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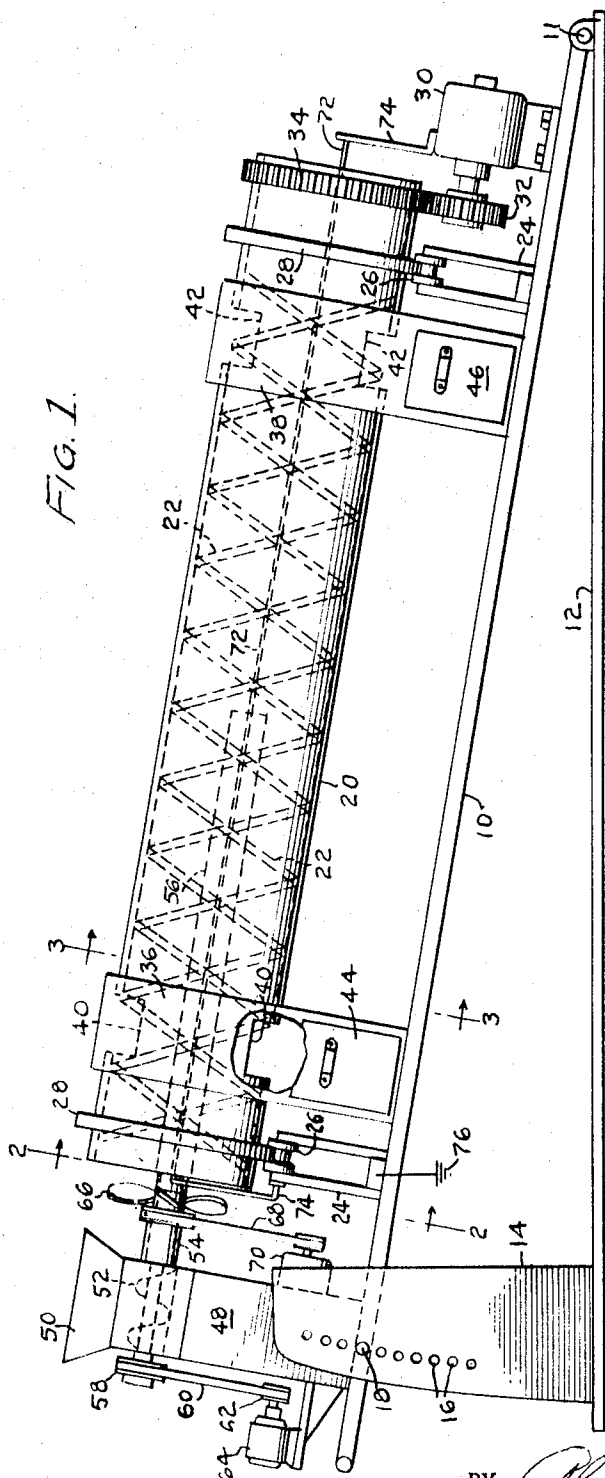
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3,458,041

ELECTROSTATIC SEPARATION OF DRY MATERIALS

Filed June 25, 1968

2 Sheets-Sheet 1



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FIG. 2.

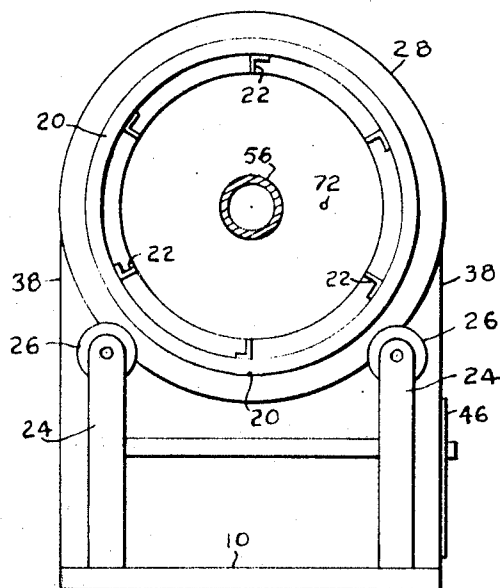
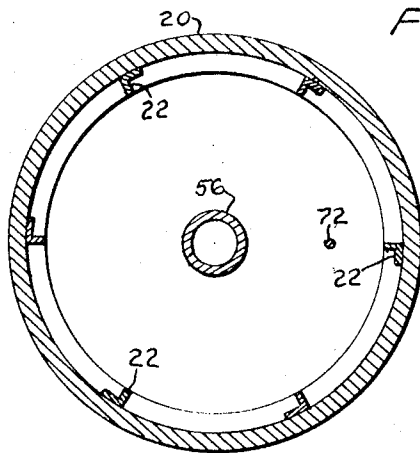


