H. A. WENTWORTH.

ELECTRIC SEPARATOR.

APPLICATION FILED FEB. 3, 1908.

899,364. Patented Sept. 22, 1908.

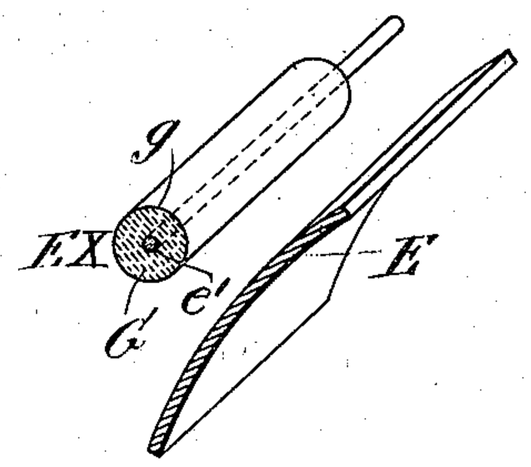

Fig. 1.

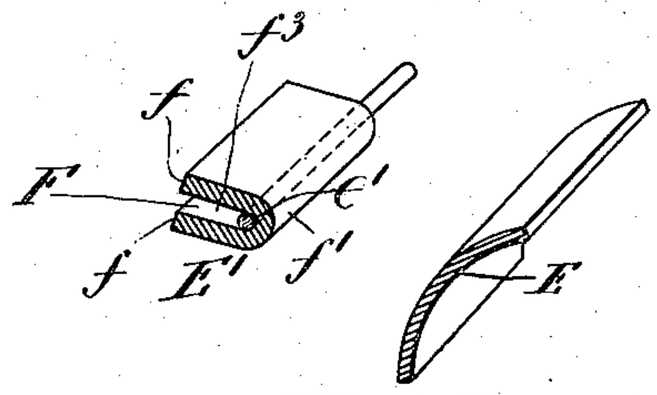

Fig. 2.

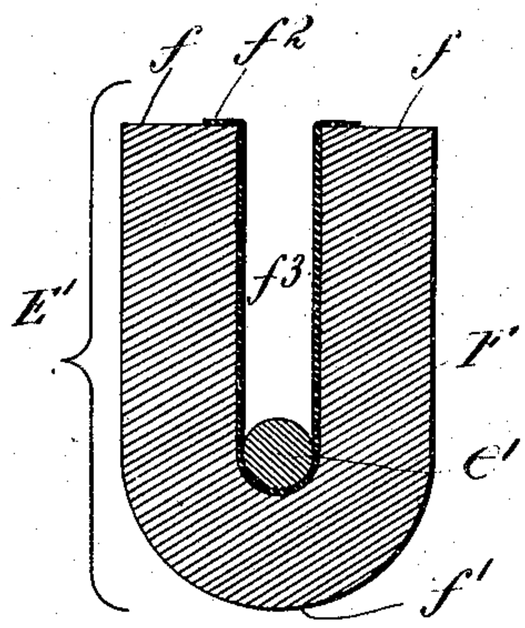

Fig. 3.

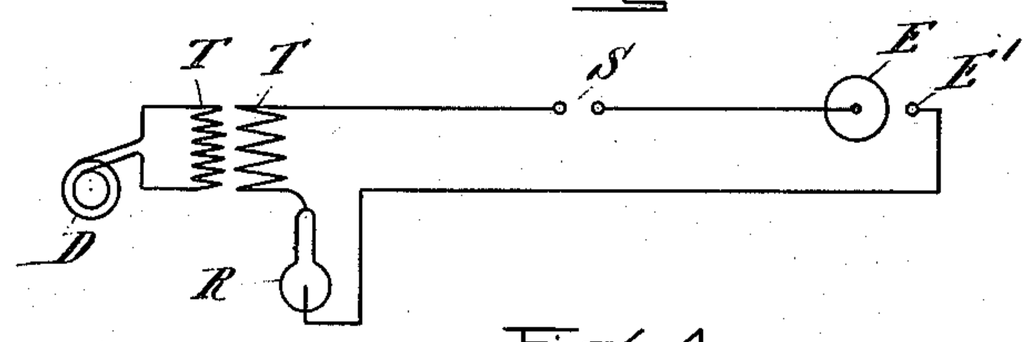

Fig. 4.

