockets which flow in the powder towards the outlet of the container, aerate the powder substantially throughout its depth, and on leaving the free level of the powder carry particles with them and produce a cloud, removing moisture from the compressed air by cooling it prior to its admission to the container and utilizing the heat of the compressed air to heat the powder container to a temperature above that of the cooled air admitted into the powder.

The invention also provides apparatus for spraying powder comprising in combination a container for powder having an outlet spaced away above the free level of the powder for the discharge from a cloud space above said free level of the air having powder suspended therein and an air-admission aerating device for air at superatmospheric pressure that is situated in the container near the bottom thereof, and comprises a plurality of rectilinear imperforate air delivery passages all situated near the bottom of the container and arranged to direct a plurality of substantially horizontal streams of compressed air towards the adjacent surrounding part of the side wall of the container, the outlet ends of which passages are spaced away from the said side wall so far that substantially horizontal tunnels in the powder will be broken up under the weight of the head of powder to form air bubbles or air pockets which flow substantially throughout the depth of the powder to the outlet, thereby aerate the powder and produce a cloud of air and powder in said cloud space.

Conveniently, the container has a main chamber for powder, and a lower smaller base chamber also for powder, in which the aerating device is situated, that portion of the container at the junction of said chambers being conical and constricted.

According to a further feature of the invention, guide means is arranged in the container between the air inlet and the free level of the powder to lead the discontinuous air streams along a predetermined upward path through the body of the powder.

This guide means may be an upwardly-directed tube that is spaced throughout its length away from the wall of the container, and having its lower end received within a lower conical part of the container.

Other features of the invention relate to heating means for heating the powder in the container, to retaining means for preventing powder

from being carried backwards through the air inlet, and to other features described hereinafter.

The invention is diagrammatically illustrated by way of example in the accompanying drawing, wherein:—

Figure 1 is an elevation, partly in vertical section, showing one form of spraying apparatus according to the invention, adapted for carrying the improved method of spraying powder into practice;

Figure 2 is a vertical section showing an air-admission device on an enlarged scale;

Figure 3 is an elevation showing a cap used when filling the spraying apparatus with powder.

Like reference characters designate like parts throughout the several views.

Referring first to Figures 1 and 2, the spraying apparatus comprises a container for powder having a body portion 16 and a cover 18 detachably secured thereto by swivelling nut-equipped studs 20. The body portion 16 has three parts of different size, namely a cylindrical upper portion 22, a cylindrical lower portion 23, and a conical portion 24 between the same. The parts 22 and 24 constitute a main chamber for powder, while the part 23 constitutes a lower or base chamber, whereof the capacity is considerably smaller than that of the main chamber, for the purpose described hereinafter.

An air-admission device 26 is accommodated in the lower part of the base chamber 23. As shown most clearly in Figure 2, this device is an inlet nozzle having a circular head 27 and a threaded hollow stem 28 for connection to a supply of compressed air. An annular channel 29 surrounding the head 27, has opening into it four horizontally-directed air inlets 30 connected each by a horizontal duct 31 to a vertical bore 32 in the stem 28. The admitted current of compressed air will be broken up as described hereinafter and subdivided into a plurality of smaller discontinuous air streams which will be distributed in and aerate the powder and flow therein towards the outlet of the container, and produce a cloud of air and powder above the free level of the body of powder in the container.

The cover 18 is so shaped as to provide the upper part of the container with a cloud chamber or mixing chamber that lies above the body of the container and serves for receiving the dust-laden air before it leaves the outlet. The cover 18 has parts of different size, namely a lower conical part 34, a cylindrical part 35 of smaller diameter above the latter, an upper conical part 36, and a tubular portion 37 having the outlet of the container. The cloud chamber is of smaller cross-section than the part 22 of the body of the container, is substantially conical in shape, and the parts 34 and 36, which serve for guiding powder-laden air to the outlet, both slope upwards, so that surplus powder that impinges on the walls of the cloud chamber, and is not ejected through the outlet, will fall back into the body of the container.

After the container has been filled with powder to a suitable height, and air under suitable super-atmospheric pressure is admitted continuously into the powder below its free level, the main current of air entering through the bore 32 of the air-admission device is divided in the latter into branch currents of air in the horizontal ducts 31, and each of these is subdivided into streams of air bubbles or pockets which flow upwards in the powder towards the outlet. These streams are so weak in relation to the head of powder opposing their flow as to prevent the formation of tunnels, shafts or free passages by them in the powder, but are so strong that, on leaving the free level of the powder, they will carry particles with them and produce a cloud. In other words, the air streams pass discontinuously through the powder and aerate it by forming therein air pockets or bubbles that burst at the free level of the powder. The breaking up of the air into air pockets or bubbles is promoted because the air currents leaving the inlets 30 flow substantially horizontally through part of the body of powder which tends to fall under gravity on to them and break them up.

