No. 796,012. PATENTED AUG. 1, 1905.

G. W. PICKARD.

METHOD OF ELECTROSTATIC SEPARATION.

APPLICATION FILED NOV. 12, 1904.

Fig. 1.

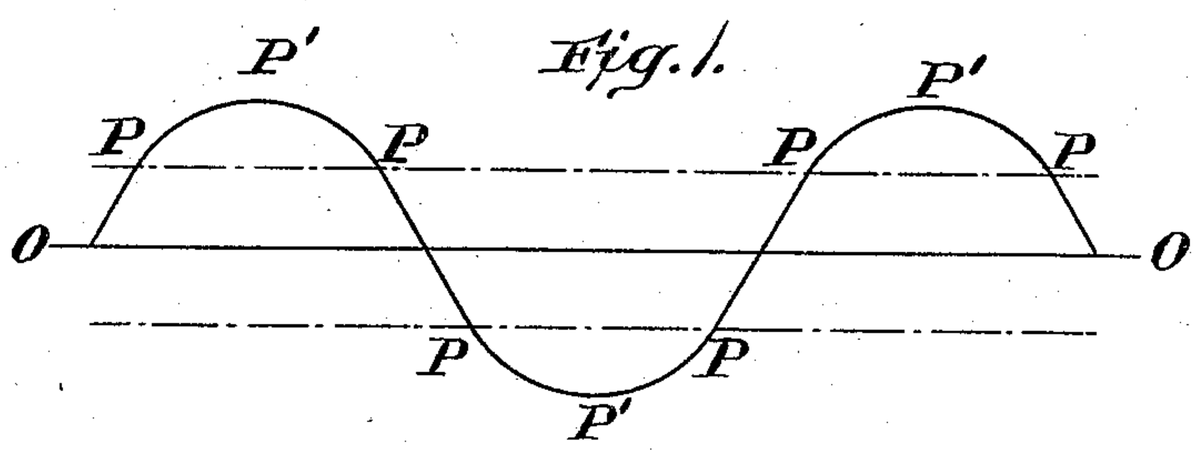


Fig. 2.

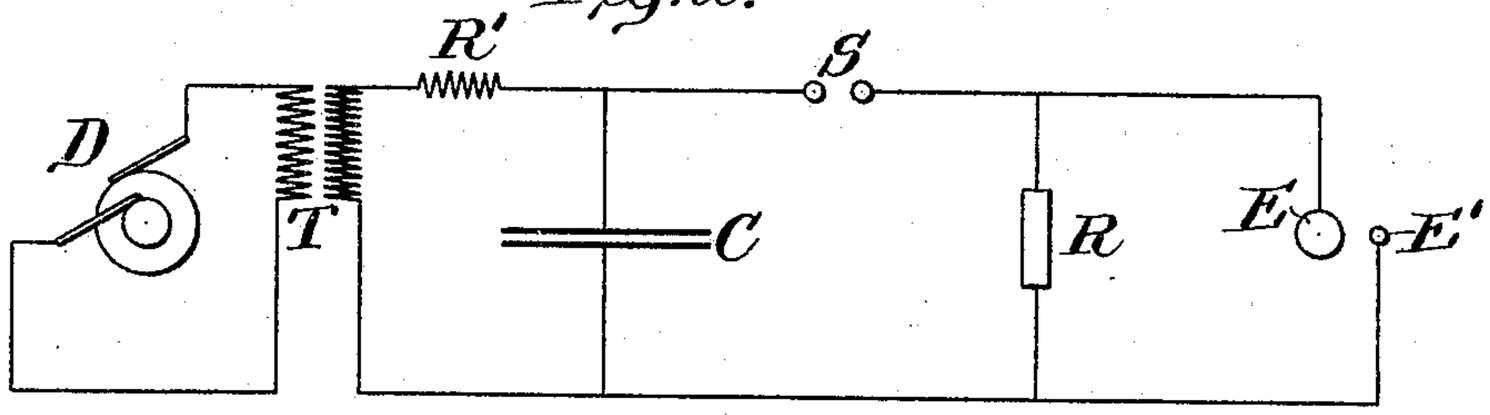


Fig. 3.

