C. Q. PAYNE.

ELECTROSTATIC SEPARATOR.

APPLICATION FILED MAR. 15, 1911.

997,322. Patented July 11, 1911.

Fig. 8

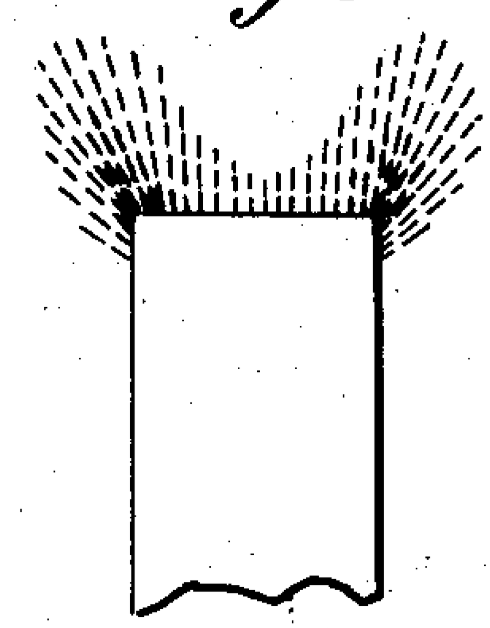


Fig. 2

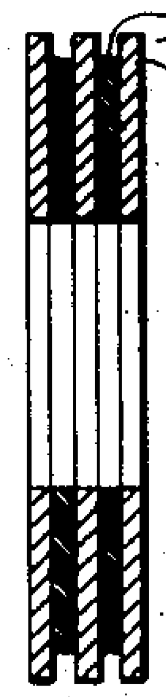


Fig. 3

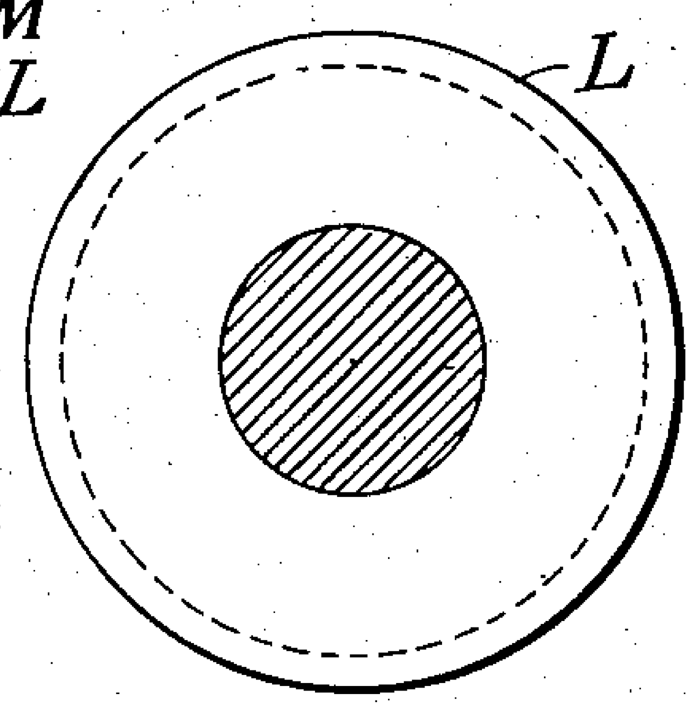


Fig. 4

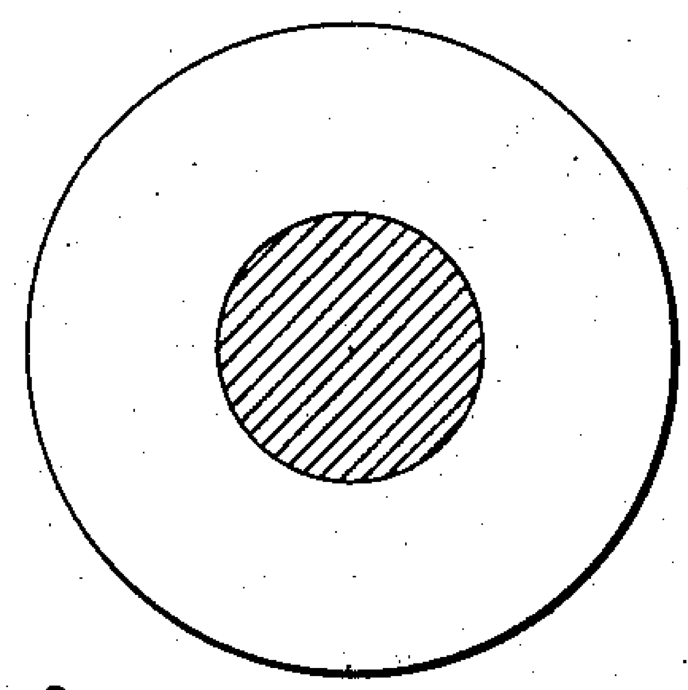
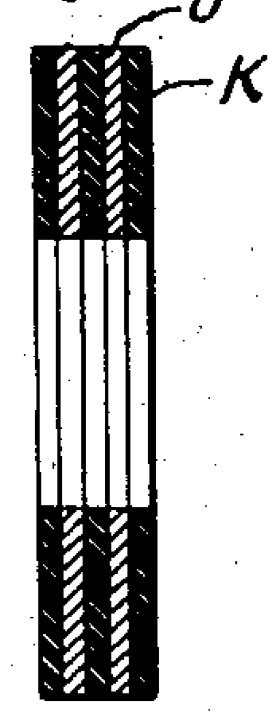