FIG. 3



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ELECTROSTATIC SEPARATION OF DRY MATERIALS

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7 Claims

ABSTRACT OF THE DISCLOSURE

A rotatable, inclined, grounded cylinder formed wholly of conducting material and having internal helical ribs is continuously supplied with material from the upper end thereof; the heavier components of the material are fed toward the upper end of the cylinder by the helical ribs, while the lighter material, having little mass, frictionally adheres to the cylinder and is rotated thereby almost to the high point and then drops into engagement with a relatively lower point along the bottom of the cylinder. The repeating of this process causes the lighter material to be gradually fed to and discharged adjacent the lower end of the cylinder. Electrostatic means adjacent the cylinder charges the particles of less conductive material and increases its electrostatic attraction with the cylinder so that it tends to rotate therewith toward a radially higher point before it drops back to the bottom of the cylinder, thus increasing the effectiveness of the separation of the less conductive material from the more conductive and usually heavier material.

Cross references to related application

This application is an improvement over the structure shown in my copending application, Ser. No. 663,312, filed Aug. 25, 1967.

Background of the invention

The apparatus is efficient in separating dry materials. For example, waste wire materials from a factory may be chopped into relatively small pieces and subjected to the action of a hammermill to separate insulation from the wire. The insulation is preferably completely separated from the wire so that the latter can be reclaimed. The apparatus is useful in many other arts, for example, in the separation of tobacco stems from leaf material in which one of the materials is heavier than the other to facilitate separation. Tobacco stem pieces, for example, are more solid and have greater mass than the leaf pieces and accordingly the present apparatus is effective in the separation of such material. Prior art mechanisms have been devised for the electrostatic separation of the materials. The present construction makes use of such phenomenon but utilizes it in connection with the difference in specific gravity between two materials to be separated, such as those referred to.

In my copending application referred to, I have shown a generally similar apparatus wherein the tilted rotatable cylinder is made up circumferentially of alternate strips of conducting and insulating material having means in the form of external brushes engaging the cylinder to ground the conducting portions thereof. One of more external electrodes serves to provide electrostatic charges for the cylinder to cause the less conductive materials to electrostatically adhere to the inside of the cylinder.

Summary of the invention

The apparatus comprises an elongated cylinder formed wholly of conducting material as distinguished from my prior construction. Such cylinder contains against the

inner face thereof helical flanges extending from one end of the cylinder to the other. The inclination of the helices and the direction of rotation of the cylinder are such that any materials of sufficient weight to remain in contact with the helices during rotation of the cylinder will be conveyed to the upper end of the cylinder to be discharged therefrom. Less conductive materials, for example, wire insulation, will tend to adhere by friction to the inside of the cylinder so that individual particles tend to rotate in a plane perpendicular to the axis of the cylinder. The frictional engagement of the less conductive material with the cylinder decreases as the material moves circumferentially upwardly from the lowermost point of the cylinder during rotation thereof. This adhering tendency of such particles is increased by the electrostatic charging of the cylinder so that the particles will move upwardly to points adjacent the top of the cylinder, whereupon the particles drop vertically at an angle to the rotational planes where the particles started to rotate with the cylinder. Therefore, as each particle drops, it comes into contact with the cylinder at a point spaced longitudinally downwardly of the cylinder from the point at which it started to rotate with the cylinder.