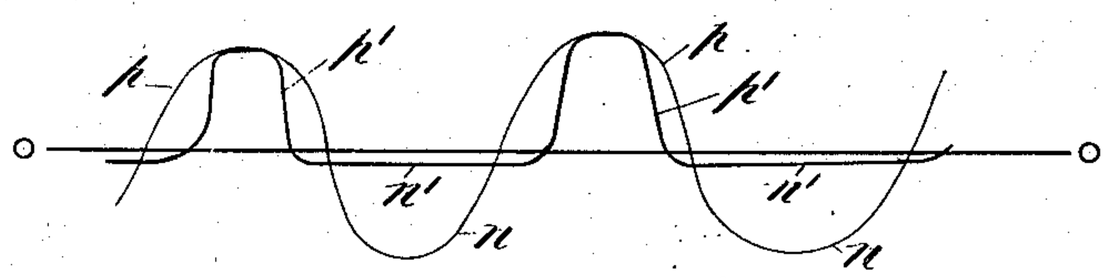

Fig. 5.

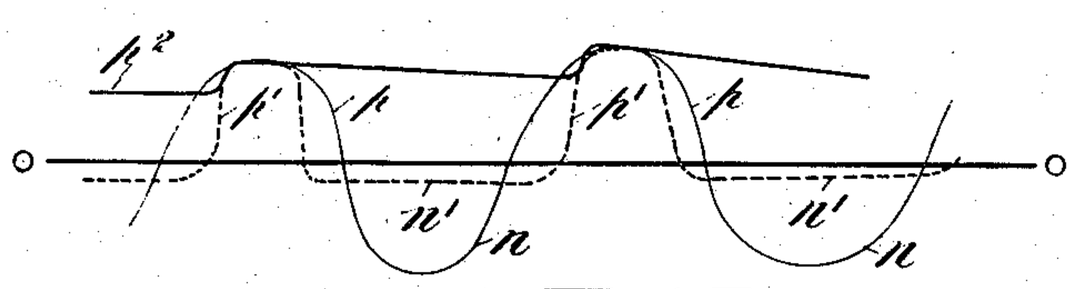

Fig. 6.

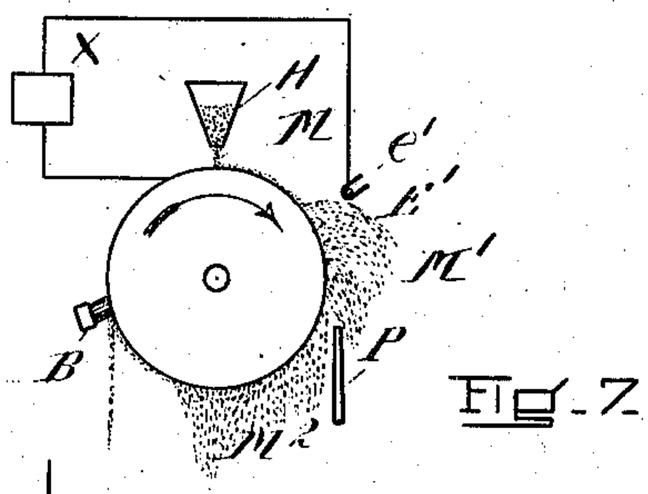

Fig. 7.