Fig. 5



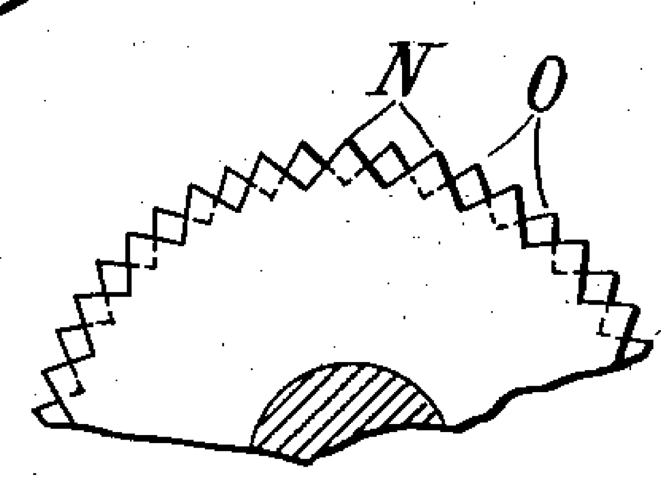


Fig. 6

Fig. 7

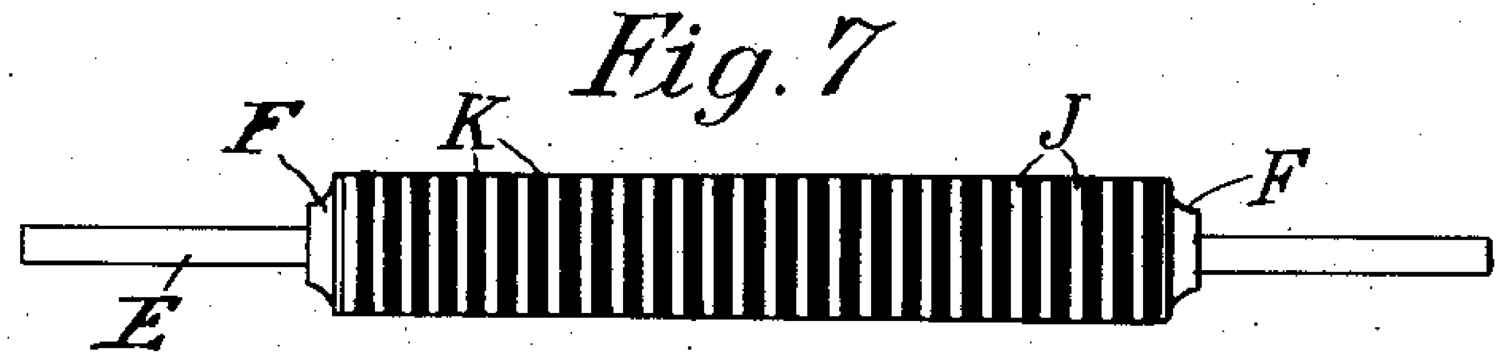
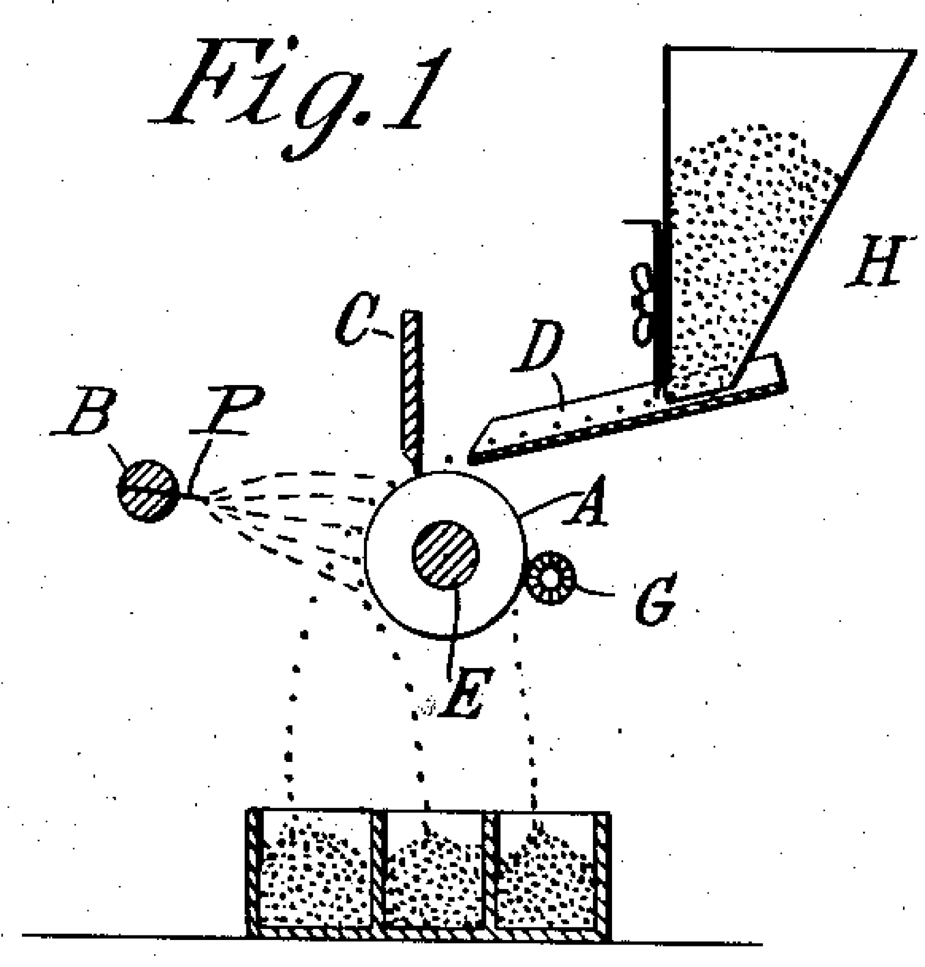


Fig. 1



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UNITED STATES PATENT OFFICE.

CLARENCE Q. PAYNE, OF NEW YORK, N. Y.

ELECTROSTATIC SEPARATOR.

997,322. Specification of Letters Patent. Patented July 11, 1911.

Application filed March 15, 1911. Serial No. 614,586.

To all whom it may concern:

Be it known that I, Clarence Q. Payne, a citizen of the United States of America, residing in the borough of Manhattan, city, county, and State of New York, have invented certain new and useful Improvements in Electrostatic Separators, of which the following is a full and true description.

My invention relates to improvements in apparatus for the electrical separation of mineral particles, such as usually compose ore mixtures, and which differ in their electrical conductivity, whereby a more perfect separation between the good conductors from the poor conductors can be brought out.

It consists essentially in the use of a separating electrode made up of a series of disks in place of a continuous metal plate, or of a cylinder having a continuous metal surface. The disks localize and condense the electrostatic charges at their edge-faces, and this action not only aids and intensifies the attractions and repulsions upon the mineral particles, but also assists in overcoming the mechanical interference of one set of particles in an ore mixture undergoing separation with another set, whereby better results are accomplished.

In my accompanying application, Serial Number 614,585, filed March 15, 1911, I have described and claimed a novel method of ore separation which is applicable both to magnetic and also to electrostatic separation, and which serves to overcome the mechanical interference or entanglement of one set of particles by another while they are undergoing separation. My present invention is concerned with improvements in apparatus adapted to be used in carrying out the method of electrostatic separation described in my said application.

All of the electrostatic separators of which I have any knowledge employ for the separating electrode either a continuous metal plate or a cylinder having a continuous metallic surface upon which the material undergoes separation while it is conveyed through the electrostatic field. The separation by such means of the electrically conducting from the non-conducting particles of an ore mixture, when it is passed through a single electrostatic field, is usually only an approximate one and the products so obtained must be separated a number of times in order to obtain satisfactory commercial results. The reason for this is partly due to the fact that the surface distribution of electrical density upon a continuous surface, such as that of a cylindrical separating electrode does not afford adequate control over the motions of the particles to prevent mechanical interference of one set of particles with another while they are undergoing separation.

