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(54) METHOD FOR PRODUCING ELECTRIFIED POWDERS BY FRICTION

(54) METHODE DE PRODUCTION DE POUDRES ELECTRISEES PAR FRICTION

(57) **Abstract:**

Electrified powders are used in particular for agricultural or industrial powdering, for producing high voltages.

The co-pending application, Serial No. 537,829 provided the possibility of electrifying powders by friction. Further research has made it possible to ascertain the means which it is necessary to use for obtaining this object. During this research it has been discovered in particular that:

1. In order to suitably electrify the powder it is necessary to make all the grains come into contact with the friction surface and even to make each grain effect several successive contacts. Simple partitions arranged as baffles are not sufficient for obtaining this result, since the current of gas effects a turning movement about these obstacles and imparts the same movement to the particles.

The invention comprises in particular the provision of numerous contacts between the grains of powder and the friction member, either by arranging numerous small obstacles, threads for example, in the path of grains, or by constraining the grains to circulate between two flat surfaces which are very close together and which may optionally be subjected to vibrations.

2. At the instant when a grain of powder comes into contact with the friction surface, said grain must not be subjected to the effect of an opposing magnetic field which may be due, either to the charge of the adjacent grains of powder, or to the charge of the friction surface.

In order to obviate these drawbacks, the invention comprises, either dividing the space a very large number of times by means of threads or of small objects forming so many electrostatic screens, or arranging the friction members in such a manner that the charges which are deposited thereon are

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symmetrical with respect to the grains of powder.

3. The electrified grains must not remain adhering to the friction surface by electrostatic attraction, which would prevent fresh grains from coming into contact with the friction surface and might cause the apparatus to become obstructed.

Furthermore, electrified grains must never be allowed to collect together, since there would thus be a risk of their mutually repellant charges escaping.

The devices described obviate these drawbacks, since the current of gas that carries the powder along readily sweeps the small obstacles used, and the same applies to the parallel leaves.

4. The nature of the powder and of the friction surfaces determines the polarity of the charges exchanged, and to a certain extent the magnitude of said charges. It has been ascertained for various powders, which friction substance is the most suitable for each of them.

Resilient friction substances that resist wear should preferably be chosen, since the carrying away of the material of the friction member hinders the separation of the charges of opposite polarity.

Care should also be taken to prevent dampness, which impairs the electrification by friction.

Amongst the substance which are particularly suitable for constructing the friction members, mention was made of rubber, horse-hair, threads and sheets of plastic material.

5. In the case in which a powder is to be used which is difficult to electrify, such powder may be mixed with another powder that holds the charge well, for example sulphur, casein, anthraquinone, lime. In certain cases it may be preferably only to mix the two powders after one of them has passed through the

electrifying device, in order not to hinder the operation.

6. The powders which have been electrified under the conditions hereinbefore described can be projected, without special care, on the objects to be powdered. It is also possible to set up an electric field round the object to be powdered, in order to activate precipitation.

For carrying out the principles hereinbefore explained, devices for electrifying powders have been constructed which can be classified in the two following categories.

A). The current of air charged with powder is conveyed through a tube containing numerous small spaces which are evenly distributed throughout the available volume.

Such obstacles may comprise fine threads, heaps of balls, crystals, etc. They may be insulating or more or less conducting.

Such a device definitely corresponds to the invention:

It provides a large contact area.

The space is divided into fairly small portions so that the grains of powder cannot create an intense electric field therein.

If the obstacles are sufficiently conducting, they readily allow the charges which they collect to be eliminated. If they are not, their symmetrical arrangement causes said charges to have little action on the development of fresh charges.

The small obstacles, in particular the threads, are well swept by the current of air and no accumulations of powder are formed.

B). The current of air charged with powder is blown in between two leaves which are resilient or are resiliently held in contact. The air pressure slightly separates the leaves and enables the powder to pass.

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Such a device also corresponds to the invention :

It provides a large area of contact.

The space between the leaves always remains very small.

A grain of powder located between two leaves carrying equal charges of the same polarity is not subjected to the electric field produced by said charges.

The speed of the air current between the leaves, the vibrations caused by said air current, and the choice of the substance used (rubber for example) prevent the powder from heaping up between the leaves.