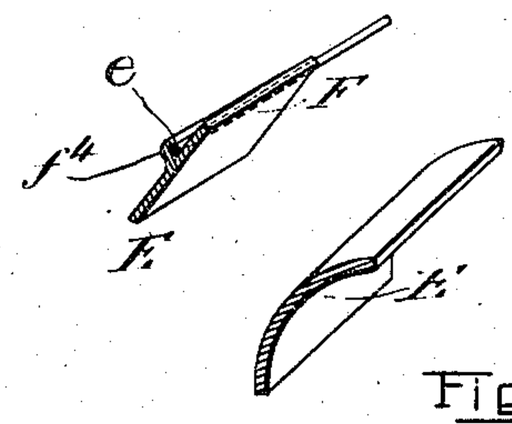

Fig. 8.

WITNESSES

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HENRY AZOR WENTWORTH, OF LYNN, MASSACHUSETTS, ASSIGNOR TO HUFF ELECTROSTATIC SEPARATOR COMPANY, OF BOSTON, MASSACHUSETTS, A CORPORATION OF MAINE.

ELECTRIC SEPARATOR.

No. 899,364. Specification of Letters Patent. Patented Sept. 22, 1908.

Application filed February 3, 1908. Serial No. 413,999.

To all whom it may concern:

Be it known that I, HENRY AZOR WENTWORTH, a citizen of the United States, and resident of Lynn, in the county of Essex and State of Massachusetts, have invented new and useful Improvements in Electric Separators, of which the following is a specification.

My invention relates to apparatus for electrical separation of different components of mixed comminuted solid material and consists in improvements in such apparatus presently to be described.

In Patent No. 801,380 dated the 10th day of Oct. 1905, issued to Charles H. Huff, there is described an electrical apparatus in which one structural feature consists in an electrode composed of a wire entirely surrounded by a dielectric envelop, more specifically a metal wire drawn through a relatively thick glass tube. When the electrical apparatus is excited from a source of varying potential, a concentrated and effective field is established between the insulated electrode and the uninsulated electrode, and, so far as I am aware, in situations where the field is rapidly varying, the structure described in the said Huff patent serves its purpose admirably. The diversity of materials which it is desirable to treat separatively by electrical means is so great that, although the separative process employing brief intermittent potential (as described in Patent No. 805,694, dated Nov. 28, 1905 to Philip H. Wynne), is effective over a very large range and variety of materials, nevertheless, some mixtures of material have been encountered which, while responsive to electrical separation under conditions of intermittent and alternating potential, may be more effectively treated under conditions of steady and unidirectional electric charge. Treatment of some mixtures by electrical separation employing a substantially constant and continuous potential, sometimes in itself is sufficient to effect a commercially acceptable separation or concentration and sometimes is of value as a preparatory or supplementary adjunct to the electrical separation characterized by conditions of intermittent and alternating potential. A difficulty which often attended the employment of steady unidirectional charge is that the persistence of the charge, when the potential is raised, produces disruptive discharges unless adequate means are provided to prevent them. The surrounding of one of the electrodes, as in the said Huff patent, by a continuous dielectric envelop while effective to prevent disruptive discharge introduces another detrimental phenomenon in the operation of the separator when steady or unidirectional potential is employed.

My invention herein to be described consists of new factors in electrostatic separation apparatus by which unidirectional charges at high potential and of substantially continuous character may be employed without involving the detrimental incidents heretofore observed.

In the drawings hereto annexed which illustrate embodiments of my invention,—Figure 1 is a fragmentary illustration in perspective showing a portion of the apparatus described in the said Huff patent; Fig. 2 is a fragmentary illustration of an apparatus which embodies features of my present improvement; Fig. 3 is a detail on an enlarged scale in cross section showing an electrode and its insulating support; Fig. 4 is a diagram illustrating an electrical generating apparatus for an electrostatic separator; Fig. 5 shows in diagram the character of the potential wave form produced by the apparatus of Fig. 4; Fig. 6 is a diagram showing a modified wave form such as is produced by the employment of my improvements; Fig. 7 is a diagram showing the fundamental elements of an electrical separation apparatus containing my improvements; and Fig. 8 is a fragmentary view of an electrical separation apparatus which embodies my invention in a modified form.

