United States Patent

[11] 3,567,120

[72] Inventor **Nakao Suda**
Sado-gun, Japan

[21] Appl. No. **723,449**
[22] Filed **Apr. 23, 1968**
[45] Patented **Mar. 2, 1971**

[73] Assignee **Mitsubishi Jukogyo Kabushiki Kaisha**
Tokyo, Japan

---

[54] **METHOD FOR SPREADING POWDER AND DEVICE THEREFOR**
6 Claims, 14 Drawing Figs.

[52] **U.S. Cl.** **239/8,** 239/77, 239/152, 239/171, 239/450, 239/561, 239/567, 239/655

[51] **Int. Cl.** **A01n 17/02,** A62c 1/12

[50] **Field of Search** 239/654, 655, 152, 153, 154, 450, 77, 78, 171; 239/146, 547, 188, 8

[56] **References Cited**

UNITED STATES PATENTS

3,341,125	9/1967	Sweeney et al.	239/8
3,439,875	4/1969	Randall et al.	239/8
483,269	9/1892	Talley	239/655
1,058,752	4/1913	Johnson	239/655
1,538,779	5/1925	Allgrum et al.	239/655
2,388,798	11/1945	Parker	239/655
2,740,230	4/1956	Clapper	239/654

Primary Examiner—Lloyd L. King
Attorney—McGlew and Toren

ABSTRACT: A method for spreading powder in which air under pressure carrying a pulverulent treating agent in the form of powder and/or granular material is forced into a soft and light tubular pipe from one end or both ends thereof and discharged or spread downwardly through a plurality of nozzles disposed spaced apart from each other longitudinally of the tubular pipe.