In an electrostatic field the motion of a particle from one point to another is determined partly by the intensity of the field charge and partly by a difference of potential between the two points, *i. e.*, by a difference of the density of the lines of force at the two points.

In the case of an electrostatic field established between a smooth cylindrical separating electrode and its opposing parallel charging electrode, the intensity of the field varies as a whole, and the maximum density of the lines of force is along the plane which joins the axes of the two electrodes. When particles of an ore mixture are fed upon the top of such a separating electrode, they are then conveyed by its rotation from a position of less to one of greater electrical density, and hence the conductors and non-conductors in the ore mixture are repelled or attracted along a certain arc of the cylinder in directions which are approximately the same as those in which they are being conveyed; *i. e.*, along curvilinear elements of the separating cylinder. This causes a certain amount of mechanical interference and entanglement of one set of particles of the ore mixture with another while they are undergoing separation and this tends to produce a defective separation.

I am aware that the difficulty above described has heretofore been sought to be reduced in practice in two ways, viz: first, by making the diameter of the separating cylinder quite small, so as to limit the arc of interference to as small dimensions as possible, and secondly, by acting upon the particles intermittently in the electrostatic field, so that by rapid shocks or intermittent changes of electrical intensity, the sudden rise and fall of electrical intensity will create artificial differences of potential in a field where such differences would be slight under conditions of continuous field charge between the electrodes.

I am aware that in Patent No. 714,256 to

Sutton, *et al.*, dated November 25, 1902, it is proposed to inductively charge a magnetic separating cylinder formed of iron disks, spaced from one another, so that the cylinder so formed may act as a condenser, also that the charge thereon may assist in the magnetic removal of attracted particles, as well as to cause fine gold particles to adhere to magnetic particles when the latter are acted upon by the magnetic cylinder.

My improved apparatus is distinguished from that heretofore used for electrostatic separation in that it comprises structural features whereby wide differences of electrical potential may be secured within a field having a continuous field charge. In such a field a very high intensity of field charges is of less importance and intermittent accessions or changes of electrical intensity are unnecessary.

In carrying out my invention, I employ a cylindrical electrode formed of a series of electrically conducting disks the edges of which form the separating surface.

In the drawing accompanying and forming a part of this specification I have illustrated one embodiment of my invention and some of the modifications which may be made therein.

Referring to these drawings: Figure 1 shows in cross-section a complete electrostatic ore separator which embodies my invention. Figs. 2 to 6 inclusive illustrate three modifications of disks adapted to be used on said cylinder. Fig. 7 illustrates a separating cylinder adapted to be used in said separator. Fig. 8 illustrates diagrammatically the distribution of electrical density upon the edge face of a conducting disk in the separator when it has received a charge of electricity by being brought within an electrostatic field.

In the electrostatic ore separator shown in sectional view in Fig. 1, the separating cylinder or electrode A is provided with a series of disks which may have any one of the various constructions hereinafter described, all of which have edges electrically exposed, in order that by the condensing effect of the disk edges upon the lines of electrical force, wide differences of electrical potential may be obtained within the field. The cylinder A constitutes the separating electrode and is parallel with the other electrode B. The latter, for convenience, may be designated the "charging electrode." The charging electrode is provided with a thin plate P, which is inserted in the body of the electrode. The exposed edge of this plate supplies a continuous convective discharge toward the exposed edge faces of the conducting disk of the separating roll, which thus insures uniform conditions of surface distribution of the static charge.

Between the electrodes an electrostatic field is established by means of a static-electric generator or else by means of an alternating dynamo having a transformer and rectifier in circuit, in order to supply a unidirectional field charge of electricity of sufficient intensity to accomplish the purpose of my invention.

The usual feed hopper H is provided and is adapted to coöperate with the feed tray D and the shield C to supply a uniform quantity of crushed ore to the separating cylinder A. This cylinder, as above stated, is formed of a series of disks arranged and intended to produce a similar distribution of electrical density to that shown in Fig. 8. As illustrated in Fig. 8, each of the sharp edges of the disk exerts a peculiar condensing effect upon the electric lines of force in its vicinity and causes them to accumulate greatly along the edges as compared with their surface distribution between the edges. The effect of this condensing effect of the disk edges upon the electric lines of force is to exert upon a particle brought within the vicinity of the charged edges a great difference of potential and hence a great moving force, either of attraction or repulsion, depending upon the character of the electric charge upon the moving particle, as compared with that of the charged disk.