In Fig. 1 which shows a portion of the apparatus described in the aforesaid Huff patent (which may be referred to, to supply details not herein shown) E is a portion of a cylindrical drum electrode and $E^{\times}$ designates collectively the structure of the opposed electrode, wherein e' is a metal wire and G is a glass tube inclosing the wire. When the charge upon the wire e' is unidirectional and the potential employed is sufficiently high to cause a repulsion of electro conductive particles from the surface of the electrode E, many of these particles, especially the very fine dust, will be carried into contact with the surface g of the dielectric envelop G and will cling thereto; eventually, in the operation of the machine, coating the tube G with a superficial film of closely packed conductive

material. The effect of this is to convert the electrode E× into a condenser. The surface of the wire *e'* on the one hand, and the film of the conductive particles on the tube G, on the other hand, supplying the conductive surfaces, and the glass or other dielectric material of the tube G constituting the dielectric which separates the two conductive surfaces. This condition of course destroys the effectiveness of the electrostatic field between the two electrodes E E× and vitiates the performance of the apparatus.

Even where there is no quantity of dust to actually stick to the electrode or other dielectric envelop, there is a slight electrical discharge from the metal cylinder to the surface of the glass, which after a short period of excitation carries sufficient charge through the air to the surface of the glass to give the condenser effect and thus vitiate the action of the machine.

In Fig. 2 there is illustrated in part an apparatus, by the aid of which unidirectional and, if desired, substantially constant high potentials may be employed without incurring the disadvantages due either to disruptive discharge or to the above described condenser effect. As in Fig. 1, E represents a portion of a metallic cylindrical drum electrode. The opposed electrode represented collectively by E' consists of a metallic portion *e'* shown as a wire, and a barrier F, composed of low conductive material, as wood or fiber, the whole or part of which should be of sufficiently effective insulating material so as to prevent disruptive discharge from the surface of wire *e'* directly to the electrode E and yet should be capable of allowing an electric charge to creep over it. The wire *e'* is partially surrounded by a barrier F which in effect lies between the drum E and the wire *e'*. In the form shown in Fig. 2 the partial envelop or barrier F consists of low conductive material U-shaped in cross-section, the wire *e'* lying at the bottom of the groove f^3 which is flanked on either side by the wings *f*. The bottom of the U at *f'* stands between the wire *e* and the electrode E. In Fig. 3 the construction of the electrode E' is shown on a larger scale. If the substance of which the envelop F is composed in itself will stand a high disruptive voltage, the wire *e'* may be laid in contact with the envelop F at the bottom of the groove f^3. If, however, a more effective insulation is desired, a sheet or sheets of better insulating material such as oiled cambric, may be laid in the groove F^3 as a lining, as at f^2.

The precise shape of the barrier or envelop F is by no means essential; there is shown in Fig. 8 a form consisting of a flat strip, to the back of which the wire *e'* is secured; in the instance shown, the wire rests upon the ledge f^4. The effect of the above described structure is as follows: When the electrode wire *e'* is connected to a source of unidirectional electric charge, the charge creeps over the surface of the barrier F around the wings *f* to the portion at *f'* which is presented in opposition to the surface of the electrode E. The field is established as between the surface at *f'* and the electrode E, and is maintained by the flow of charge from the wire *e'* over the surface of the barrier at F. As the surface presented to the electrode E is low-conductive material, the danger of disruptive discharge is minimized. The possibility of such discharge from the metal surface of the wire *e'* is effectively reduced because the path of such discharge would have to be from the wire *e'* around the barrier F and thence to the electrode E. This creeping charge over the barrier F immediately neutralizes the small but cumulative charges brought over by the repelled material from the opposite electrode, or by the slight electrical discharge. Whereas with the Huff glass electrode of non conducting material, which was used merely to prevent disruptive discharge or to concentrate the field, a very thin layer of mineral dust repelled across and adhering thereto, effectually reduced the efficiency of the action of the machine, with my new form of apparatus this dust may accumulate upon the barrier to a thickness of $\frac{1}{8}$ inch or more without impairing the action of the machine. In practical field use of the machine, this is a very important feature.