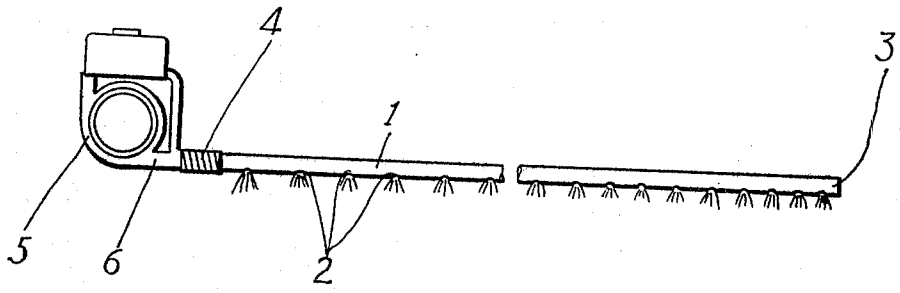


FIG. 1

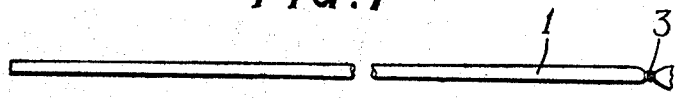


FIG. 2

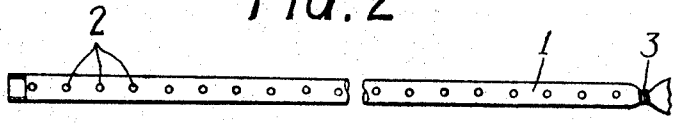


FIG. 3

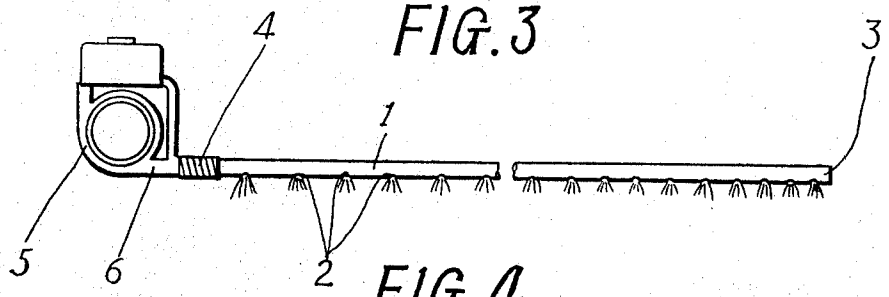


FIG. 4

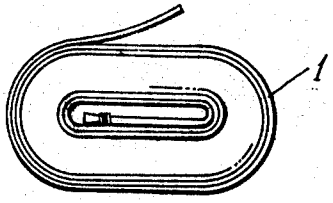
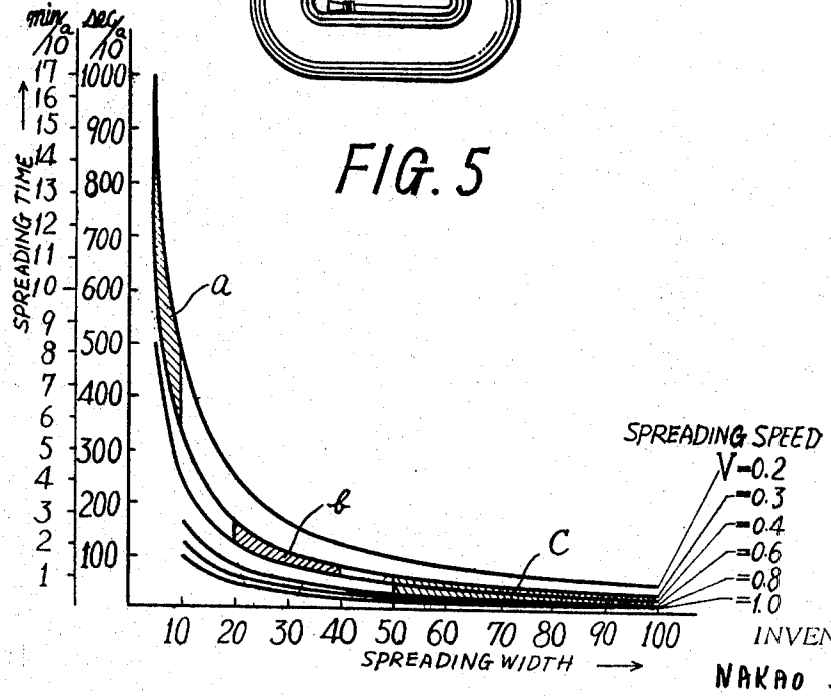


FIG. 5



INVENTOR.
NAKAO SUDA

BY Mulgan and Town
Attorneys

FIG. 7

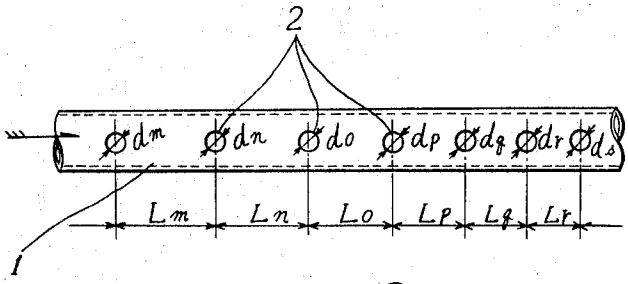


FIG. 8

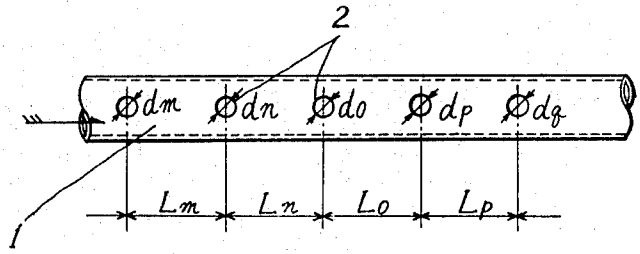


FIG. 9

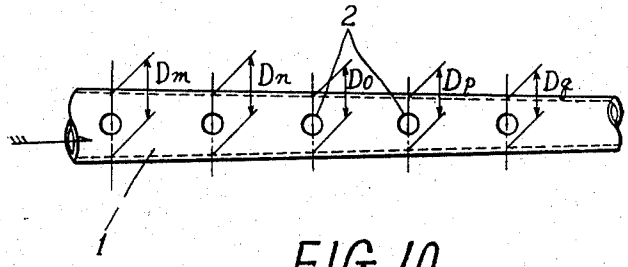


FIG. 10

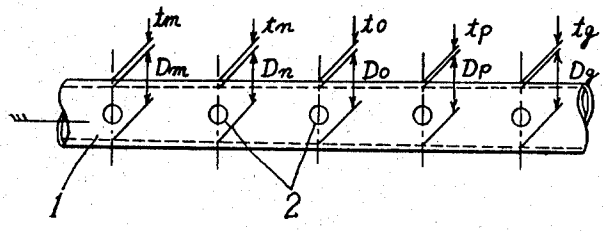
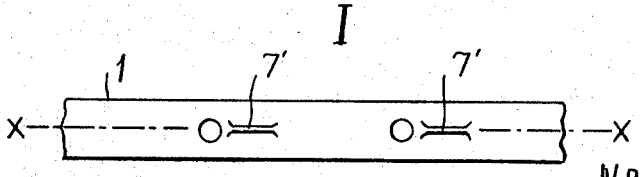