The disks may be assembled in various ways, so that the edge faces of a certain series shall form the separating surface of the cylindrical electrode. For example, I have shown in Figs. 2 and 3, in section and side elevation, disks L, of greater, and disks M, of less, diameter assembled alternately, so that the edges of the larger disks project and are thus electrically exposed.

In Figs. 4 and 5 disks of the same diameter are shown, but every alternate disk K is made of electrically non-conducting material such as fiber, ebonite, celluloid, etc. The edges of the conducting disks J, which may be of steel or brass, etc., although thus physically in contact with those of the non-conducting disks, are yet for the purpose of ore separation electrically exposed.

In Fig. 6 I have shown in sectional view disks with toothed edges. These may be so assembled that the teeth N and O of alternate disks are placed out of alinement so as to expose the maximum number of points and edges of the teeth. Points exert the maximum condensing effect upon the electric lines of force in a field. In fact, the electrical density can be made so great as to create what is known as an "electric wind," or a motion of the surrounding air particles away from the point by ionizing the air. The same result may also be accomplished between blunt edged or rounded electrodes of unequal diameters by means of high-voltage discharges.

While the exposed points of toothed disks may be employed in the case of those ore mixtures which require very great differences of potential, yet for the most part the electrically exposed edges of smooth cylindrical disks exert a more uniform effect upon the ore particles undergoing separation, and have also other mechanical advantages over disks having toothed edges.

In Fig. 7 I have shown a complete separating cylinder such as may be employed in my approved apparatus. In this arrangement the separating surface consists of two series of disks mounted upon shaft E, and held in place by means of compression flanges F F. One series J is made up of electrically conducting disks such as iron, brass, etc., while the other series K is made up of electrically non-conducting disks such as fiber, celluloid, etc., and the disks of one series are alternately interleaved with those of the other series. The separating cylinder may also be provided with disks whose edges are physically free or out of contact, as well as electrically exposed, as shown in Figs. 2, 3 and 6.

In the operation of the separators the material to be treated is fed from the hopper H by means of the feed-tray D to the edge-faces of the disks which form the separating surface of the cylinder A. By the rotation of the cylinder it is then conveyed into the field established between the electrodes A and B. Those particles of the ore mixture which are good conductors of electricity, upon falling upon the charged edges of the disks, assume at once a charge of electricity of the same polarity, and are promptly repelled or else drop off. Those particles of less electrical conductivity are removed less promptly, while the non-conducting particles may be made to attach themselves to the disk edges by the attraction of charges of unlike polarity, until they are removed by the brush G or other device. By thus causing the particles to pursue different paths of movement as they pass through an electrostatic field, a separation can be made between the minerals of an ore mixture which are of unequal electrical conductivity, and this result is obtained most readily by my invention whereby wide differences of electrical potential are secured in an electrostatic field by the structural features of the separating electrode.

I claim as my invention:

1. In an electrostatic separator, the combination of a charging electrode, a separating electrode formed of a series of conducting disks, the edge faces of adjoining disks being separated, means for causing an electrical discharge through one electrode to the other, and means for passing the material to be separated through the region of discharge between the electrodes, substantially as described.

2. In a separator of the kind described, a charging electrode, a separating electrode oppositely disposed and parallel therewith formed of a series of conducting disks, the edge faces of which are electrically exposed and form the separating surface of the electrode, means for causing an electrical discharge from the charging electrode to the exposed edges of the disks on the separating electrode, and means for passing the material to be separated through the region of discharge between the electrodes, substantially as described.

3. In a separator of the kind described, a charging electrode, a separating electrode oppositely disposed and parallel therewith and formed of a series of conducting and non-conducting disks alternating with one another, means for causing an electrical discharge from the charging electrode to the edges of the conducting disks, and means for passing the material to be separated through the region of discharge between the electrodes.

4. In a separator of the kind described, an elongated charging electrode, a cylindrical separating electrode disposed parallel to said charging electrode and formed of a series of conducting disks spaced from one another, the edge faces of which form the separating surface of the electrode, means for causing an electrical discharge from one electrode to the other, and means for passing the material to be separated through the region of discharge between the electrodes, substantially as described.

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