When the top surface of the powder is at a comparatively high level in the container, the powder may reach the outlet in a denser cloud than may be required and may then be ejected in too dense a jet. Means may, therefore, be employed to hinder the propulsion of the dust-laden air by shielding the outlet before the powder reaches it in dense form, thus ensuring a desired strength of mixture of air and powder, and regularity of discharge thereof. As illustrated in Figure 1, this shielding means consists of a baffle 39 arranged between the free level of the powder and the outlet, which baffle is so shaped, preferably as a cone or pyramid, as to prevent powder from settling on its upper face.

This baffle 39, in the form of a hollow cone, is carried by the upper end of an internal stem 40, whereof the lower nut-equipped end is detachably carried in a spider 41 mounted in lugs at the junction of the two parts 34, 35 of the cloud chamber. The baffle 39 thus forms with the conical part 36 of the cloud chamber, an annular space through which the dust-laden air passes to the outlet. The upper part of the cloud chamber, whether provided with the baffle 39 or not, diminishes in size towards the outlet. This diminution of capacity is accentuated when the conical baffle, which in some cases may be a solid cone, is provided quite close to the outlet. The baffle 39, which carries spacing ribs 139, preferably has its stem 40 loosely carried by the spider 41 so that it may vibrate slightly owing to the powder impinging on it, thus tending to prevent powder from settling permanently on it.

When the powder in the container is nearly exhausted, and its free level becomes comparatively low, there is a danger that the force of the air admitted to the container may be so strong that free passages or shafts will be blown through the powder, or "wells" may be formed in the powder. In order to prevent air from flowing continuously through a free passage in the powder, or for delaying such flow, when the quantity of powder in the body of the container has become depleted, means is provided which may be constituted by a baffle movable with the changes in level of the top surface of the powder, as described hereinafter. The base chamber 23 serves the same purpose, as its capacity is smaller than that of the main chamber 22, 24 and the air inlet is situated in the lower part of the base chamber. This base chamber is preferably so dimensioned that its height is such that when there is no powder left in the main body 22, 24 of the container, the head of powder in the base chamber, when full or nearly full, will still be sufficient to cause the formation of streams of air bubbles or pockets, and to prevent free passages of air from being formed through the powder.

The lower part of the main chamber **22**, **24** is streamlined to prevent an accumulation of powder from permanently lodging therein above the base chamber **23**, and for leading the powder into the latter. Preferably, that portion of the container at the junction of the main and base chambers has the form of a Venturi tube, for the purpose of increasing the velocity of the air streams as they enter the main chamber. The constricted annular portion **123** of substantially triangular cross-section is fitted to help to guide the bubbles up the guide tube. It is of smaller diameter than the guide tube. When the powder level falls below the circular feed slot **223** and the bubbles therefore burst below that slot, the constriction **123** causes the powder cloud to be guided up the guide tube, instead of permitting some of it passing through the feed slot. This arrangement thus delays the time when the density of the delivered jet seriously changes owing to the considerably diminished quantity of powder left in the container.

Guide means in the form of an upwardly-directed tube **44** is preferably arranged in the container above the air inlet. When the free level of the powder is above the annular slot **223** described hereinafter, this tube will lead the discontinuous air streams along a predetermined upward path through the powder, while, when the powder level lies below the slot **223**, the tube serves as a guide for the powder cloud. The discontinuous air streams are thus prevented from bursting haphazardly over the entire area of the top surface of the powder, when the powder level is above the slot **223**. The guide tube **44**, which may be either cylindrical, as shown, or funnel-shaped, is spaced throughout its length away from the peripheral wall of the container, and has its lower end received in spaced relation within the conical part **24**, thus providing an annular feed slot or gap **223** at the bottom of the tube **44**. This tube is provided with four lateral wings **46**, whereof the lower ends are cut away and bear on the conical part **24** of the main chamber, so that the tube **44** can be readily removed when desired for cleaning purposes and for emptying a residue of powder from the container. When filling the container with powder, a conical cap **48** is preferably placed on the top of the tube **44**, as shown in Figure 3, so that the powder is filled in by way of the annular space surrounding the tube **44** and, after filling the base-chamber **23**, rises part way up the inside of the tube **44** and also to near the top of the annular outer space surrounding it. When the apparatus is in use, the discontinuous air streams, or the majority thereof, will be guided up the tube, and the cloud composed of dust-laden air will be formed in the upper part of the tube and rise into the cloud chamber. Powder surrounding the tube will gradually flow downwards towards the air inlet to replace the powder that leaves the container, being assisted by the agitation of the powder by the air streams. By reason of the free space or gap at the top end of the guide tube powder that does not find its way through the outlet is prevented from accumulating and piling up unduly upon the powder already within the tube, because a good deal of it will tend to be thrown outward and descend on to the top of powder surrounding the tube. The guide tube **44** thus constitutes means for keeping that part of the top surface of the powder towards which most of the air rises, situated below the level of the remainder of the top surface for assisting in producing a jet of dust-laden air of uniform density. Accumulations in the guide tube might, in certain circumstances, tend to upset the consistency of the mixture or choke the outlet. If desired, the tube **44** may be perforated and, in some cases, it may be extended to the top of the main chamber, as described hereinafter.