FIG. 11



INVENTOR.
NAKAO SUDA

BY Murgless and Torrey
attorneys

FIG. 11

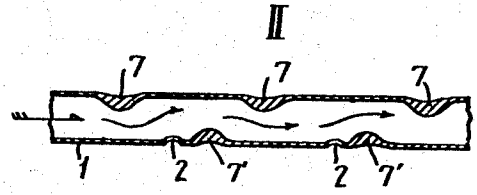


FIG. 12

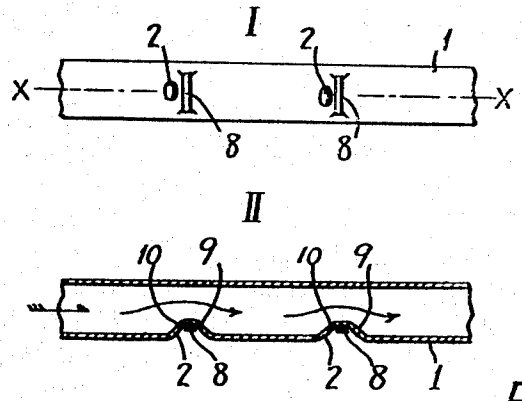
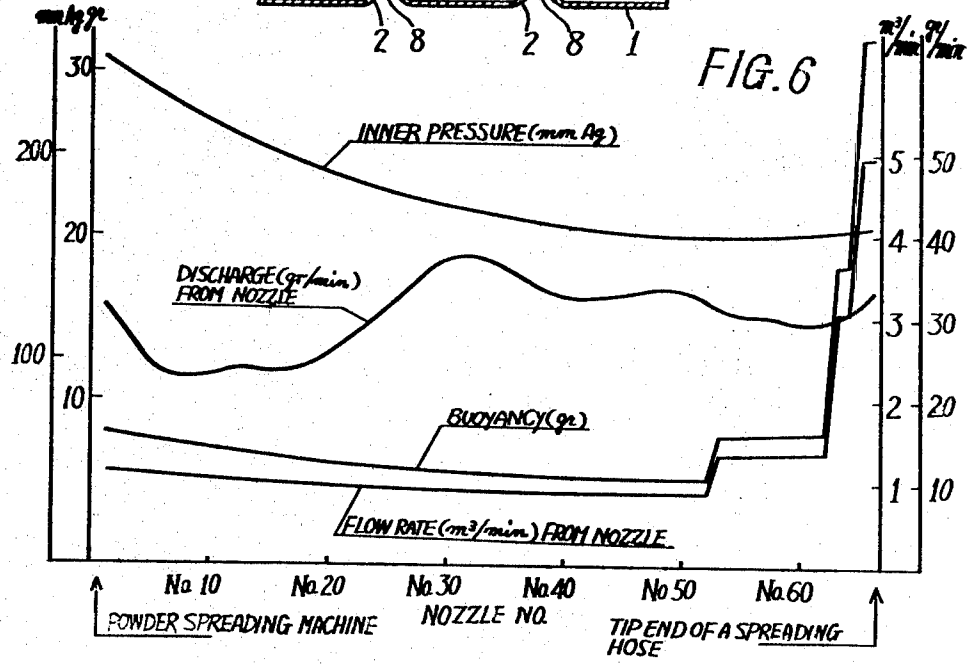


FIG. 6



INVENTOR.
NAKAO SUDA
BY
Marlow and Tuttle
attorneys

METHOD FOR SPREADING POWDER AND DEVICE THEREFOR

BRIEF SUMMARY OF THE INVENTION

The present invention relates to a method for spreading powder and device therefor.

In the specification, it is to be understood that "powder" refers to "powder," "granular material" and "a mixture of powder and granular material." In the conventional work of spreading agricultural chemical agents such as herbicides, insecticides, fungicides, etc., an operator carrying a power-driven spreading machine on his shoulder spreads the agents through a pipe connected by a universal joint to the machine. In the case of spreading a large quantity of the agents over a large area, a helicopter or a light plane is employed to spread the agents from the air over a predetermined area. However, in the former case of manual spreading, the operator must move around the whole area for spreading the agents so that the manual spreading operation involves very hard labor, but results in less productivity. In the latter case of employing a helicopter or a light plane, the cost is very high with less spreading efficiency so that this method cannot be employed on a small farm as an advantageous or economical method.

