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C. H. HUFF.

APPARATUS FOR ELECTROSTATIC SEPARATION OF SUBSTANCES OF DIVERSE ELECTRIC SUSCEPTIBILITIES.

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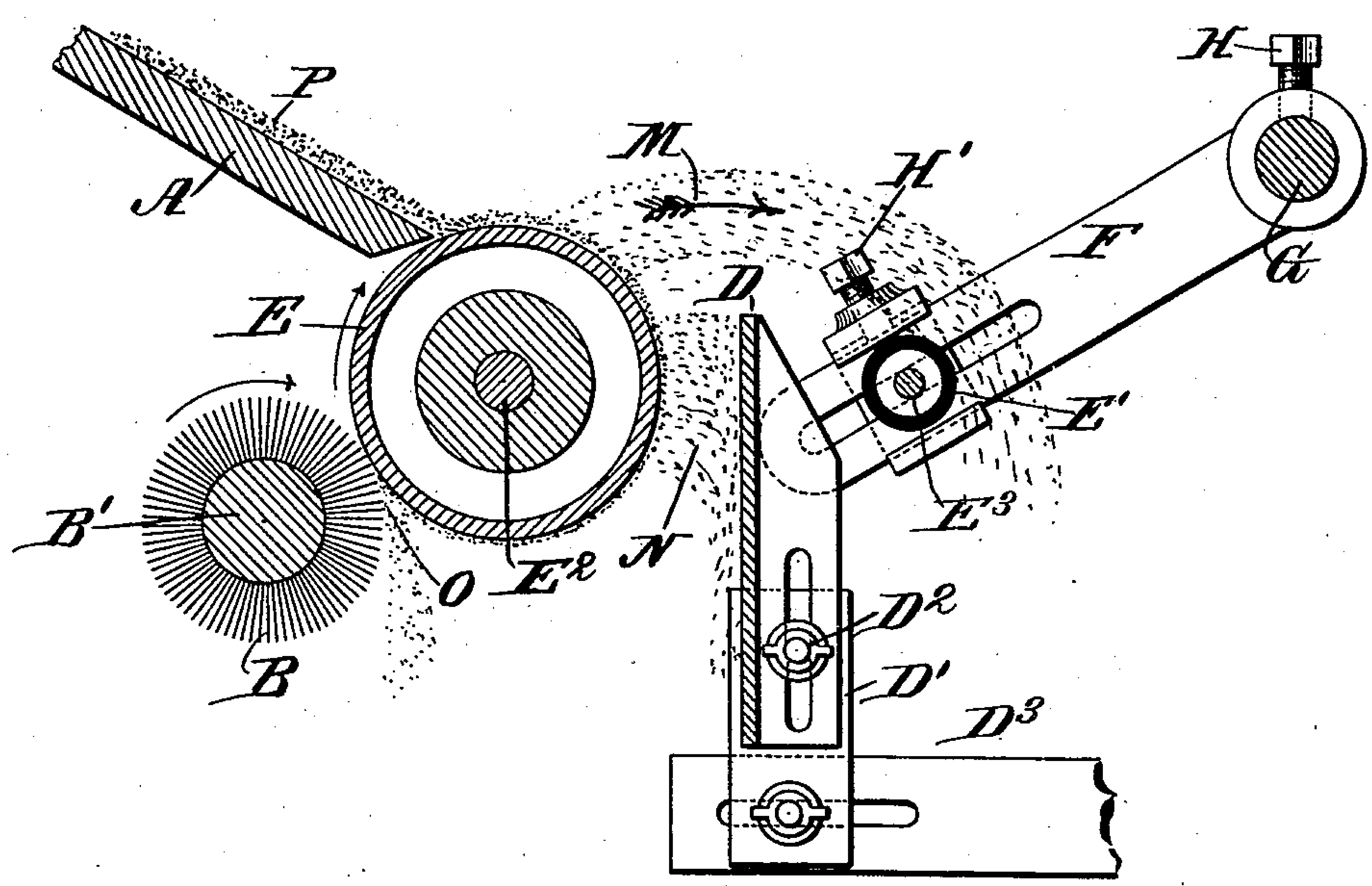

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APPARATUS FOR ELECTROSTATIC SEPARATION OF SUBSTANCES OF DIVERSE ELECTRIC SUSCEPTIBILITIES.