Since the leaves are very close together, particles of powder might become locked between them, which would clog the apparatus. This difficulty can be avoided by arranging the leaves in such a manner that the pressure of the air produced by the blower is capable, in case of obstruction, of separating the adjacent leaves and of thereby unclogging the apparatus. Owing to this arrangement, it is even sometimes unnecessary to provide a permanent spacing between the two leaves ; the air pressure moves them apart just enough to allow the powder to pass. It is moreover possible to make the leaves more or less readily separable, and even to make such separation adjustable, either by using flexible leaves, or by holding them in contact with one another by pressure of a spring.

The nature of the surfaces of the leaves plays an essential part in the electrification, since it is these surfaces which come into contact with the powder. Said surfaces may be smooth, or provided with various asperities, or provided with a covering of suitable composition.

Each leaf may be composed of two constituents : an internal constituent, chosen to provide maximum electrification, and an external constituent, the function of which is both

to provide the requisite resilience and, by means of its conductivity, to enable the electric charges developed on the friction surfaces to flow away.

Finally, particular devices may be added for carrying away the charges, such as : metal blades, spikes, wires, etc. interposed between the leaves, in the thickness of same, or on the outside. Said devices may act, either by decreasing the distance which the charges have to travel in a poor conducting substance, or by causing the friction surface to discharge, by ionizing the adjacent gaseous medium.

The aforesaid leaves may be provided with more or less numerous asperities or holes, which leads to constructions more or less similar to those characterised by the presence of numerous small obstacles.

The leaves may also be provided with longitudinal striae, i.e. directed in the same direction as that in which the powder circulates, which is tantamount to providing a whole set of more of less numerous parallel capillary tubes, which may even be reduced to one per machine element.

In order to make the invention more clearly understood, several embodiments have been illustrated in the accompanying diagrammatic drawing which are given by way of non-limitative examples.

Fig 1 is a section of an apparatus for producing electrified powder, provided with a tube containing a network of wire.

Fig 2 is a section of an apparatus provided with a tube containing obstacles.

Fig 3 is a modification of fig 2 .

Fig 4 shows an apparatus provided with a piston pump.

Fig 5 shows a combined apparatus provided with a tube containing a network of wire and whith a tube containing

obstacles.

Fig 6 is a general longitudinal sectional view of an apparatus for producing electrified powder.

Fig 7 is a similar section of a modification.

Fig 8 is a plan view corresponding to Fig 7 .

Fig 9 shows a section of another modification.

Fig 10 is a section through the line 11-11 of Fig 9.

Fig 11 is a section of another device.

Fig 12 is a section through the line 13-13 of Fig 11.

Fig 13 is a modification.

In Fig 1 of the accompanying drawings, an embodiment of a device for producing electrified powder has been shown by way of a non-limitative example, which is provided with a centrifugal fan 18 producing a current of air in the tube 19. A certain quantity of powder may be introduced into this air current.

The mixture of air and powder reaches the tube 20 which is electrically connected to the earth. The inside of the tube 20 is occupied by a cylindrical roll 21 obtained by winding a long strip of wire gauze formed by stainless steel wires of a few hundredths of a millimeter diameter. The whole arrangement forms a network of wires which is sufficiently open for the air current charged with powder to pass readily through it and the particles are charged by striking the wires of the network.

At 22 is shown an insulating tube which serves to convey the air charged with electrified powder towards the using apparatus : electric powdering machine, collector of electrostatic machines, etc.

In the previous example, the electrifying device essentially comprises a network of steel wires. It would be

possible to use any other wires of sufficient conductivity grouped in screens, pads, etc.

It would also be possible to use blades, small balls, granular or crystalline substances packed in a container through which the current of air charged with powder passes.

The electrifying devices hereinbefore referred to are supplied with air charged with powder, by means of known apparatus such as : rubber bulbs, a piston pump, a compressed gas cylinder etc.

In Fig 2, a rubber bulb 23 has been shown by way of example which contains powder and is provided with an electrifying tube 24 containing obstacles, and in Fig 3 a distributing apparatus has been shown in which bulbs 25, 26 supply the air to a powder container 27 provided with an outlet for the powder through an electrifying tube 28 containing obstacles. In the embodiment of Fig 4, a pump 29 is attached to a receptacle 30 containing the powder, provided with an outlet tube 31 which is an electrifying tube containing obstacles.

In Fig 5 a complex electrifing apparatus has been provided in which the powder successively passes through two tubes 32, 33, the first containing obstacles such as balls and the second a pad of wire gauze.