The outlet **37** of the container may be provided with a discharge nozzle, but it is preferably connected by a flexible delivery tube **49** with a nozzle or spray gun.

Preferably, the container **16** is operatively connected to moisture-eliminating means through which the compressed air, e. g. at a pressure of 30 to 70 lbs. per square inch, is passed before it is admitted to the container in order to prevent moisture from damping the powder in the latter, which is a matter of great importance for the proper working of the apparatus. This moisture-eliminating means may consist of a condenser and after-cooler **72** in which the compressed air can expand and thus deposit its moisture by condensation, a drain cock **74** being provided at the base of the condenser.

In order to assist in keeping the powder dry in the container, heating means is preferably provided for heating the same, e. g. electrically, or by means of steam, hot water, hot oil or other medium. Preferably, the heating means is constituted by a jacket **76** surrounding the container, through which jacket the compressed air is passed on its way to the moisture-eliminating means. As illustrated, a main air-supply pipe **78**, for the compressed air, which will be heated by the compressing operation, is connected by way of a stop-cock **80** to the jacket **76**, having a drain cock **77**, and flows by way of a pipe **82** to the lower portion of the condenser **72**, the upper portion of which it leaves by way of a pipe **84** connected to a reducing valve **86** provided with a manometer **88**. An air-supply pipe **90** connected at one end to the reducing valve **86**, has its other end connected to two branch pipes **92**, **94** provided respectively with stop valves **93** and **95**. The branch pipe **92** leads to the stem **28** of the air-admission device **26**, and the branch pipe **94** is connected to the delivery tube **49**, so that it serves to supply additional or fresh air to the dust-laden air that is passing through the tube **49** before it leaves the nozzle **52**. This arrangement ensures that the powder container is heated to a temperature above that of the air admitted to it, so that moisture is not liable to be condensed in the container. The jacket **76** also functions as a moisture-eliminating means owing to the cooling effect of the container on the heated compressed air admitted into the jacket. The branch pipe **94** may be led from any desired point on the air-supply line, for example from a point anterior to the pressure reduction valve **86**, so that air of a pressure greater than that passing through the branch **92** may pass through the branch **94**. Also, the end of the pipe **94** shown connected to the outlet branch **37** may, if desired, be introduced into the cloud chamber **35**, or into the body of the container above the free level of the powder.

When the spray jet is shut off by closing the valves **93** and **95**, or by closing a valve carried by the nozzle or spray gun, the powder container **16** will temporarily remain full of compressed air. If, for any reason, the air pressure in the powder container is higher than that in the