No. 801,380. **Specification of Letters Patent.** **Patented Oct. 10, 1905.**

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To all whom it may concern:

Be it known that I, CHARLES H. HUFF, a citizen of the United States, and a resident of Brockton, in the county of Plymouth and State of Massachusetts, have invented new and useful Improvements in Apparatus for Electrostatic Separation of Substances of Diverse Electric Susceptibilities, of which the following is a specification.

My invention relates to the art of separating the components of mixed materials by the application thereto of static electricity; and it consists of improvements in apparatus whereby differentiated particles of a mass or mixture are separated from each other, classified, or concentrated.

In Dolbear's United States Patent No. 685,508 there is described and claimed the electrostatic method of separating conductors from non-conductors and an apparatus for carrying into effect the said method. In that apparatus, as the same is described in the Dolbear patent, a stream of comminuted material, partly conductors and partly non-conductors, is made to flow or fall into contact with a statically-charged conductive electrode surface. Thereupon the conductors, becoming charged, are repelled, while the non-conductors, not becoming charged, are not repelled, or, as stated in the said patent, may adhere to the electrode-surface, from which a brush removes them. When in the operation of such an apparatus the potential at the electrodes is raised so as to repel conductive particles more emphatically, the immediate object is attained; but the desired final result—viz., separation of particles according to differences in conductivity—is wholly or partly defeated, because unless the application of high potential be regulated the particles of low conductivity become charged, as well as those of high conductivity, and are repelled along with them. Therefore while the apparatus and process described in the said Dolbear patent will, under proper conditions of potential and wide difference between the conductivities of the materials treated, effect separation and concentration neither are as rapid or as complete as might be desired, especially for commercial purposes.

It should be borne in mind that the time required to charge a particle in contact with a body at very high potential is infinitesimal, even though the particle be of inferior conductivity, and that the time periods of charge fluctuation, which are according to ordinary standards of comparison very rapid, are so much longer than the time required to charge a particle of matter that the phases of such electrical fluctuations are relatively and substantially continuous when judged by the charge-time standard.

My improvements are embodied in apparatus susceptible of use both for separation processes, which employ potential unregulated in time with respect to the charge times of differently-conductive particles, and for processes which regulate the application of potential with respect to the said charge times and are characterized by an arrangement of electrodes susceptible of receiving a static charge having so intense a field that if unregulated the potential effect is felt not only by the more susceptible particles brought into contact with one of the electrodes, but also by particles of inferior susceptibility. Further, the final separation of repelled particles may be effected by my improved apparatus by virtue of the differences in force wherewith they are repelled, as the average trajectory of repelled particles of one class diverges sufficiently from the average trajectory of repelled particles of another class. I take advantage, therefore, both of the differences in the force wherewith different particles are repelled and of the differences in time required by different substances to become charged. In this connection I employ in combination with the electrodes a divider which is interposed in the path or trajectory of repulsion of one class of particles, so as to arrest these, while permitting another class of particles to pursue their way uninterrupted, so that although particles of diverse grades of susceptibility to the static charge are actually repelled from the electrode wherewith they come in contact they are mechanically separated according to differences in degree of their respective repulsions.

While my improvements may hypothetically be embodied in an apparatus containing but one electrode, the earth or surrounding objects inductively affected standing for the opposite electrode, far more satisfactory results can be obtained by using two oppositely-charged electrodes. Moreover, two electrodes constructed according to my invention can be brought by adjustment into very close proximity to each other, and thus create a convective static field of great power.

When the repellent charges at the electrodes are regulated so as to endure but an infinitesimal instant of time, it is of great practical importance that during the brief intervals of their persistance the field created by them should be intense, and for this purpose my arrangement of electrodes is distinctly advantageous.

In the accompanying drawing there is illustrated an apparatus which embodies my invention and improvement.