In view of the above, the fundamental object of the present invention is to eliminate the drawbacks in the conventional agricultural chemical agent-spreading method as described above.

Another object of the present invention is to provide a method for spreading powder characterized by forcing air under pressure, carrying an agent in the form of powder, into at least one terminal of a soft and light hose, and discharging or ejecting downwardly the air, carrying the agent in the form of powder and/or granular material, from a plurality of nozzles disposed spaced apart from each other longitudinally of the hose.

Still another object of the present invention is to provide a method for spreading powder characterized in that one side of a soft and light hose is provided with a plurality of nozzles spaced apart from each other longitudinally of the hose, and one end of the hose is coupled to means for discharging air carrying an agent in the form of powder and/or granular material.

The present invention is more particularly directed to a method for spreading powder in which, as a spreading hose, is used an elongated tube made of soft plastic film such as polyethylene, polypropylene, etc. having a very thin wall thickness; this hose is provided with a suitable number of small apertures for discharging or ejecting powder or the like, spaced apart from each other by a suitable distance; these small apertures are so arranged and disposed that they are directed downwardly when the hose is extended for spreading operation; and one end of the hose is closed in any suitable manner such as by welding, fastening, etc. while the other end of the hose is coupled through a suitable coupling to a discharge port of a power-driven spreading machine.

The method of operation of the spreading device according to the present invention is as follows. First, the power-driven spreading machine is activated. When the air is discharged or ejected through the small apertures of the hose against the ground, the reaction force of the air jet acts upon the hose so as to give buoyancy to the hose, thereby holding the hose at a certain level above the ground.

At the same time, the agricultural chemical agents carried by the air under pressure are discharged or spread through the small apertures of the hose. Therefore, when the hose is moved in a suitable direction in a suitable manner, while the agents are being discharged or spread as described above, a uniform and effective spreading operation can be accomplished.

To facilitate an understanding of the present invention, FIG. 5 shows the characteristic curves of the spreading powders of

the devices of the present invention and of the prior art, respectively. The parameter of the characteristic curve is the speed of moving the device. The hatched portion *a* in the figure indicates the spreading time per unit area when a conventional shoulder type power-driven spreading machine only is used; the hatched portion *b*, the spreading time per unit area when a spreading hose according to the present invention is attached to the spreading machine; and the hatched portion *c*, the spreading time per unit area when a spreading hose according to the present invention is attached to a farm duster. When only a shoulder-type power-driven spreading machine is used in a conventional method, the spreading range is approximately 10 meters at the most, even if the operator extends his hand to the full. However, when a spreading hose according to the present invention is used together with the power-driven spreading machine, the spreading range can be extended as far as 100 meters and spreading time can be reduced to such an extent that it is beyond comparison. Thus, it will be clearly understood that the method and device for spreading powder according to the present invention has an extremely high performance as compared with the conventional methods and devices.

BRIEF EXPLANATION OF THE DRAWINGS

FIG. **1** is a front elevation view of a spreading hose used in the present invention;

FIG. **2** is a bottom view thereof;

FIG. **3** is a view of a general embodiment of a powder-spreading device according to the present invention;

FIG. **4** is a front elevation view of a spreading hose in its wound state;

FIG. **5** graphically illustrates the characteristic performance curves of various spreading devices;

FIG. **6** graphically illustrates the pressure distribution, the discharge distribution, the buoyancy distribution and the air flow rate distribution along the longitudinal direction a of a spreading hose constructed according to the first embodiment of the present invention shown in FIG. **1**, **2** and **3**;

FIGS. **7**, **8**, **9** and **10** show various respective embodiments of the present invention for ensuring the uniform spreading; and

FIGS. **11** and **12** show respectively two embodiments of a spreading hose, according to the present invention, in which the inner wall surface of the spreading hose is provided with a plurality of barrier projections spaced apart from each other by a suitable distance in order to cause wavering and vortex motions of the air carrying the agricultural chemicals such as herbicides, insecticides and fungicides, thereby ensuring the effective spreading operation of said agricultural chemicals containing granular agents, FIGS. **11–I** and **12–I** being bottom views while FIGS. **11–II** and **12–II** are the sectional views taken along the lines X–X of FIGS. **11–1** and **12–1**, respectively.