The particles therefore drop from between two adjacent helices to the next adjacent helices toward the lower end of the cylinder, and this operation being repeated at each rotation of the cylinder, the less conductive particles gradually reach a discharge point adjacent the lower end of the cylinder. The more solid particles of greater mass have lower frictional engagement with the cylinder during rotation thereof and are not lifted to a substantial extent with the cylinder as the latter rotates. The particles of greater mass, therefore, engaging the cylinder between two adjacent helices, will be fed or conveyed by the helices toward the upper end of the cylinder to be discharged therefrom.

The electrostatic charging of the less conductive particles causes them to be rotated with the cylinder toward positions near the top of the cylinder to drop into engagement with the bottom of the cylinder at a longitudinally lower point thereof. This electrostatic charge insures that all of the less conductive particles will be lifted and dropped, thus increasing the effectiveness of the separating action. Thus, such particles progress more rapidly toward the discharge end of the cylinder, while particles of greater mass are not sufficiently electrostatically attracted to the interior of the cylinder to overcome their weight and they are accordingly conveyed upwardly therealong by the helices. In my prior construction, a grounded device adjacent the cylinder alters the potential in strips of the cylinder to prevent the less conductive particles from passing over the top center of the cylinder. This was necessary with the use of a cylinder made up of alternate longitudinal strips of conducting and insulating material. I have found that if the entire cylinder is made of conducting material, the inclination of the cylinder and the speed of rotation thereof, as well as the potential of the electrostatic charge, may be adjusted so that the electrostatic charge affecting the less conductive particles will not be sufficient to overcome the weight thereof, hence the lighter particles will drop before passing over the top center of the cylinder to be separated in the manner described.

Brief description of the drawings

FIGURE 1 is a side elevation of the apparatus;

FIGURE 2 is a section on line 2—2 of FIGURE 1;

and FIGURE 3 is a similar view on line 3—3 of FIGURE 1.

Description of a preferred embodiment of the invention

Referring particularly to FIGURE 1, an elongated supporting plate 10 is pivoted at one end as at 11 to a base plate 12. The other end of the base plate is provided with spaced standards 14 having adjusting openings 16 arranged in an arc of a circle concentric with the axis of the pivot 11. The openings 16 are adapted to receive pins 18 to support the plate 10 at any desired angle to the horizontal.

Above the plate 10 is arranged an elongated cylinder 20, open at both ends, and made up wholly of conducting material. The cylinder contains a plurality of helices 22 which may be made of either conducting or non-conducting material. Six of these helical ribs are shown in FIGURES 2 and 3 and the cylinder 20 is rotated in a manner to be described so that the helices act as conveyors for any material in contact therewith to move such material toward the upper end of the cylinder 20. The bearing standards 24 are mounted on plate 10 and carry grooved rollers 26 (FIGURES 1 and 2) receiving annular ribs 28 carried by the cylinder 20 adjacent opposite ends thereof. Thus, the cylinder 20 is supported by the plate 10 for rotation on its axis.

Any suitable means may be employed for rotating the cylinder. For example, a variable speed motor 30 (FIGURE 1) may be mounted on the plate 10 and provided with a driving pinion 32 meshing with a ring gear 34 surrounding and fixed to the cylinder 20.

Casings 36 and 38 extend around the cylinder 20 at points spaced from the respective ends thereof and the interiors of these casings communicate with the interior of the cylinder through openings 40 and 42, respectively, these openings all being identical. The sides of the casings 36 and 38 extend downwardly vertically to the plate 10, as shown in FIGURE 2, and the lower portions of these casings constitute receptacles for the two materials to be separated. The two casings 36 and 38 are provided with doors or gates 44 and 46, respectively, which may be opened for the withdrawal of material from the casings. It will be apparent that if desired, the members 44 and 46 may be drawers in which the material may collect.

