

June 13, 1944.

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2,351,089

DUST PRECIPITATOR

Filed Nov. 4, 1941

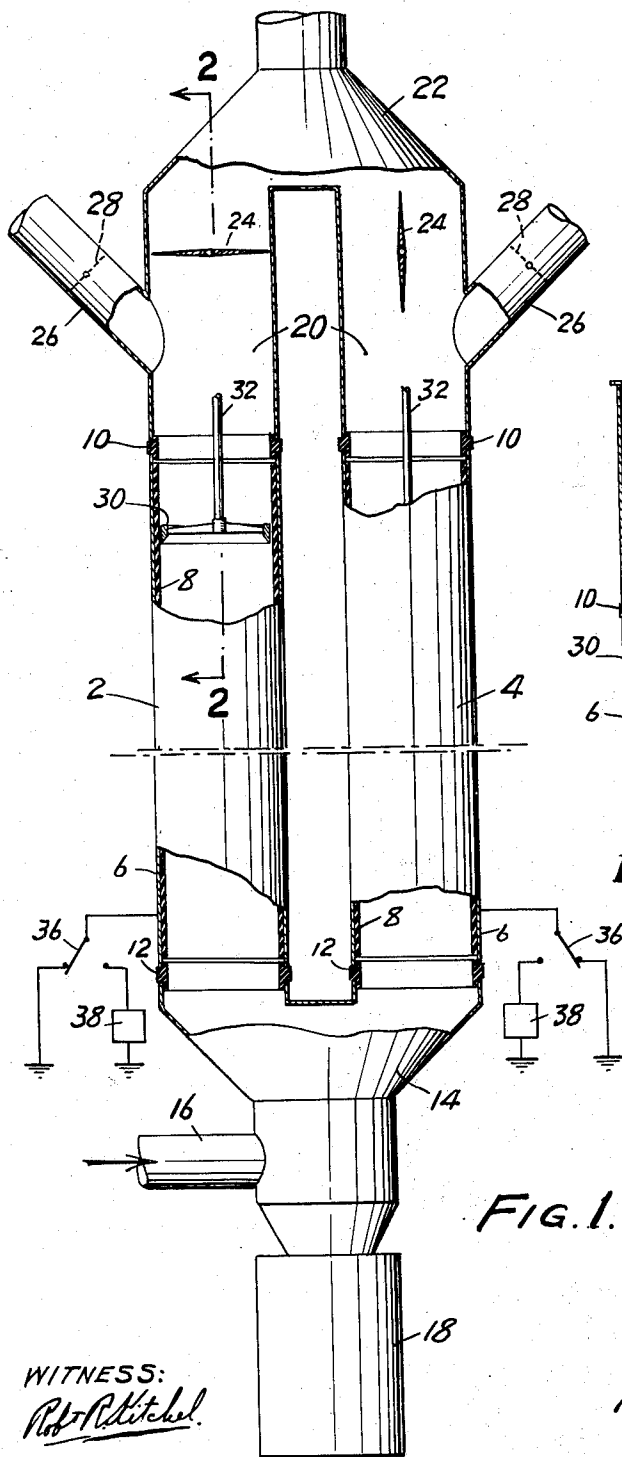


FIG. 1.

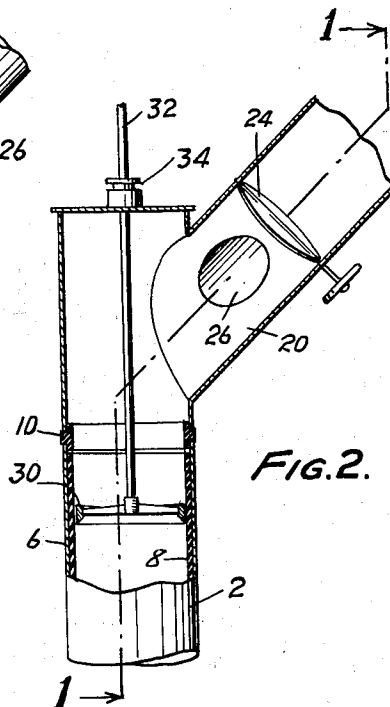


FIG. 2.

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2,351,089

DUST PRECIPITATOR

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Application November 4, 1941, Serial No. 417,764

2 Claims. (Cl. 183-7)

This invention relates to a precipitator of electrical type for dusts, smokes and mists. For simplicity of description, reference will be made primarily to the precipitation of dust, it being understood that within this term there is included precipitation of any particles or droplets of solid or semisolid nature.

The separation of fine particles suspended in air or gas streams is of importance in many industries, both for the collection of the material of the particles because of their value and to abate nuisances occasioned by their presence in the atmosphere. Dust precipitators are of various types, of which the usual ones operating on hydrodynamic principles are well adapted for the precipitation of particles of large size. These precipitators or separators fail, however, when the particles are very fine, and for proper precipitation under these conditions, electrical precipitators have been devised to cause the particles to be precipitated out through the use of applied electrical fields. These electrical precipitators, however, are costly in construction and operation, requiring the use of considerable power at very high voltages.