DETAILED DESCRIPTION OF THE INVENTION

A powder-spreading method according to the present invention will be best understood from the following description taken in conjunction with the accompanying drawings, in which the most general embodiment of the present invention is shown in FIGS. **1**, **2** and **3**. A spreading hose **1** made of thin polyethylene has a plurality of small apertures **2** at the bottom side thereof for discharging or ejecting the agricultural chemicals. One end **3** of the spreading hose may be closed in a suitable manner but the other end of the spreading hose **1** is coupled through a coupling **4** to a discharge port **6** of a power-driven spreading machine **5**. When the spreading hose **1** is not in use, it is a flattened tube and may be folded or wound like a belt for storage as shown in FIG. **4**. When spreading work is to be made, the spreading hose **1** is extended over the ground. When the power-driven spreading machine **5** is started, the spreading hose **1** is expanded round and the air is discharged or ejected from the small apertures **2** together with the

agricultural chemicals. At the same time, the reaction of the ejected flow of the air acts as buoyancy upon the spreading hose 1 so that the spraying hose 1 is caused to float over the ground as soon as the spreading machine 5 is driven, whereby the spreading hose 1 can be maintained at a level or height above the ground while the agricultural chemical powders are being spread.

Thus, when the spreading hose 1 is located at a right angle relative to the direction of movement of the spreading hose 1, the spreading operation can be effected instantaneously in a width equivalent to the length of the spreading hose 1. When the spreading hose 1 is inclined relative to its direction of movement, a spreading hose holder on the left side is protected from being exposed to the spread chemical powders even when the wind blows at a right angle relative to the direction of movement of the spreading hose 1. Another advantage of positioning the spreading hose 1 angularly of the direction of its movement is that nonuniform spreading over the whole length of the spreading hose can be eliminated even if the spreading hose 1 is throttled or closed partially because it is too long.

FIG. 6 shows the performance characteristic curves of a spreading device constructed according to the first embodiment of the present invention shown in FIGS. 1, 2, and 3. The spreading hose 1 having the length of 20 m. was made of a soft polyethylene film having a thickness of 0.08 mm. (approximately 0.032 inches) and a mean diameter of 40 mm. (1 37/64 inches). The pitch of the small apertures was 300 mm. (approximately 15 inches), and the numbers and diameters of the small apertures from the ends coupled to the power-driven spreading machine to the center of the spreading hose were 52 × 8 mm., 10 × 10 mm., 25 × 15 mm., and 2 × 19 mm.

In the case of a spreading hose having a length of 100 m, the spreading hose was made of a soft polyethylene film having a wall thickness of 0.1 mm.

The mean diameter of the spreading hose was 125 mm., and the pitch of the small apertures was 500 mm. The numbers and diameters of the small apertures from the ends coupled to the power-driven spreading machines to the center of the spreading hose, 15 × 5 mm., 65 × 6 mm., 45 × 7 mm., 25 × 8 mm., 20 × 10 mm., 15 × 11 mm., 10 × 13 mm., and 5 × 14 mm.

The most important technical problem encountered in the practical use of a powder-spreading device according to the present invention is to uniformly spread the powder. It is imperative that the powders should be spread uniformly over the whole length of the spreading hose. When the diameter of the hose is fixed and the pitch of the small apertures is constant throughout the whole length of the hose, the flow rates of the air from the small apertures will be reduced at the small apertures nearer to the end of the hose remote from the spreading machine so that the discharge of the agricultural chemical powder carried by the air discharged through these small apertures will be reduced accordingly.

Thus, it is necessary to increase the diameters of the small apertures as they approach to the end of the spreading hose remote from the spreading machine when a pitch is fixed over the whole length of the spreading hose; to decrease the pitches as the small apertures approach to the end of the spreading hose remote from the power-driven spreading machine when the diameters of the small apertures is fixed; or to decrease the inner diameter of the spreading hose as it nears to the end thereof remote from the power-driven spreading machine.

