Dec. 17, 1940. H. L. BULLOCK 2,225,096

ELECTROSTATIC SEPARATOR

Filed Dec. 6, 1938

Fig. 1.

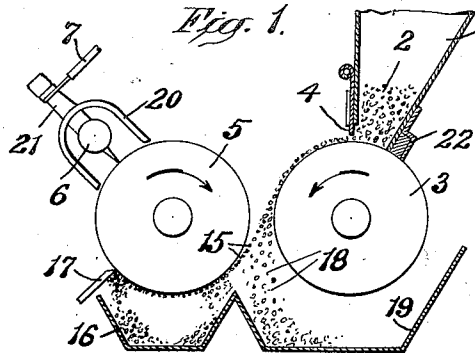


Fig. 2.

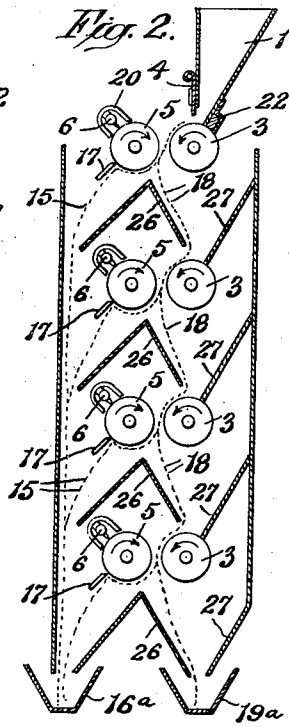


Fig. 3.

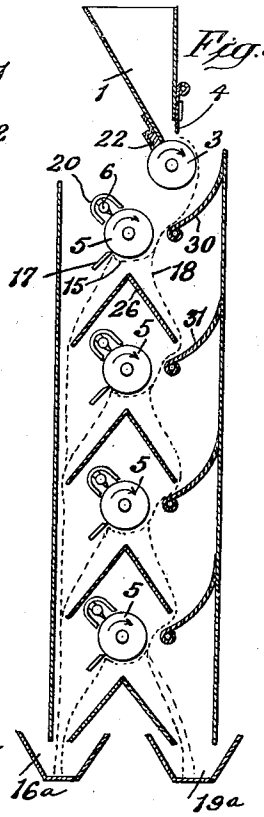


Fig. 4.

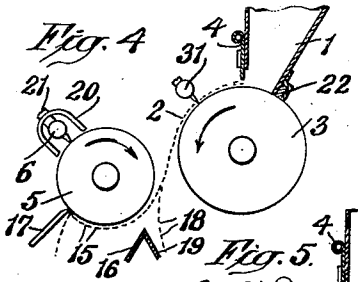


Fig. 5.

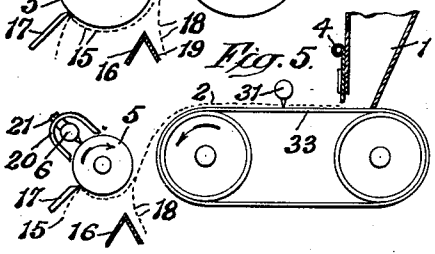


Fig. 6.

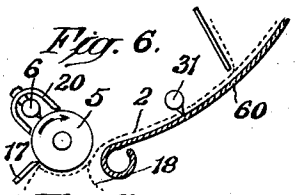


Fig. 7.

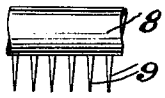


Fig. 8.

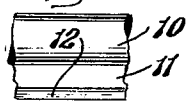


Fig. 9.

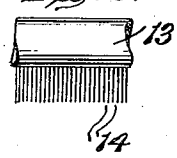


Fig. 10.

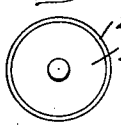
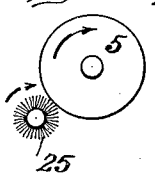


Fig. 11.



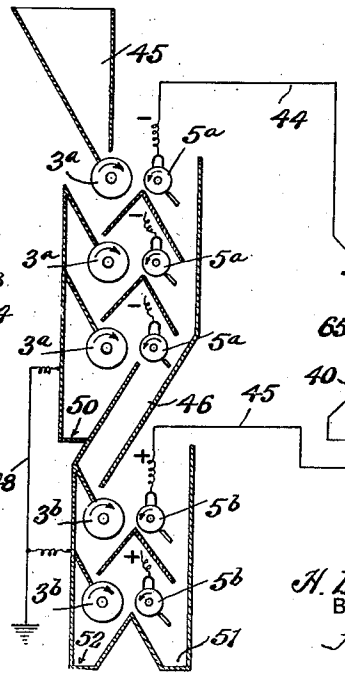
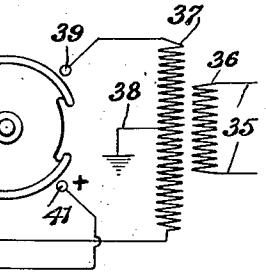


Fig. 12.