It is the general object of the present invention to provide a precipitator operating on electrical principles but without requirements of large input power or elaborate and costly construction.

A further object of the invention relates to an arrangement of such precipitator in which proper cleaning may be effected without permitting the dust to escape into the atmosphere.

The above and other objects of the invention, and particularly those relating to details, will become apparent from the following description, read in conjunction with the accompanying drawing, in which:

Figure 1 is an elevation, partly in section, as indicated by the trace indicated at 1-1 in Figure 2, showing a preferred form of apparatus involving the principle of the invention; and

Figure 2 is a fragmentary section through the upper portion of one stack of the apparatus taken generally on the plane indicated at 2-2 in Figure 1.

The apparatus comprises primarily two members 2 and 4, which, for simplicity, will be referred to as stacks, though they may be located in any position either horizontal or vertical. These two stacks may be of identical construction and comprise, in the embodiment illustrated, metal tubes 6 lined interiorly, as indicated at 8, with insulation, which may take the form of an

insulating plastic coating or a separate insulating sleeve. The insulation used should be a good one to prevent current leakage even under high potential differences.

The upper and lower ends of the stacks 2 and 4 are preferably insulated from adjacent parts of the apparatus by means of insulating rings 10 and 12. While this insulation is unnecessary in the most fundamental form of the apparatus, it must be provided in the event that it is desired to bring the metal tubes 6 to a potential above ground, as will be hereafter described.

The rings 12 support the stacks 2 and 4 over a header member 14 into which the elastic fluid carrying the particles of dust or mist is introduced through a tube 16. A collector 18 may be located below this and is conventionally illustrated as a cylindrical tank, though it may take any suitable form, depending upon the product being collected.

The stacks 2 and 4 have similar extensions 20 insulated from them by the upper rings 10, which extensions are connected to an outlet header 22, which may be subject to suction or open to the atmosphere, as desired, or may be connected to a condensing or scrubbing apparatus in the event that the gas passing through the apparatus is to have vapors condensed therefrom or is to be recovered for any purpose. Valves 24, independently operable either manually or automatically, are provided in the extensions 20. Side outlets 26 are provided between the valves 24 and the stacks 2 and 4 and are controlled by valves 28, which may be manually or automatically operated. These side extensions may normally open to the atmosphere, though the openings may be to gas or vapor supplying apparatus if that is desirable.

Scrapers 30 may be provided in the stacks 2 and 4 and take the form of annular knives supported by suitable spiders from actuating rods 32. These rods 32 pass through stuffing boxes 34 provided in the extensions 20. In order that the rods will not interfere with the valves 24, the extensions 20 are desirably offset in a fashion which will be clear from Figure 2.

The metal tubes 6 may be connected to independent switches 36 serving either to connect them to ground or, if desired, to high direct voltage supplies diagrammatically indicated at 38.

Depending upon the material being handled, the inside surfaces of the portion 14 of the apparatus and the tube 16 may not be coated with insulating material, though this is generally desirable for the reasons presently to be outlined.

Generally speaking, and particularly when produced by an intense fine grinding operation, fine particles of the type not easily precipitated by so-called mechanical precipitators will carry considerable static charges. These charges may be produced in various ways by promoting friction or through the use of charge-inducing devices with the result that the particles of a dust, smoke or mist entering the tube 16 may be highly charged. If, for example, the valve 24 of the right hand stack is open and the other valves are closed, and the switch 36 of the right hand stack is thrown to the grounded position, these charged particles will be attracted by the opposite induced charges on the tube 6 and will consequently move toward and against the insulating liner 8 of the stack. If the insulating liner were missing, the particles could discharge upon reaching the metal wall 6; but with the insulating liner present, they are arrested upon meeting the wall and cannot be discharged, so that they will remain in contact with the wall by electrostatic attraction. The force tending to adhere the particles to the wall is of considerable amount, so that it is not readily dislodged by the air or gas currents passing it. This same action occurs on all other particles until ultimately a substantial coating of dust will have accumulated on the inner wall of the stack. The stacks are desirably sufficiently long so that even weakly charged particles will be caused to move toward and adhere to the inside of the stack. Thus the elastic fluid which escapes into the extension 20 will be substantially free of particles.

What occurs in the operation of precipitating a charged particle may be explained as follows:

A charged particle suspended in the gas within the stack will induce an equal and opposite charge on the conductor surrounding the stack, polarization occurring in the dielectric tube. An equal and similar charge is driven to ground. Accordingly, a force exists attracting the particle towards the wall.