A finely-pulverized mass of material—such as, for instance, metal-bearing ore (marked P in the drawing)—is conveyed by an apron or other suitable instrumentality (marked A) to and upon the surface of the repelling-electrode E. This electrode is here shown in cross-section as a roller mounted upon a shaft E^2, which gives the electrode a movement of rotation in the direction of the arrow marked thereon. The electrode-surface is electroconductive and should therefore be of some suitable metal. This is charged by connection with a static machine, Ruhmkorff coil, or other proper source of static electricity. The electrode E^3, which is preferably of much smaller superficial extent than the electrode E, is here shown in cross-section as a metal wire. This wire is incased in an envelop of glass or other insulating material E'. Between these two electrodes E and E^3 (which are oppositely charged) I arrange a barrier or divider D, shown in this instance in cross-section as a plate, which should be of wood, glass, or other low conductor. This is adjustably mounted upon a support D' and is secured thereto by some adjusting means, such as a thumb-screw D^2, passing through a slot in the divider D. In order to provide for adjustment in all directions, the support D' is adjustably mounted in a similar way upon a part D^3. The relatively small size of the electrode E^3 causes a concentration of the lines of force of the static field and enhances the initial repellent effect at the electrode E.

The interposition of the dielectric divider D (which by reason of its relatively greater facility for transmitting lines of force causes the lines in its neighborhood to be gathered toward it and deflected from their normal direction) assists in the concentration of the lines of force to some extent and is therefore measurably advantageous as an electrically-functional adjunct. The result is a lifting of particles from the electrode E and a consequently wide trajectory, through which the more sensitive portion of such particles passes.

As the mass P of mingled comminuted material containing particles of different grades of electrosusceptibility or sensitiveness passes into contact with the electrode E it is carried thereby over and into the electrical field between the two electrodes E and E^3. As the particles move from the region of inferior to that of superior intensity of field the metallic particles which are the most susceptible to the influence of the field are first repelled and by the cumulative effect of the convective field find their way to the surface of the mass (if they are entangled therein) and leap across the gap over or upon or into the neighborhood of the electrode E^3 and thence fall into a suitable receptacle. Meanwhile the particles of inferior susceptibility, if the charge be prolonged or continuous, have been more slowly acquiring a charge of sign similar to that of the electrode E and presently as they arrive at the more intense parts of the field of influence leave electrode E and contact therewith and leap across the gap toward the electrode E^3. Here the barrier or divider D, which is adjusted to a point appropriate to existing conditions in the apparatus, mechanically arrests the less susceptible particles as they leap from the electrode E and causes them to be deposited in a proper place, and thus to be isolated from the more highly susceptible particles, which have passed through the trajectories, (indicated by a feathered arrow and marked M.) The particles of inferior electroconductivity being repelled through the paths marked N are, as stated, arrested by the divider D. If in the mass P there are any particles so unsusceptible to the influence of the electrode E—as, for instance, of such low conductivity that they are carried out of the influence of the convective field before acquiring a sympathetic charge—they may be removed by some mechanical means, as a brush B, rotating in the direction of the arrow upon a shaft B' and fall from the point marked O into a proper receptacle. The adjustability of the divider renders the apparatus extremely flexible or adaptable to different electrical conditions and to different mixtures of matter to be treated. This adjustability may with advantage be supplemented by making one or both of the electrodes E or E^3 also adjustable toward or from each other or from the divider D, as suggested by the adjustable slotted arm F, mounted on a bar G, the adjustments of arm F and electrode E' being secured by set-screws H and H'. If there are particles in the mass which express several different grades of electroconductivity, these may be separated or isolated from each other by virtue of the cumulative effect of the convective field. They pass from a region of comparatively feeble to one of comparatively intense charge upon the electrode, and thence such particles as remain in contact with the electrode pass away from the region of strong convective influence. The possibilities, therefore, of differentiation between the particles of graded susceptibility are very varied.

By having the electrode E^3 much smaller in superficial area than electrode E the particles repelled from E and passing over the divider D are brought together at electrode E^3. Moreover, the region of maximum intensity of force is concentrated more or less on a line normal to the nearest adjacent surfaces of the two electrodes. Therefore particles of superior susceptibility will be repelled from electrode E over divider D before this region of maximum intensity of charge is passed, while those particles of inferior susceptibility will enter or pass this region before they are repelled and hence in their flight will be intercepted by the divider D and separated from the other particles.