Referring to Fig 6, it will be seen that the apparatus comprises a pump P, by means of which air can be supplied to a receptacle A containing the powder. Said pump is provided with a tube T opening between two leaves F_1 and F_2 which are pressed against one another by light springs r. The mixture of air and powder blown between the leaves moves them apart and is electrified as it comes into contact with them. A cloud of electrified powder is obtained at N.

Figs 7 and 8 show an electrifying device comprising two

rubber leaves F_1 and F_2 which are fixed to a base S by means of laterally arranged clamping strips l. The resilience of the rubber is sufficient to enable the air charged with powder blown through the tube T to pass through the apparatus in the lengthwise direction. This device is suitable in particular for electrifying powders mainly comprising lime, silica, metallic oxides, etc.

The device of Fig 9 and 10 is similar to the previous one, but the rubber leaves are replaced by thin flexible sheets C_1 C_2, on which a silk fabric has been cemented at D_1 D_2. The whole arrangement is held for example by means of rivets located on the sides. The powder passing between the two sheets is in direct contact with the silk. This device is suitable in particular for electrifying crushed sulphur.

In the arrangement of Fig 11, a U-tube is packed with a pile of discs R or suitable material, for example of rubber if it is required to electrify a powder mainly comprising silica. The discs are provided with holes, as shown at O in Fig 12, or with slits as shown at V in fig 13 . The discs can be kept a short distance from one another by means of spacing washers E . Two consecutive discs are so arranged that their holes are not on the sameaxis. Consequently, the current of gas charged with powder, after having passed through the holes of one disc has to travel a certain distance, before reaching the holes of the next disc, through the lamellar space between the two discs, which is in accordance with the invention.

In addition to the holes intended for the powder to pass through, the discs may be provided at their centre with a small hole through which passes a fine wire F which is connected to the frame of the apparatus and the purpose of which is to produce, by ionization, the neutralization of the charges

which tend to accumulate on the discs.

The foregoing examples are not intended for any other purpose than to illustrate the principle of the apparatus. In particular, the nature of the leaves and the composition of the powders are essentially variable. The same applies to the dimensions, the output, the shape and the number of the leaves. It is understood, in particular, that the leaves may be rectangular, triangular, circular, segment-shaped, etc. They may be flat, wound in the shape of concentric cylinders or of spirals, or folded on themselves.

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The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:-

1. A device for dusting plants and the like comprising means to provide a supply of powder, means to provide a flow of gas to carry the powder and means for electrifying by friction fine particles of powder carried along by a low speed current of gas.

2. Devices according to claim 1, wherein said electrifying means comprise passing the current of gas charged with powder through a space provided with numerous fixed obstacles of small size, and capable of carrying an electric charge, the distance between said obstacles being in the order of one millimeter.

3. Devices according to claim 2, wherein the empty space between the obstacles, and also the diameter of said obstacles such as threads or wires reach, at certain points, the order of magnitude of the particles of powder.

4. Devices according to claim 2, wherein the obstacles comprise very fine threads or wires, blades, heaps of balls, granules, crystals.

5. Devices according to claim 2, wherein use is made of powders of suitable dimensions which hold the charge well.

6. Devices according to claim 1, wherein use is made of insulating powders with fine homogeneous spherical particles.

7. Devices according to claim 1, wherein two different powders are mixed together at the inlet or at the outlet of the apparatus, one of which holds the charge well and the other fulfills the conditions of use.

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8. Devices according to claim 1, wherein use is made of the powders which are electrified by simple friction for producing high voltages.

9. Devices according to claim 1, wherein members such as rubber bulbs, air pumps, fans, etc. are provided for distributing the mixture of air and powder through electrifying tubes containing obstacles.

10. Devices according to claim 1, wherein closely spaced parallel leaves are provided, between which a current of gas charged with powder is blown, which produces the friction of the particles against the active surfaces of the leaves.

11. Devices according to claim 10, wherein the current of gas circulates parallel to the length of the leaves.

12. Devices according to claim 10, wherein the general direction of the current of gas is at right angles to the surface of the leaves.

13. Devices according to claim 10, wherein parallel leaves are provided which are moved apart by the current of gas.

14. Devices according to claim 10, wherein a pile of very closely spaced discs or parallel blades is provided through which the current of gas effects a sinuous travel.

15. Devices according to claim 10, wherein the surfaces of said leaves in contact with the powder are provided with any devices or means which facilitate electrification, such as covering of suitable substances, asperities, striae, and the like.