When the charged particle reaches the inside surface of the dielectric, its movement is arrested, but because of the dielectric, it cannot reach the conducting grounded sheath to be discharged. Consequently, it is held, attracted by the induced opposite charge on the other side of the dielectric.

Despite the fact that the charged particle is on the inside of the dielectric tube, its effect to prevent similar attraction of other charged particles is very small, since immediately opposite it is a total charge of opposite sign and the net field within the tube is that due to both charges, forming in effect a doublet. As pointed out in works on electrostatics, e. g., Jeans' "The Mathematical Theory of Electricity and Magnetism," fifth edition, Cambridge University Press, 1927, the resultant field of a charged particle adjacent to an extensive surface is identical with that of a dipole formed by two opposite, closely spaced, equal charges, the effective field of which at a distance is very small. Viewed in another way, the bound particle and the grounded conductor and dielectric form a condenser of large capacity which, even when charged with a large charge, will have a low potential, not capable of substantially inhibiting attraction of a charged particle.

In order to clean the stack after the accumulation of the particles, the scraper 30 in that stack may be moved downwardly to scrape the

agglomerated particles from the wall. During this action a considerable amount of dust will be again raised, but with the apparatus shown, this dust can be prevented from escaping through the outlet.

For this purpose the stacks 2 and 4 are caused to operate alternately through the clearing periods, normally operating simultaneously in parallel. After an accumulation in the stack 4 has been built up to the proper extent, as indicated, for example, by observation through a side opening or by a testing means, the valve 24 of the stack 4 will be closed, the tube 6 of the stack 2 remaining grounded so that accumulation of dust will continue to occur therein. The scraper 30 in the stack 4 may now be operated and the major portion of the accumulated material therein will fall into the receiver 18. Dust which is raised can escape from the apparatus only by passing through the tube 2 in which it will be precipitated. Residual dust in the stack 4 may be removed therefrom by supplying a pressure slightly in excess of that existing in 16 to the corresponding tube 26 and opening valve 28, whereupon the dust from stack 4 will be blown out of it and upwardly through the stack 2 to be precipitated therein. Of course, in the event that suction is applied to the outlet 22, the tube 26 may be opened to the atmosphere, provided pressure conditions in 16 are sufficient to permit a downward flow of air through stack 4. After stack 4 is cleaned it may be restored to operation in parallel with stack 2. It will be evident that with accumulation of material in stack 2 a reverse procedure may be adopted to clean out that stack. Thus by causing the stacks to be alternately cleaned, a continuous precipitation of dust may be accomplished with cleaning of the stacks but without permitting the escape of particles.

The purpose of the high voltage supplies 38 is to cause release of the particles which have accumulated on the walls either without the scrapers or with the scrapers. By applying a voltage to the tube 6 of the same sign as the voltage on the accumulated particles, the electrostatic attraction will be broken and the particles thus released except to the extent that they tend to adhere mechanically. By the use of a suitable jarring means, however, their dislodgement will be readily effected. It will be evident that while a voltage may be thus applied, the power required is extremely small, since it is merely that required for charging what is, in effect, a condenser formed by the metal 6, the insulation 8 and the particles. This is in contrast to the use of substantial power required to effect the ionization in electrical precipitators heretofore known.

It will be evident that numerous variations of the apparatus may be provided without departing from the principles of the invention. The stacks may, of course, be used singly if the loss of dust during cleaning is immaterial. These stacks may take numerous forms. For example, they may be of glass and the outer conducting material need not be continuous, but may be provided by a metal mesh or screen which is grounded. In fact, it will be evident that since an electrical condenser effect is desired, all that is required is an arrangement which, from the electrical sense, will provide a condenser configuration. The outer conductor 6 need not have any high degree of conductivity, since the displacement currents which it is required to carry

are extremely minute. It may accordingly merely take the form of a metallic paint, or coating or lacquer containing carbon, or some other moderately conductive material.

If mists of liquid are being precipitated, drop-
lets will, of course, form on the inner walls of the
stacks, ultimately becoming enlarged to a size
sufficient to permit their running down the walls
by gravity. In such case, it is desirable to have
an arrangement such that the liquid may drip
from the insulating liner of the stack through an
air space so as to not to short circuit and ground
all of the liquid coating on the inside of the
liner.

Numerous other forms of the invention will be
apparent to those skilled in the art.

What I claim and desire to protect by Letters
Patent is:

1. Apparatus for the precipitation of elec-
trically charged dust or the like from suspension
in an elastic fluid comprising a passage present-
ing a wall of insulating material to said suspen-
sion, the outside of at least a portion of said wall
being substantially covered with grounded con-
ducting material, and said passage having no
substantial potential gradient within its interior.

2. Apparatus for the precipitation of elec-
trically charged dust or the like from suspen-
sion in an elastic fluid comprising a passage
presenting a surface of insulating material to
said suspension, said surface being backed by
grounded conducting material, and said passage
having no substantial potential gradient within
its interior.

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