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UNITED STATES PATENT OFFICE

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ELECTROSTATIC SEPARATOR

Harry Leslie Bullock, New York, N. Y.

Application December 6, 1938, Serial No. 244,154

2 Claims. (Cl. 209—129)

This invention relates to a separating device adapted for use in the separation of various materials from one another, such as one non-metallic material from another, non-metallic materials from metallics, or the separation of certain metallics of a non-magnetic nature from various other kinds of material.

The invention relates particularly to electrostatic separators. Electrostatic separators have been developed in the past and as known at the present time are subject to several serious limitations. Due to a lack of understanding of the difference between the action of low tension and high tension electricity and reasoning from the known facts relating to low tension current, it was assumed by numerous workers in this art that since an electric current was used to generate the static field, the electrodes must be conductors of electricity. Following this theory, machines were constructed in which were included large exposed areas of metal rods, tubes, wires and bands joined together in a continuous electric circuit. Satisfactory results with this construction called for the use of direct current voltages varying from 14,000 to 35,000 volts. These large exposed areas of highly charged metal were subject to heavy losses of static charge during damp weather. The machine operators were exposed to dangerously high voltages and a single ground at any point on the machine rendered the entire separating field inoperative.

My experiments have conclusively demonstrated that an efficient electrostatic separator can be constructed in which the electrodes may be composed of non-metallic, dielectric or insulating material, such as hard rubber, glass, fibre, Bakelite, Celluloid, or any other good non-conductors. Static electricity is electricity at rest and it consists of surface charges. These charges are most efficient for producing a strong, static field of attraction when they are present on the surface of strong dielectrics or non-conductors.

Accordingly, one object of the invention is to produce an electrostatic separator of the character hereinafter described wherein one or more of the electrodes employed are composed of dielectric material with the many advantages following from such a construction.

Another object of the invention is to provide an electrostatic separator in which negatively and positively charged electrodes are employed in the same separator whereby the substance to be drawn or separated from the mass of material will be operated upon by first, a negatively charged electrode and secondly, by a positively charged electrode or vice versa, with the result that a very efficient method of obtaining exceedingly pure separation results.

In the accompanying drawing wherein several embodiments of the invention are shown, Fig. 1 is a diagrammatic view disclosing an embodiment of the invention; Fig. 2 is a diagrammatic view illustrating a plurality of separating devices arranged in gang formation so that a multiple passage of the material to be separated past the electrodes is obtained; Fig. 3 is a view similar to Fig. 2 of a slightly modified structure; Fig. 4 shows an arrangement whereby the separation of certain materials is improved by first passing it through a static field of one polarity and then passing it through a field of opposite polarity; Fig. 5 shows a similar arrangement wherein a belt conveyor is used to convey the material to the rotary electrode; Fig. 6 is a view showing a modification of the structures of Figs. 4 and 5, wherein a chute is employed to convey the material to the rotary electrode; Figs. 7, 8 and 9 show various forms of electrical conductors used for applying a charge to the electrodes; Fig. 10 is an end view of an electrode having a core of metal or other conducting material and an outer face portion of a dielectric; Fig. 11 is a diagrammatic view illustrating the use of a rotary brush or similar means for removing the material adherent to the rotary electrode; and Fig. 12 shows an arrangement whereby the material to be separated is first subjected to a negative charge and next subjected to a positive charge.