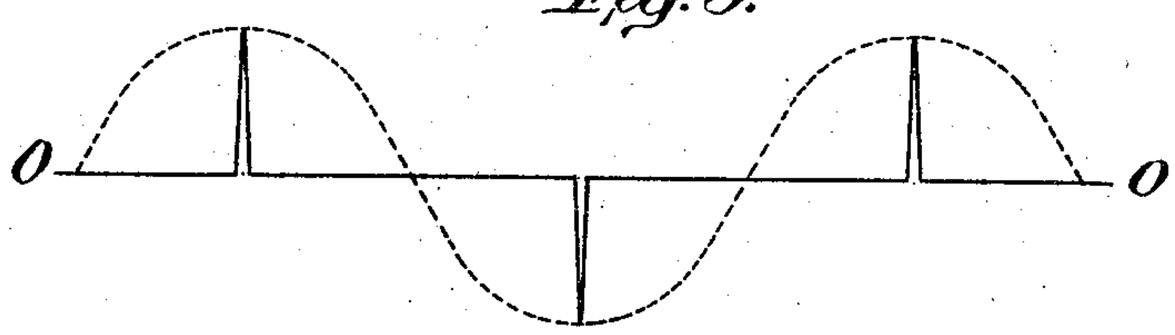
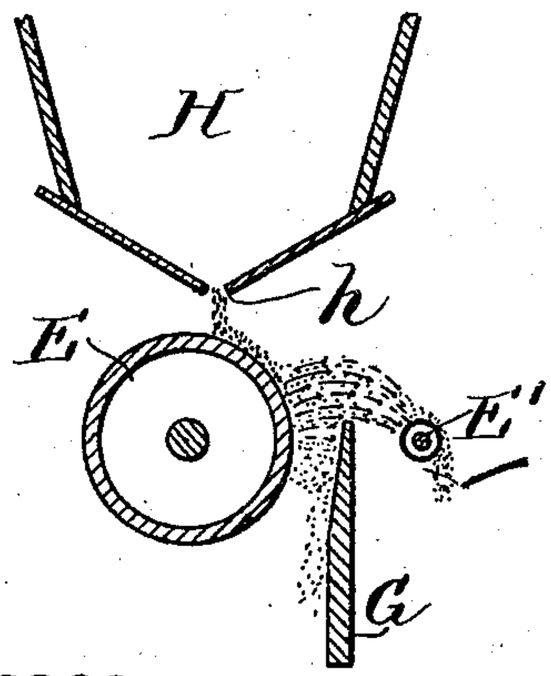


Fig. 4.



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UNITED STATES PATENT OFFICE.

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METHOD OF ELECTROSTATIC SEPARATION.

No. 796,012. Specification of Letters Patent. Patented Aug. 1, 1905.

Application filed November 12, 1904. Serial No. 232,481.

To all whom it may concern:

Be it known that I, GREENLEAF W. PICKARD, a citizen of the United States, and a resident of Boston, in the county of Suffolk and State of Massachusetts, have invented new and useful Improvements in Methods of Electrostatic Separation, of which the following is a specification.

My invention relates to the art of electrostatic separation or concentration, as of metallic ores from the earths wherewith they are mingled; and it consists of an improved method of applying electrical energy to the electrodes which constitute the instruments at which or by which the electrostatic separation is effected.

Otherwise viewed, my invention has for its object the regulation, both as to potential and duration of charge, of the electric energy applied to and at or between a pair of electrodes, so that the charge of the electrode may be adjusted to varying requirements—such as are met with, for instance, in the great diversity of materials and conditions of electrostatic separation.

It has been discovered by Philip Henry Wynne that electrostatic separation or concentration (the terms may be used interchangeably) is more effectively carried on by employing a potential at the electrodes or in the working electrostatic field which varies rapidly and emphatically as contrasted with steady potential or one which is maintained as uniform as is practicable under working conditions. For some purposes and classes of material excellently economical separation can be obtained by employing as the immediate source of electrical energy a high-frequency alternating-current dynamo with a suitable transformer to step the potential up to an effective intensity; but the gradual rise and fall of potential which is characteristic of such a cycle is not suited to a great majority of materials and conditions if maximum separative efficiency is to be secured. During such potential cycles or such portions of them as actually accomplish electrostatic separation there is a protraction of the static charge which brings about or is liable to bring about undesirable effects, whereof the exact nature is not wholly clear, but whereof the consequences, practically considered, are felt in imperfect separation of differentiated particles of matter. Whatever may be the immediate causes of this imperfect performance, it is at least certain that they proceed from protraction of the static charge, which has time to communicate itself or its influence to particles in the mass under treatment which it is not desired to have responsively subjected to the charge.

In the drawings hereto annexed, Figure 1 represents a curve denoting a potential phase cycle. Fig. 2 illustrates diagrammatically an apparatus for producing sharp potential variations. Fig. 3 shows a phase-cycle curve characteristic of the results produced by an apparatus like that of Fig. 2, and Fig. 4 shows in cross-section the elementary parts of an electrostatic separator.