16. Devices according to claim 10, wherein said leaves are provided with holes or with slits.

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17. Devices according to claim 10, wherein said leaves are made of poor conducting substances and are provided with members for eliminating the charges which accumulate thereon, said members comprising brush-discharge devices (spikes, combs and the like) or conducting members such as wires embedded in the body or fixed to the surfaces thereof.

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Fig 3

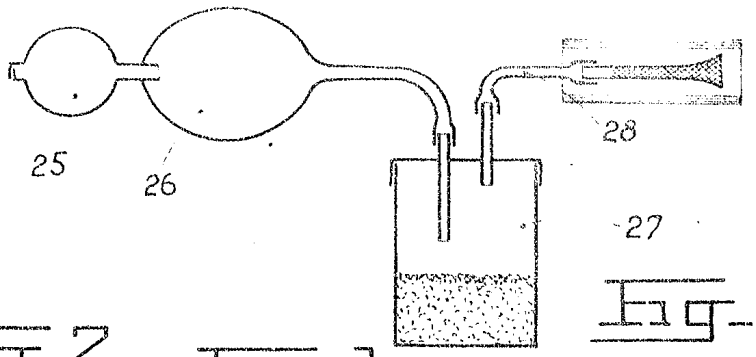


Fig 2

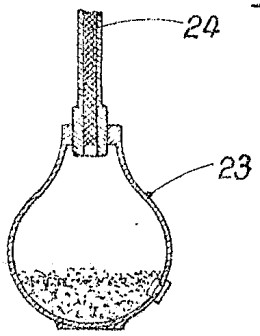


Fig 1

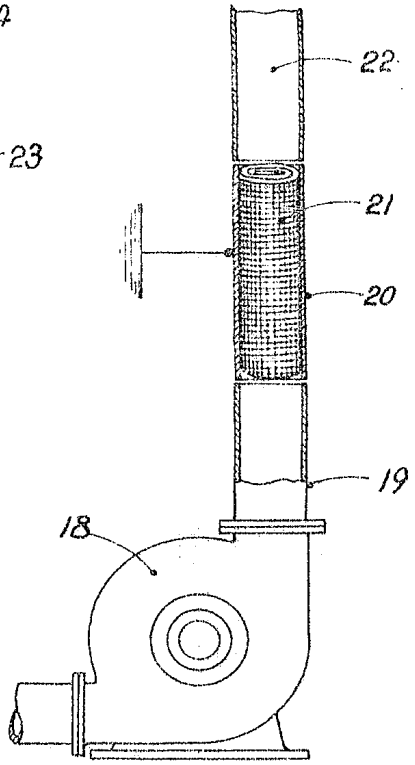


Fig 5

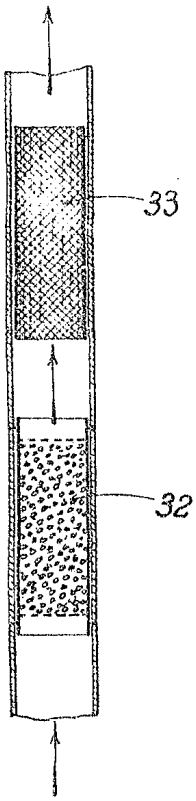
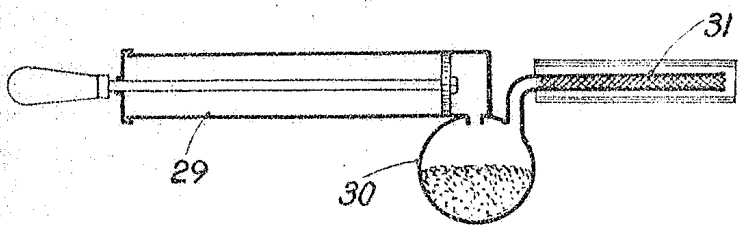


Fig 4



Certified to be the drawings referred to in the Specification hereunto annexed.