In Fig. 1 the invention in its simplest form is disclosed. There, 1 indicates a portion of a hopper containing the material 2 to be separated. Rotatably mounted below the outlet end of the hopper 1 is a feed roll 3 driven by suitable mechanism in the direction of the arrow. The amount of material fed from the hopper 1 to roll 3 may be regulated by raising or lowering the feed gate 4. The feed roll 3 may be of either metallic or non-metallic material and located opposite to the same and spaced therefrom is the rotating dielectric electrode 5, driven by any suitable mechanism in a direction opposite to that of the feed roll, or as shown by the arrow. Above the electrode 5 is the conductor 6 which is fed with high tension current by the wire 7 extending from a suitable source of current. The conductor 6 may be constructed in numerous ways, several of which are disclosed in Figs. 7 to 9 inclusive. For example, in Fig. 7 the conductor is disclosed as a round rod 8 from which a plurality of points, pins or prongs 9 project, the

end portions of these projecting elements being disposed adjacent to the periphery of the electrode to thereby carry the induced surface charges to a point opposite the feed roll 3 near the path of the material to be separated. The conductor might also be a round rod of small diameter with the pins or other projections omitted, the periphery of such rod being located adjacent to the periphery of the rotating electrode 5. Another example of a conductor is shown in Fig. 8 where the same comprises a rod 10 from which extends a flexible blade 11 formed with a knife edge 12 operative against the periphery of the roll 5. In Fig. 9 is shown another modification, wherein a rod 13 is provided with a plurality of closely-spaced flexible wires or bristles 14 which operate against the periphery of the roll or electrode 5.

Whatever the structure of the conductor is, examples of which are described above, its operation, when adjusted close to or in contact with the periphery of a non-conducting roll or electrode 5, induces or sets up a static charge on the surface of non-conducting roll or electrode, these static charges on the surface of the non-conducting roll or electrode produce in their turn a static field surrounding the non-conducting roll or electrode. The elements or ingredients of the material 2 which have the lowest surface conductivity, will thus be drawn away from roll 3, as indicated at 15, and from their natural path of fall. Some of the attracted particles 15 will drop directly into the container 16 while the other attracted particles will attach themselves to the surface of the rotating electrode 5 and will be carried around thereby until they are scraped off by the scraper 17 to fall down into the container 16. The portions of the material which have higher surface conductivity, will not be attracted, as indicated at 18, but will fall freely downward into container 19, located below roll 3. The distance between the feed roll 3 and the rotating electrode 5 is regulated to suit the type of material being separated and the center line of the rotating electrode may be located above, below or on the same line as the level of the center line of the feed roll.

The mounting for the conductor 6 comprises a guard 20 of insulating material and of channel-shaped conformation. An insulated binding post 21 connects the wire 7 and the conductor 6. The hopper is provided with a seal or wiper 22 to keep the material 2 from escaping at the back of the hopper 1.

While I have herein stated that it is desirable that the rotating electrode or roll 5 be composed of non-conducting material, and Fig. 1 shows the same as being made of solid material of that nature, it is obvious that the same may be made with an outer layer of non-conducting material, as shown at 23 in Fig. 10, disposed over a core 24 of metal or other conducting material. By grounding the core 24, and by employing the correct thickness of non-conducting material for the outer layer of the roll, it is possible to thus control the strength of the induced field. Another modification in the structure may consist of the use of a rotating brush, as shown at 25 in Fig. 11 as a substitute for the blade-like scraper 17 of Fig. 1.

In Fig. 2 is shown a suggested commercial application of the invention. There, a superimposed arrangement of the roll structure of Fig. 1 is disclosed. An angular separating plate 26 is disposed between each pair of rolls and that disposed below it. Thus, the portions of the material having the higher surface conductivity, and indicated at 18, falling from the topmost roller 3, will fall against the guide plates 26 and 27 down the next pair of rolls, and continue its descent until it reaches the container 19a, being subjected as it is brought to each pair of rolls, to the static field of the roll 5 in each pair. Thus, with this structure, repeated subjection of the material to be separated, to the effect of the static field of each electrode 5 results in a very complete separation of the material. The material 15 attracted by the electrodes 5 falls into container 16a.

The structure shown in Fig. 3 is similar to that shown in Fig. 2 except that in the structure there shown, the material 2 leaving feed roll 3 falls upon a chute 30 which directs it toward rotating electrode 5 which picks up the material 15 of lowest surface conductivity, while that of higher surface conductivity falls down to the next chute 31 which directs it toward the next electrode 5, this being continued until the material has been handled by a number of rollers and chutes, the separated particles finally falling down into the receptacles 16a and 19a as previously described.

Certain treatments serve to increase the attraction differential and are sometimes advisable before bringing the material into the separation zone. For example, the material may be heated to secure better separation of certain materials. Also the separation of certain materials is improved by first passing it through a static field of opposite polarity. This may be accomplished as indicated in Fig. 4 where the path of the material being fed is extended to allow a spray electrode 31, similar in construction to any of those shown in Figs. 7 to 9 inclusive, to play upon the surface of the moving material 2. The feed roll 3 there shown is made considerably larger than the electrode 31. In Fig. 5 a similar result is attained by the use of a feed belt 33 over which the spray electrode 31 is disposed to play upon the surface of the material 2 carried by the belt toward the electrode 5. In Fig. 6 is shown a gravity chute 60 down which the material 2 slides toward the rotating electrode 5. A spray electrode 31 plays upon the surface of the material 2 as it moves toward the electrode 5.