A standard 48 is mounted on the plate 10 and carries at its upper end a hopper 50 into which the mixture of material is to be fed. This material is fed by a screw conveyor 52 through an outlet 54 and thence through a pipe 56 terminating in the cylinder 20 substantially centrally of the length thereof. The shaft of the conveyor 52 carries a pulley 58 around which passes a belt 60 driven by the pulley 62 of a motor 64.

Both ends of the cylinder 20 are open for the movement of air therethrough, and to supply a current of air a fan 66 surrounds the outlet 54 and is driven through a belt 68 operated by a motor 70.

Referring to FIGURES 1 and 2, an elongated electrode 72 is supported within the cylinder by supports 74 beyond the ends of the cylinder. This electrode is charged with high voltage current to induce electrostatic charges in the cylinder 20, thus charging the less conductive particles therein and causing them to adhere to the interior of the cylinder so that they tend to rotate therewith to points beyond what would occur through the normal frictional engagement of such particles with the cylinder. It will be understood that this cylinder is grounded in any suitable manner, for example, through one of the bearing standards 24 as at 76.

The apparatus is intended for use in the separation of dry solid materials encountered in a wide variety of industrial operations such as mining and related operations, requiring separation of minerals and ores, food processing requiring for example separation of hulls from seeds or beans, tobacco processing requiring the separation of stems from leaf materials, etc. The device also has been effectively used for separating waste pieces of wire from

insulation, which separation usually has been accomplished by burning off the insulation with a consequent pollution of the atmosphere and a loss of some of the metal by oxidation.

Assuming the apparatus is to be used for separating insulation from waste wire, the wire is chopped into relatively small pieces and the insulation loosened therefrom by subjecting the pieces to the operation of a hammermill or other suitable means. The material thus treated is fed to the hopper 50 and flows through pipe 56 into the cylinder 20 to be discharged substantially centrally of the length thereof. The wire pieces, loosened from the insulation, tends to slide around the cylinder 20 as the latter is rotated and thus is gradually fed by the helices 22 upwardly along the cylinder 20 to be discharged through the openings 40 for collection in the casing 36.

The insulating material being of less mass, tends to frictionally engage the cylinder 20 to rotate therewith instead of being moved by the helices 22. As the lighter material is carried upwardly around the cylinder by friction, the frictional engagement decreases and at some point usually above the midpoint between the lowermost and the uppermost point, the material will drop. It is desired to carry the less conductive material upwardly almost to the top of the cylinder, and this is the function of the electrostatic charging of the less conductive material. Just before it reaches the top center of the cylinder, the less conductive material will drop to the bottom of the cylinder. The material will thus fall out of the space between two adjacent helices into to the space between the next lower adjacent pair of helices. In the latter space, the less conductive material will again be carried upwardly by the cylinder and dropped in the space between the next lower adjacent pair of helices. This successive lifting and dropping of the less conductive materials causes them to progress gradually toward the right or lower end of the cylinder in FIGURE 1 to be discharged through the openings 42 into the bottom of the casing 38 to be periodically removed.

As the less conductive material can be caused to adhere to the cylinder until it reaches a point near the top thereof, each dropping of such material by gravity to the bottom of the cylinder will represent slightly greater progress toward the right than if friction alone is depended upon. The electrostatic charge accomplishes this result by causing a slightly higher degree of adherence of the less conductive particles to the cylinder so that all particles in any space between two adjacent helices will drop into the space between the next adjacent lower pair of helices. The electrostatic charge will be slightly less than that which would be necessary to overcome the weight of the less conductive particles. This charge may be adjusted and the speed of rotation and inclination of the cylinder may be adjusted to provide the fastest possible complete separation of the materials.

The heavier or more conductive particles of wire or other material are not electrostatically affected, hence will slide along the surface of the interior of the cylinder to be fed by the helices toward the upper end of the cylinder to be discharged through the openings 40.