FIGS. 7, 8, 9 and 10 illustrate some embodiments of the present invention for effecting the uniform spreading of the agricultural chemical powders. In the embodiment shown in FIG. 7, the diameter of the small apertures is fixed while the pitches thereof are decreased continuously or in steps. That is, when the diameter of the spreading hose is fixed throughout the whole length thereof and the diameters of all of the small apertures are equal, the discharge of the agricultural chemical powders through the small apertures decreases gradually as the small apertures approach from the coupling to the end remote from the power-driven spreading machine. Therefore, the quantity of the powder supplied or spread over an object is varied. However, when the pitches of the small apertures are made shorter, the quantity of the powders supplied or spread per unit length of the spreading hose, that is over unit area of an object, can be maintained constant over the whole length of the spreading hose.

That is, when

$$d_m = d_n = \text{---} = d_r = \text{const.},$$

the pitches are continuously decreased as shown by the relation of:

$$L_m > L_n > \text{---} > L_r$$

or the pitches are decreased in step as shown by the relation of:

$$L_m = L_n > L_o = L_p\ L_g => L_r$$

FIG. 8 shows an embodiment of the present invention in which the diameters of the small apertures are decreased continuously or in steps while the pitch is maintained constant. When the inner diameter of the spreading hose is maintained constant and the pitch of the small apertures is also kept constant, the inner pressure of the spreading hose is decreased toward its end remote from the power-driven spreading machine.

In this case, however, by gradually increasing the diameters of the small apertures as they approach to the end of the spreading hose remote from the power-driven spreading machine, the decrease of the discharge of the powder from the small apertures of the spreading hose can be compensated, thereby maintaining a uniform supply or spread quantity of the powder per unit area over the whole length of the spreading hose.

That is, when

$$L_m = L_n = \text{---}\ L_r = \text{const.},$$

the diameters of the small apertures are gradually and continuously increased as shown by the relation of:

$$d_m < d_n < d_o \text{ ---} < d_r \text{ or}$$

the diameters of the small apertures are increased in step as shown by the relation of:

$$d_m = d_n < d_o = \text{---} < d_q = d_r$$

FIG. 9 illustrates a spreading hose according to the present invention in which the diameter of the spreading hose is reduced continuously and gradually toward its end remote from the power-driven spreading machine. As described hereinbefore, the air flow rate in the spreading hose is reduced as the air approaches to the end remote from the spreading machine because much air is flown out or discharged through the small apertures of the spreading hose. When the diameter of the spreading hose is reduced continuously and gradually towards the end remote from the power-driven spreading machine, the velocities of the air flow at various small aperture positions can be maintained substantially equal so that the discharge of the powders may be maintained constant over the whole length of the spreading hose.

That is, when

$$L_m = L_n = \text{---} = L_q = \text{const. and}$$

$$d_m = d_n = \text{---} = d_q = \text{const.},$$

the diameter of the spreading hose is continuously reduced as shown by the relation of:

$$D_m > D_n > D_o > \text{---} > D_q.$$

The spreading hose shown in FIG. 10 has the same outer diameter over the whole length thereof while the wall thickness of the spreading hose is reduced toward its end remote from the spreading machine.

That is, when

$$L_m = L_n = \text{---} L_q = \text{const.}$$

$$d_m = d_n = \text{---} d_q = \text{const., and}$$

$$D_m < D_n < \text{---} < D_q,$$

the wall thickness is increased as shown by the relation of:

$$t_m > t_n > \text{---} > t_q,$$

The air pressure (distribution) within the spreading hose is lowered as the air moves away from the air flow inlet of the spreading hose. Therefore, when the wall thickness is selected to withstand the above described pressure, the weight of the spreading hose can be reduced without lowering the strength thereof.

A powder spreading device according to the present invention is mainly employed in spreading powder form agents, but may be equally used for spreading the agricultural chemical agents containing a large amount of agents in the granular form. The agricultural chemical agents in the granular form has an apparent density higher than that of agents in the form of powder so that the force of inertia of the agents in the granular form is larger. Therefore, an agent in the granular form tends to merely pass through the small aperture, and is not ejected or spread. It is, therefore, not preferable to supply into and spread from a spreading hose for use in spreading agents in the form of powder the agents in the granular form. However, according to the present invention a spreading hose is provided therein with suitable barriers or weirs so that the air flow carrying the chemical agents in the granular form is caused to make wavering and vortex motions so as to change the directions of the flows of the chemical agents, thereby effecting the uniform spreading of the chemical agents in the granular form.