Especially under the conditions of time-regulations of charge which limit the duration of potential accession to brief instants will the above-described apparatus prove efficient. The small dimensions of the electrode E^3, which in practice is a copper wire not more than one-sixteenth inch in diameter, together with the pronounced curvature of the electrode E, which is in practice a metal roller about three-fourths inch in diameter, and the glass or other dielectric envelop of the electrode E^3 all contribute to the desired concentration of the lines of force. These lines are closely collected at the electrode E^3 and in the body of the glass envelop E'. The two electrodes can be brought into very close juxtaposition without danger of sparking by reason of the protective effect of the envelop E' and by this close proximity of the electrodes the lines of force are very closely concentrated. Here, again, the dielectric divider D assists in concentrating the forces of the static field.

Potentials exceeding one hundred thousand volts can be employed provided the duration of individual charges at the electrodes be very brief, and such high potentials, together with the close juxtaposition of the electrodes, greatly facilitate the work of separating particles of different conductivities.

I claim—

1. In an electrostatic separator, the combination of oppositely-charged electrodes and means to intensify that concentration of the lines of force for which the shape and proximity of the electrodes are responsible.

2. In an electrostatic separator, the combination of a repelling-electrode, an oppositely-charged electrode having an effective area so small in relation to the repelling-electrode as to effect a material convergence of the lines of force and provided also with a dielectric envelop, and means to feed material to the repelling-electrode.

3. In an electrostatic separator, the combination of a rotary metallic electrode, an oppositely-charged electrode of metallic material having an effective area so small in relation to the rotary electrode as to effect a material convergence of the lines of force and provided also with a dielectric envelop, and a divider between the two electrodes.

4. In an electrostatic separator, the combination of a rotary metallic electrode, an oppositely-charged electrode of conductive material, provided with a dielectric envelop, having an effective area so small in relation to the repelling-electrode as to effect a material convergence of the lines of force.

5. In an electrostatic separator, a repelling-electrode and an oppositely-charged electrode, means to intensify that concentration of the lines of force of the static field for which the shape and proximity of the electrodes are responsible, means to feed material to the repelling-electrode at a region thereon of relatively low field intensity, and means to move the material thence into a region of relatively high field intensity.

6. In an electrostatic separator, the combination of a repelling-electrode, an opposite electrode, means to intensify that concentration of the lines of force in the static field for which the shape and proximity of the electrodes are responsible, means to deliver material to the repelling-electrode at a region thereon of relatively low intensity of field, the repelling-electrode being rotary to transport the particles of material toward the opposite electrode and into a region of relatively high intensity of field.

7. In an electrostatic separator, the combination of a repelling-electrode, an opposite electrode, means to intensify that concentration of the lines of force in the static field for which the shape and proximity of the electrodes are responsible, means to feed material to the repelling-electrode at a region thereon of relatively low field intensity, the repelling-electrode being rotary to transport material from said point of delivery toward the opposite electrode and into a region of relatively high field intensity, and a divider to intercept particles of lower grade of conductivity during their movement from the repelling-electrode.

8. The combination in an electrostatic separator, of a rotary horizontal electrode, means for feeding material thereto, an opposite electrode parallel to the first electrode, and a vertically and horizontally adjustable dielectric divider between the electrodes and parallel thereto.

9. The combination in an electrostatic separator, of a rotary horizontal electrode having a conductive surface, means for feeding material thereto, an opposite electrode consisting of a metal wire of small diameter parallel to the first electrode and enveloped in a glass tube, and a dielectric divider parallel with and between the electrodes.

10. The combination in an electrostatic separator, of a repelling-electrode, means to feed material thereto, an opposite electrode provided with a dielectric envelop and having an effective area so small in relation to the repelling-electrode as to effect a material convergence of the lines of force, and a dielec-

tric divider between and parallel with the electrodes.

11. The combination in an electrostatic separator, of a rotary repelling-electrode, means to feed material thereto, and an opposite electrode of conductive material provided with a dielectric envelop, said electrode having an effective area so small in relation to the repelling-electrode as to effect a material convergence of the lines of force.

Signed by me at Boston, Massachusetts, this 4th day of August, 1904.

CHARLES H. HUFF.

Witnesses:

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