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Fig 6

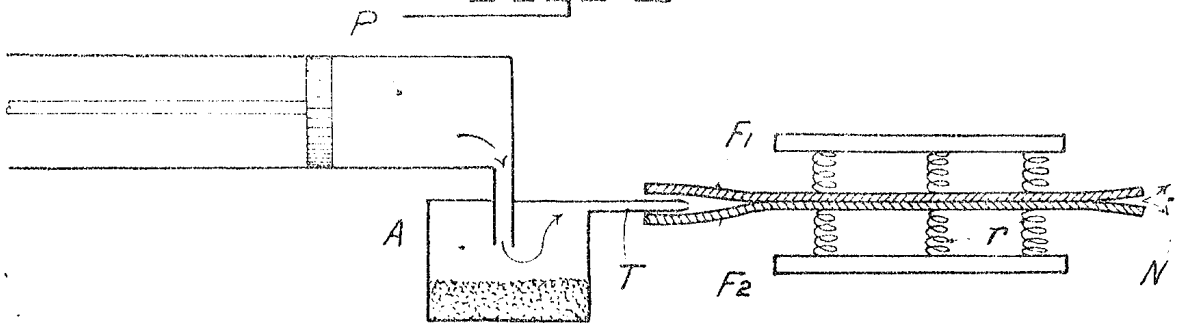


Fig 7

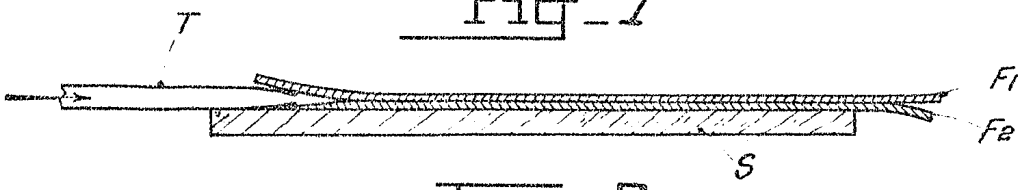


Fig 8

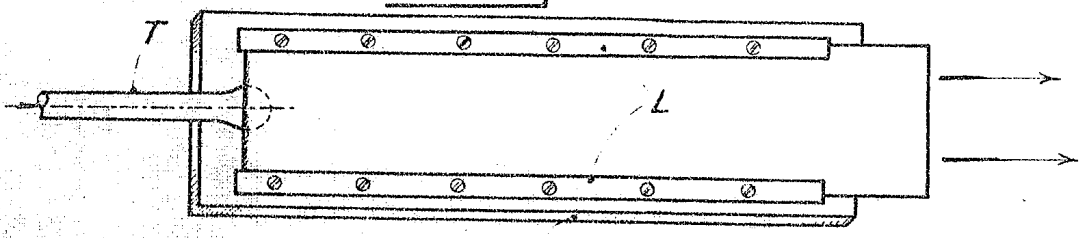


Fig 9

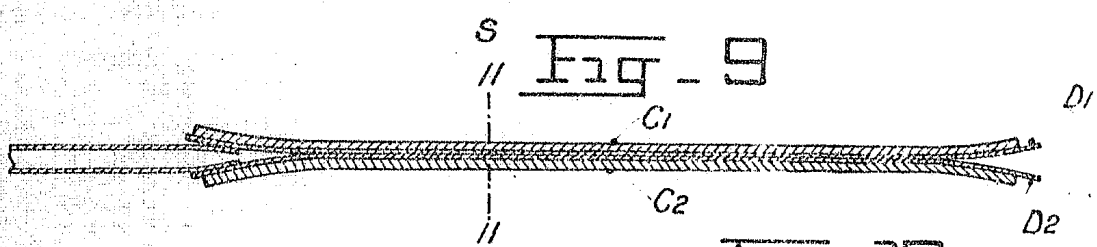


Fig 10

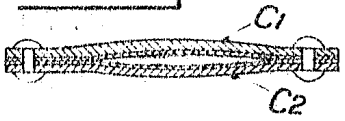


Fig 12

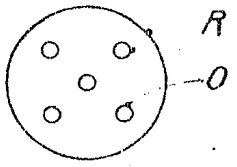


Fig 11

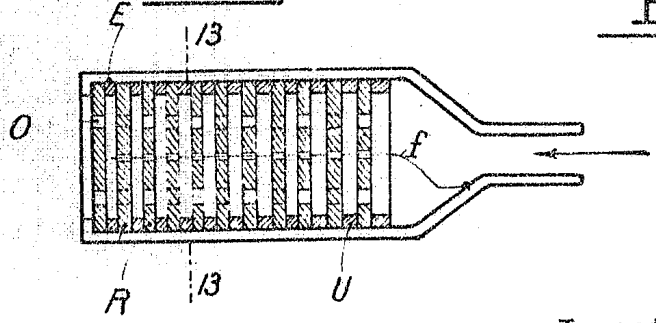
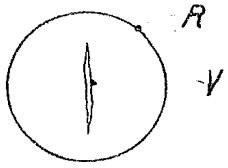


Fig 13



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