The conditions referred to will be understood by reference to Fig. 1 of the drawings hereto annexed, wherein *o o* represent the zero-line of potential, and the curve represents the potential-phase cycle. At some point—say P—either on the positive or negative side, the potential acquires sufficient intensity to repel or separate a selected portion of the material under treatment. During that part of the cycle represented by P P′ P the electrodes possess a separating charge which may persist during a large fraction of the time occupied by the entire cycle, and under some conditions and with some materials this charge will have time to be felt by other particles than those desired to be influenced. Whatever changes may be imposed upon the potential-phase cycle at the electrodes, it is of course essential that at least a working minimum potential be available, and the object which I obtain by my improved method is to regulate and reduce the time element in the potential-phase cycle as it is effectuated at the electrodes, while retaining all the values of high potential for separating purposes.

Speaking with reference to the curve which graphically represents the phase cycle produced by a source of electrical energy—such as, for instance, a high-frequency alternating-current dynamo—my invention is characterized by the cutting out more or less of the potential ordinates at will, leaving only such portions of the crest of the cycle wave as may be found desirable for separation purposes to be communicated to the electrodes. In Fig. 2 is illustrated diagrammatically an apparatus for producing this result. D represents an

alternating-current high-frequency dynamo, and T a transformer connected therewith. E E′ are the electrodes of the separator, connected electrically with the transformer-terminals, except for the spark-gap S, which is in one branch or the other of the connections. Between the transformer and the spark-gap S there is placed in parallel with the electrodes a condenser C, and between the spark-gap and the electrodes there is connected a non-inductive resistance R, also in parallel with the electrodes. With this arrangement the condenser C becomes to all practical intents the source of potential for the electrodes and the transformer T is excluded from all immediate influence over the electrodes. A resistance R′ may be interposed between the transformer T and condenser C to damp and prevent the occurrence of oscillatory disturbances in the circuit. As the potential phase created by the transformer rises toward the potential at which the spark-gap is set to break the condenser is charged, the electrodes E E′ remain unaffected. When this potential is reached, the spark-gap S breaks, the electrodes E E′ are excited, and the function of the resistance R follows in the series of occurrences, cutting out the electrodes; but the condenser C being susceptible of almost instantaneous discharge the potential at the electrodes drops to zero without any appreciable detention or graduation. The phase curve produced at the electrodes as contrasted with that produced by the transformer is graphically represented by Fig. 3, wherein the dotted curve represents the normal characteristic phase curve of the potential created by the source of energy, and the unbroken line represents the potential changes at the electrodes.

In my application for patent, filed August 2, 1904, Serial No. 219,242, I have shown, described, and claimed my apparatus for producing the results herein set forth in greater detail and variation, and I refer thereto for a fuller exposition of the several forms of apparatus which involve my improved method herein claimed in their operation.

The electrodes E E′ are shown conventionally in Fig. 2.

An apparatus to which my electrical devices may be advantageously applied is shown in Fig. 4, wherein H represents in cross-section a hopper slotted at *h* to deliver material to the electrode E, between which and the electrode E′ the static field is produced. A separator G is placed between the electrodes the better to segregate the particles selectively affected by the static charge.

It should be borne in mind that the phase-diagrams used for illustration do not pretend to represent with perfect fidelity any actually-produced wave form, but that they are employed to show a simple form of wave which will be approached more or less closely in actual practice. Whatever the precise form of phase curve, my invention will be found applicable to the situation.

In the practice of electrostatic separation my invention places at the service of the operator electrode impulses or excitations which may be reduced to infinitesimal time intervals. If, for instance, the potential be derived from an alternating-current dynamo having a frequency of fifty per second, the electrode excitations can be reduced by my method to two or three millionths of a second, so that during all of the time except this minute fraction the electrodes are unexcited and inert. All the disturbances of the separative process which result from prolongations of electrode excitation and require time to develop are eliminated, and very nearly perfect separation of materials is obtained.

What I claim is—

1. The method of electrostatic separation which consists in generating potential having a normal characteristic phase curve, and subjecting a mass of material to a portion of said potential represented by an included fraction of the normal phase-curve area.

2. The method of electrostatic separation, which consists in generating potential having a normal characteristic phase curve, eliminating all of the potential except a portion represented by an included fraction of the phase-curve area, and communicating this residue, as a series of static shocks, to a mass of material, meanwhile passing the material through the static field thus produced.

Signed by me at Boston, Massachusetts, this 8th day of November, 1904.

GREENLEAF W. PICKARD.

Witnesses:

JOSEPH T. BRENNAN,

CHARLES D. WOODBERRY.