branch pipe 92, the back pressure within the powder container 16 will tend to force powder back through the air inlet in the base chamber 23 and into the branch pipe 92. This would be very unsatisfactory, as the pipe 92 might become choked. To obviate this defect, retaining means in the form of a screen 96 of finely perforated textile material is arranged between the air inlet and the powder in the container. As shown most clearly in Figure 2, this screen 96 has the form of a small bag, whereof the bottom has a hole at 98, through which the stem 28 extends, and the neck 100 is secured in position around a reduced portion 102 of the head 27 of the admission nozzle by a tie member 104 beneath a nut 106 screwed on the top of the head 27. This screen, e. g. of unbleached calico, is of such fine mesh, that it allows the air to pass freely through it into the chamber, but does not allow powder to pass through in the opposite direction. The screen 96 also assists in breaking up the entering air into a plurality of fine air streams that aerate the powder through the whole or part of its mass on their way to the discharge outlet. This aeration is very important, as the air bubbles burst on reaching the free surface of the powder and form the cloud of dust-laden air in the cloud chamber which serves as a mixing chamber. A certain degree of pressure must be maintained in the powder container in order to provide a sufficiently powerful jet emitted from the nozzle. At the same time, the higher the air pressure in the powder container, the denser becomes the jet of powder. To maintain an adequate air pressure and yet regulate the density of the dust-laden air, some fresh air is admitted to the dust-laden air, as described above, above the level of the powder. The cloud is thus diluted with fresh air from this by-pass or branch pipe 94, and the amount of dilution can be regulated by the valve 95. Further dilution of the cloud may be obtained by partially closing the valve 93 that regulates the supply of compressed air to the air inlet in the base chamber 23. Consequently, by adjusting the valves 93 and 95, wide variations in the density of the mixture of air and powder can be obtained without changing the pressure of the compressed air passing through the valve 80, that is to say, without varying the force of the jet delivered by the nozzle. The apparatus is thus particularly adapted for producing a continuous steady jet of powder-laden air of constant composition and density, such as is required for providing an even coating of metallic, e. g. zinc or aluminium, powder on large surfaces of paint.

It will be appreciated from the above that the improved spraying apparatus is of such a size and so heavy when charged with powder, that it cannot be conveniently carried in the hand of an operator, and is to be clearly distinguished from manual spraying devices so small and light that they can be carried in the hand and used like a "gun". Such manual devices comprise containers which can hold only a relatively small quantity of metal powder, so that there is no effective "head" or weight of powder which can function as described above to break up the air streams and thereby aerate the powder throughout its depth.

Various modifications may be made in the details of construction described above without departing from the invention. For example, the screen 96 may be omitted. Moreover, a feed hopper arranged outside the container may be arranged to feed powder to the latter, preferably at or near the bottom thereof.

I claim:—

1. A method of spraying powder from a container by means of air compressed to several atmospheres pressure admitted into the powder below its free level which always lies below the outlet of the container to provide a cloud space at the top of the container, consisting in subdividing a main current of highly compressed air within the body of the powder, near the bottom of the container, into streams of air bubbles or air pockets which flow in the powder towards the outlet of the container, aerate the powder substantially throughout its depth, and on leaving the free level of the powder carry particles with them and produce a cloud, removing moisture from the compressed air by cooling it prior to its admission to the container, and utilizing the heat of the compressed air to heat the powder container to a temperature above that of the cooled air admitted into the powder.

2. Apparatus for spraying powder, comprising a container having a main chamber for powder, a lower smaller base chamber for powder, and an upper conical chamber having an outlet providing a cloud space above the free level of powder in the main chamber, that portion of the container at the junction of said main and base chambers being constricted and having the form of a Venturi tube, an air-admission device for air at super-atmospheric pressure in said base chamber, a fabric screen shrouding the air-admission device, a vertical guide tube extending from a situation adjacent to said junction of the main and base chambers to a situation at the bottom of the cloud space, and a conical baffle situated in the upper portion of the container and forming an annular space leading to the outlet.

3. Apparatus for spraying powder comprising a container having a main chamber for powder and a lower smaller base chamber for powder, which main chamber has an outlet spaced away above the free level of the powder for the discharge from a cloud space above said free level of the air having powder suspended therein, that portion of the container at the junction of said main and base chambers being constricted and having substantially the form of a Venturi tube, and an air-admission aerating device for air at super-atmospheric pressure that is situated in the base chamber and comprises a plurality of rectilinear imperforate air-delivery passages all situated near the bottom of the base chamber and arranged to direct a plurality of substantially horizontal streams of compressed air towards the adjacent surrounding part of the side wall of the base chamber, the outlet ends of which passages are spaced away from the said side wall so far that substantially horizontal tunnels in the powder will be broken up under the weight of the head of powder to form air bubbles or air pockets which flow substantially throughout the depth of the powder to the outlet, thereby aerate the powder and produce a cloud of air and powder in said cloud space.

4. Apparatus for spraying powder, comprising a container for powder having an outlet spaced away above the free level of the powder for the discharge from a cloud space above said free level of the air having powder suspended therein, an air-admission aerating device for air at super-atmospheric pressure situated in the container near the bottom thereof to aerate the powder throughout its depth and produce a cloud of air

and powder in said cloud space, and guide means constituted by an upwardly directed tube that is open at both ends and has its lower end spaced away from the lower portion of the side wall of the container above the aerating device to form an annular gap, and has its upper end situated in said cloud space.