The separation of the materials is rendered more efficient by the use of the fan 66. The cylinder 20 is open at both ends and during the operation of the apparatus, the fan blows a current of air through the cylinder 20 toward the lower end thereof. This current of air does not appreciably affect the heavier particles engaging the inner wall of the cylinder. However, as the less conductive particles drop from the upper portions of the cylinder, the current of air causes these particles to take a downward course toward the right in FIGURE 1. Without the fan, the particles drop, as described above, and the fan causes the less conductive particles at each dropping thereof from the top portions of the cylinder to strike the bottom of the cylinder at points closer toward the outlet end.

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As indicated, the inclination of the cylinder from the horizontal and the speed of rotation thereof readily may be determined by experimentation. In a typical operation, for example, rubber insulated aluminum wire, chopped and prepared in the manner described, may be supplied to the hopper 50 with the cylinder arranged at an angle of 11.5° from the horizontal and rotating at a speed of 50 r.p.m. The angle of the cylinder to the horizontal may be adjusted by inserting the pins 18 in selected openings 16, and a suitable rheostat controlling the motor 30 may be adjusted to determine the speed of rotation of the cylinder.

From the foregoing it will now be seen that there is herein provided an improved Electrostatic Separation of Dry Materials which accomplishes all of the objects of this invention and others, including many advantages of great practical utility and commercial importance.

As various embodiments may be made of this inventive concept, and as many modifications may be made in the embodiment hereinbefore shown and described, it is to be understood that all matter herein is to be interpreted merely as illustrative, and not in a limiting sense.

I claim:

1. A separator for dry materials comprising an elongated, rotatable, grounded cylinder formed wholly of conducting material and inclined from the horizontal, means for feeding material to be separated to said cylinder intermediate its ends, means in said cylinder for moving heavier particles toward the higher end of said cylinder to be discharged therefrom, particles less conductive than said heavier particles adhering to the interior of the cylinder by electrostatic attraction to partake of a partial rotation with said cylinder perpendicular to the axis thereof and then to drop to thus progress toward the lower end of the cylinder to be discharged therefrom, and electrostatic means for increasing the adherence of less conductive particles to the interior of the cylinder to be rotated nearly a half revolution of said cylinder from the bottom to the top thereof before dropping to the bottom of said cylinder.

2. A separator according to claim 1 wherein said electrostatic means comprises an elongated electrode extending substantially throughout the length of said cylinder and adapted to be connected to a source of high voltage current.

3. A separator according to claim 1 wherein said means for moving heavy particles toward the higher end of said cylinder comprises an internal helical rib within said cylinder acting as a conveyor to move toward the higher end of said cylinder the heavier particles, which, because of their relative weight, remain in the bottom portion of said cylinder.

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4. A separator according to claim 1 wherein said means for moving heavy particles toward the higher end of said cylinder comprises an internal helical rib within said cylinder acting as a conveyor to move toward the higher end of said cylinder the heavier particles, which, because of their relative weight, remain in the bottom portion of said cylinder, said electrostatic means comprises an electrode extending substantially throughout the length of said cylinder and adapted to be connected to a source of high voltage current, said electrode being arranged sufficiently close to and parallel to said cylinder to deliver an electrostatic charge thereto.

5. A separator according to claim 2 wherein said electrode is arranged within and parallel to the axis of said cylinder and extends throughout the length thereof.

6. A separator according to claim 3 wherein the electrostatic charge delivered to said cylinder is sufficient to support the weight of the less conductive particles as the latter approach the high portion of said cylinder whereby such particles moving to the higher point of said cylinder between adjacent pairs of helices will drop into the space between the next adjacent pair of helices toward the lower end of said cylinder.

7. A separator according to claim 6 wherein said cylinder is open from end to end, and means for forcing a current of air through said cylinder from the higher to the lower end thereof whereby less conductive particles dropping from the higher portion of said cylinder into said current of air will be urged thereby toward the lower end of said cylinder.

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FRANK W. LUTTER, Primary Examiner

U.S. Cl. X.R.

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