A preferable mode of obtaining electric charge or high potential is to employ an apparatus such as is illustrated in Fig. 4; there E E' represent the electrodes of a separator; the primary source of energy is represented at D, which may be an alternating current dynamo. The current goes to a step-up transformer T T', one terminal of which is connected through a rectifier R to one electrode, as E', the other terminal of the coil T' goes to the opposite electrode through the spark gap S. The effect at the electrodes of the apparatus shown in Fig. 4 is diagrammatically shown in Fig. 5, where *o—o* represents the zero line of potential and the curve *p—n* the curve of alternating potential of the generator D. The potential represented by the line *p* rises to the breaking point of the spark gap S; when the spark gap breaks, the electrodes E E' are connected with the source and their potential rises. The presence of a rectifier R cuts out, we will say, the charge represented by the lower crests *n* of the potential curve so that the potential at the electrodes is represented by the curve *p'—n'*. This method of obtaining high tension charge gives a series of small impulses which last only so long as the exciting force is acting. But if steady potentials are to be used, the more nearly steady the conditions can be maintained, the more nearly uniform is the

action of the separator. If now the arrangement illustrated in Figs. 2, 3, and 8 be employed the curve of potential on the electrode wire e' is such as represented by the line p'—n' of Fig. 5. At each accession of potential the charge flows from the wire e' over the surface of the barrier F, distributing itself more and more evenly as it recedes from the wire e' so that the curve of potential at the portion f' of the barrier F, while doubtless subject to some fluctuations, is represented qualitatively by the modified wave shown by the line p^2 of Fig. 6. The surface of the barrier F serves as a reservoir to equalize the intensity of field between the portion f' of the electrode E′, and the electrode E.

In Fig. 7 there is illustrated diagrammatically the essential operative elements of an electrostatic separator such as is above described, wherein X represents, conventionally, the generative apparatus E E′ the two electrodes, H a hopper to deliver material to the electrode E (which rotates in the direction of the arrow shown), F is a divider or screen to maintain the separation electrically produced between repelled particles as at M′ and others as at M^2, B is a brush which may be used to remove from the electrode E any particles which may cling thereto.

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

1. In an electrical separator, the combination of a pair of electrodes, a barrier of low conductive material between the electrodes, close to and partly surrounding one of the electrodes, means to supply material to the other electrode, means for supplying unidirectional charge to the shielded electrode, and means for separately collecting electrically separated components of the material.

2. In an electrical separator, the combination of a pair of electrodes, a barrier between the electrodes close to and extending partly around one of the electrodes and provided with rearwardly projecting wings, means to supply material to the other electrode, means for supplying unidirectional electric charge to the shielded electrode, and means for separately collecting electrically separated components of the material.

3. In an electrical separator, the combination of electrodes, means to supply electric charge thereto in intermittent unidirectional impulses, and a reservoir of electric charge in close proximity to one of the electrodes consisting of material of low conductivity.

4. In an electrical separator, the combination of electrodes, a barrier of low conductive material between the electrodes, and close to and partially surrounding one electrode, means to supply material to the other electrode, means for maintaining substantially persistent unidirectional electric charge on the shielded electrode, and means for separately collecting electrically separated components of the material.

5. In an electrical separator, the combination of a material-receiving electrode, an opposite electrode comprising a conductive member and a low conductive barrier partially surrounding the same, means to supply unidirectional intermittent electric charge to the said conductive member, and means for separately collecting electrically separated components of the material.

6. In an electrical separator, the combination of a pair of electrodes, means to supply material thereto, a reservoir of charge, composed of low-conductive material, in close proximity to one of the electrodes and shielding it from the other electrode.

Signed by me at Boston, Massachusetts, this thirtieth day of January, 1908.

HENRY AZOR WENTWORTH.

Witnesses:

CHARLES D. WOODBERRY,

JOSEPHINE H. RYAN.