5. Apparatus for spraying powder comprising in combination a container having a main chamber for powder and a lower small base chamber for powder, which main chamber has an outlet spaced away above the free level of the powder for the discharge from a cloud space above said free level of the air having powder suspended therein, that portion of the container at the junction of said main and base chambers being conical and constricted, an air-admission aerating device for air at superatmospheric pressure situated in the base chamber to aerate the powder throughout its depth and produce a cloud of air and powder in said cloud space, and a vertical guide tube open at both ends having its lower end situated at, but spaced away from said conical portion of the wall of the container to form an annular gap, and having its upper end situated in said cloud space.

6. Apparatus for spraying powder comprising in combination a container for powder having an outlet spaced away above the free level of the powder for the discharge from a cloud space above said free level of the air having powder suspended therein, and an air-admission aerating device for air at superatmospheric pressure that is situated in the container near the bottom thereof and comprises a plurality of rectilinear imperforate air-delivery passages all situated near the bottom of the container and arranged to direct a plurality of substantially horizontal streams of compressed air towards the adjacent surrounding part of the side wall of the container, the outlet ends of which passages are spaced away from the said side wall so far that substantially horizontal tunnels in the powder will be broken up under the weight of the head of powder to form air bubbles or air pockets which flow substantially throughout the depth of the powder to the outlet, thereby aerate the powder and produce a cloud of air and powder in said cloud space, which aerating device has a horizontal annular channel that opens laterally towards the wall of the container, and said air-delivery passages open radially into said channel, and a fabric screen shrouds the channel at its otherwise open outer side.

7. Apparatus for spraying powder comprising a container for powder having an outlet spaced away above the free level of the powder for the discharge from a cloud space above said free level of the air having powder suspended therein, an air-admission aerating device for air at superatmospheric pressure that is situated in the container near the bottom thereof, which aerating device comprises a circular head having an annular groove and below the latter a horizontal annular channel that opens laterally towards the wall of the container and has a plurality of radial horizontal air-delivery passages that open into it, and a fabric screen in the form of a cylindrical bag whereof the lower end has a hole to encircle the air inlet and is clamped between the bottom of the head and the base of the container and the upper end of the bag is secured in said groove, which aerating device is arranged to direct a plurality of substantially horizontal streams of compressed air through the screen towards the adjacent surrounding part of the side wall of the container, said screen being spaced away from the said side wall so far that the air streams will be broken up under the weight of the head of powder to form air bubbles or air pockets which flow substantially throughout the depth of the powder to the outlet, thereby aerate the powder and produce a cloud of air and powder in the cloud space.

8. Apparatus for spraying powder comprising in combination a container for powder having an outlet spaced away above the free level of the powder for the discharge from a cloud space above said free level of the air having powder suspended therein, an air-admission aerating device for air at superatmospheric pressure that is situated in the container near the bottom thereof and comprises a plurality of rectilinear imperforate air-delivery passages all situated near the bottom of the container and arranged to direct a plurality of substantially horizontal streams of compressed air towards the adjacent surrounding part of the side wall of the container, the outlet ends of which passages are spaced away from the said side wall so far that substantially horizontal tunnels in the powder will be broken up under the weight of the head of powder to form air bubbles or air pockets which flow substantially throughout the depth of the powder to the outlet, thereby aerate the powder throughout its depth and produce a cloud of air and powder in said cloud space, and heating means for heating the contents of the container comprising a jacket on the latter through which jacket compressed air, serving as a heating medium, is supplied to the aerating device, which jacket also serves as a condenser for removing moisture from the compressed air.

9. Apparatus of the character described for spraying powder comprising a container having a main chamber for powder and a lower smaller cylindrical base chamber for powder, the said base chamber having a substantially horizontal base upon which the lower portion of the powder lies, which main chamber has an outlet spaced away above the free level of the powder for the discharge from a cloud space above said free level of the air having powder suspended therein, and an air-admission aerating device for air at superatmospheric pressure that is situated in the base chamber and comprises a plurality of rectilinear imperforate air-delivery passages situated near said base and arranged to direct issuing compressed air that will "tunnel" horizontally in the adjacent mass of powder, the outlet ends of which passages are spaced away from the side wall of the base chamber so far that air jets forming substantially horizontal tunnels in the powder will weaken in force and be broken up under the weight of the head of powder, before impinging upon the said side wall, to form air bubbles or air pockets which flow substantially throughout the depth of the powder to the outlet, thereby aerate the powder and produce a cloud of air and powder in said cloud space.

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