Separation tests have shown that in some mixtures of materials, one substance can be drawn from the falling mass by means of a positive electrical charge, while a reversal of the charge will leave the first material in the stream and will draw over a different substance. Use of this difference in attraction offers a very efficient method by which exceedingly pure separations may be obtained. An arrangement by which the present invention may be employed in a structure of this kind, is shown in Fig. 12. The primary A. C. current is connected at 35 to the coil 36 of a suitable transformer, and generates a high voltage A. C. current in the secondary winding 37. The secondary winding is preferably center-tapped and grounded as indicated at 38, and the ends of the winding are connected to the contact brushes 39 and 40 arranged on opposite sides of the rectifying disc 65. This rectifying disc 65 is rotated in synchronism with the A. C. current and provides alternate conducting paths to the collecting electrodes or brushes 41 and 42. Proper arrangement of the brushes 39, 40, 41 and 42 will cause the brush 42 to be charged negatively and the brush 41 to be charged posi-

tively. Insulated conductors **44** carry the negative charge to the dielectric electrodes **5***a*, while similar insulated conductors **45** carry the positive current from brush **41** to a number of dielectric electrodes **5***b*. The main body of the machine is grounded as indicated at **48**. This arrangement insures that the points of greatest difference of potential, the electrodes **5***a* and **5***b*, are separated by double insulation and also insures that the effective potential to ground at any part of the machine is only one half of the effective voltage.

In the operation of the structure shown in Fig. 12, the mixture composed of say, two materials A and B, is fed from the supply hopper **45** to the feed rolls. The material B in the mixture is one which, we will presume is attracted by a negative charge, while the material A is attracted by a positive charge. Electrodes **5***a*, being negatively charged, will draw the substance B with a slight contamination of the substance A due to mechanical carrying. The material B with a slight amount of A drawn over by the electrodes **5***a*, descends into chute **46** by which it is directed to a lower group of feed rollers **3***b*. By the use of a suitable number of electrodes **5***a*, all of the material B can be drawn from the fed substance, leaving a pure A at the collection point **50**. The portion B with slight contamination of A led to the feed rolls **3***b* is now exposed thereby to the positively charged electrodes **5***b* which draw out A causing it to be directed into the connection chamber **51**, leaving a purified B substance to fall downwardly into the collection chamber **52**. By arrangement of negative and positive charges to the electrodes, in various ways, it will be apparent that various desired separating effects are possible.

By the several arrangements herein described, surface leakage of the ordinary conductor when employed as an electrode is avoided. Since the exposed electrode is of non-conducting material, it will not transmit high voltage and the machine operator is not subjected to possible injury therefrom. Grounding of the system through the electrode is prevented; lower voltages can be employed; sparking between the electrode and frame or other metal parts is prevented, and other advantages are attained which will be clearly apparent to those skilled in this art.

Having described several embodiments of the invention, it will be obvious that the same is not to be restricted thereto, but is broad enough to cover all structures coming within the scope of the annexed claims.

What I claim is:

1. An electrostatic field separator comprising, a hopper, a feeding device disposed relative to the hopper to receive material therefrom to be separated, a rotating roll composed of dielectric non-conducting material situated near the feeding device to thereby electrostatically attract elements from the material carried by the feeding device, and means for applying a non-fluctuating static surface charge to the surface only of the dielectric roll, said means including a metallic electrode situated externally of the non-conducting roll and applying a constant and uniform layer of static electricity of one potential on the surface only of the non-conducting roll.

2. An electrostatic field separator comprising an electrode of non-conducting material, means for rotating the electrode, means adjacent to the electrode for feeding material which may be attracted by the electrode, and means for applying an electrostatic charge to the surface only of said electrode, said last-mentioned means consisting of an electrically charged metallic member, said member applying a constant and uniform electrostatic surface charge to the periphery only of said electrode, said member being operative wholly externally of the electrode and located adjacent to the surface of the same whereby the direction of charging current may be reversed at will to adapt the separator to various materials without requiring changing of the electrode.

H. LESLIE BULLOCK.