FIGS. 11 and 12 show the embodiments of the present invention for spreading the chemical agents in the granular form in an effective manner as described hereinbefore. In the embodiment shown in FIG. 11, portions, spaced apart from each other by a suitable distance, of the upper or lower sides of the spreading hose are joined and restricted, for example by a high-frequency welding machine. Thus, within the passage of the spreading hose 1 are formed the barriers 7, 7' so that wavering and/or vortex motions of the air are produced by the barriers 7 and 7'. Therefore, the chemical agents in the granular form are carried by the wavering and/or vortex flows or collide against and bound back from the barriers 7 and 7', and finally discharged or ejected from the small apertures in a very effective manner.

FIG. 12 shows another embodiment of the present invention for use in spreading the chemical agents in the granular form. Instead of reducing the inner diameter of the spreading hose by the provision of the barriers as shown in FIG. 11, flat plates 8 made of hard plastic are welded or bonded to the bottom of the spreading hose 1 so that when the inner pressure is applied to the spreading hose 1 and the spreading hose 1 begins to expand, the portions thereof to which the flat plates 8 are welded or bonded are prevented from expanding, whereby the barriers 9 are formed. Small apertures 2 are provided in the sloping surfaces 10 of the barriers 9.

The chemical agent in the granular form can be spread through these small apertures 2 in a same effective manner as in the case of the embodiment shown in FIG. 11.

In practical use of a spreading device of the present invention, the device is normally carried at its opposite ends by two operators, one of them carrying a power-driven spreading machine. In case of the length of the spreading hose being too long as compared with the width of an object, such as a rice field, over which the powders are spread, the spreading hose may be positioned angularly of the direction of its movement so that the apparent length of the spreading hose may be shortened. Furthermore, when one of the operators who is carrying the power-driven spreading machine must walk ahead or behind the other operator according to the direction of the wind in order that the other operator may be prevented from being exposed to the spread agricultural chemical agents, the spreading hose according to the present invention may be disposed angularly of movement so that a safe spreading operation may be ensured.

Another practical method of using the spreading device according to the present invention is to hold a power-driven spreading machine in a fixed position as a center and to move the closed end of the spreading hose about the center, thus defining a circle and thereby spreading the chemical agents in thus defined circular area.

As described in detail hereinbefore, an effective powder-spreading operation can be accomplished by a simple device of the present invention; the spreading hose made of soft material eliminates the fear of the crops being damaged during the powder-spreading operation; and the length of the spreading hose may be suitably adjusted in accordance with demand by closing the end remote from the power-driven spreading machine at a suitable length therefrom. Thus, it will be readily understood that many substantial advantages to agriculture are accrued from the present invention.

I claim:

1. A method of spreading a pulverulent treating agent over an area to be treated comprising the steps of maintaining an elongated laterally confined column of air under pressure, carrying the pulverulent treating agent, directed substantially horizontally and rectilinearly above the area to be treated; at longitudinally spaced locations along the laterally confined column, directing plural discrete jets of the air, carrying the pulverulent treating agent, downwardly from the column onto the area to be treated; during treatment of the area, continuously supplying additional air under pressure, carrying the pulverulent treating agent, to at least one end of the column; and utilizing the reaction force of the jets against the treated area to support the laterally confined column above the area.

2. A method of spreading a pulverulent treating agent over an area to be treated, as claimed in claim 1, including the step of moving said column in a substantially horizontal plane in a direction laterally of the length of said column and above the area to be treated.

3. A method of spreading a pulverulent treating agent over an area to be treated, as claimed in claim 1, including the step of maintaining the column in spaced substantially parallel relation above the area to be treated while moving the column laterally of itself over the area to be treated.

4. A method of spreading a pulverulent treating agent over an area to be treated, as claimed in claim 2, including the step of swinging the column substantially horizontally, over the area to be treated, about a substantially vertical pivot axis at one end of the column.

5. A method of spreading a pulverulent treating agent over an area to be treated, as claimed in claim 1, including the step of adjusting the length of the column in accordance with the extent of the area to be treated.

6. A method of spreading a pulverulent treating agent over an area to be treated, as claimed in claim 1, including the step of vibrating the column during treating of the area.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,567,120 Dated March 2, 1971

Inventor(s) NAKAO SUDA

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the heading of the patent, the name of the assignee should read

--Mitsubishi Jukogyo Kabushiki Kaisha
Tokyo, Japan (undivided half)--

Signed and sealed this 9th day of November 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patents