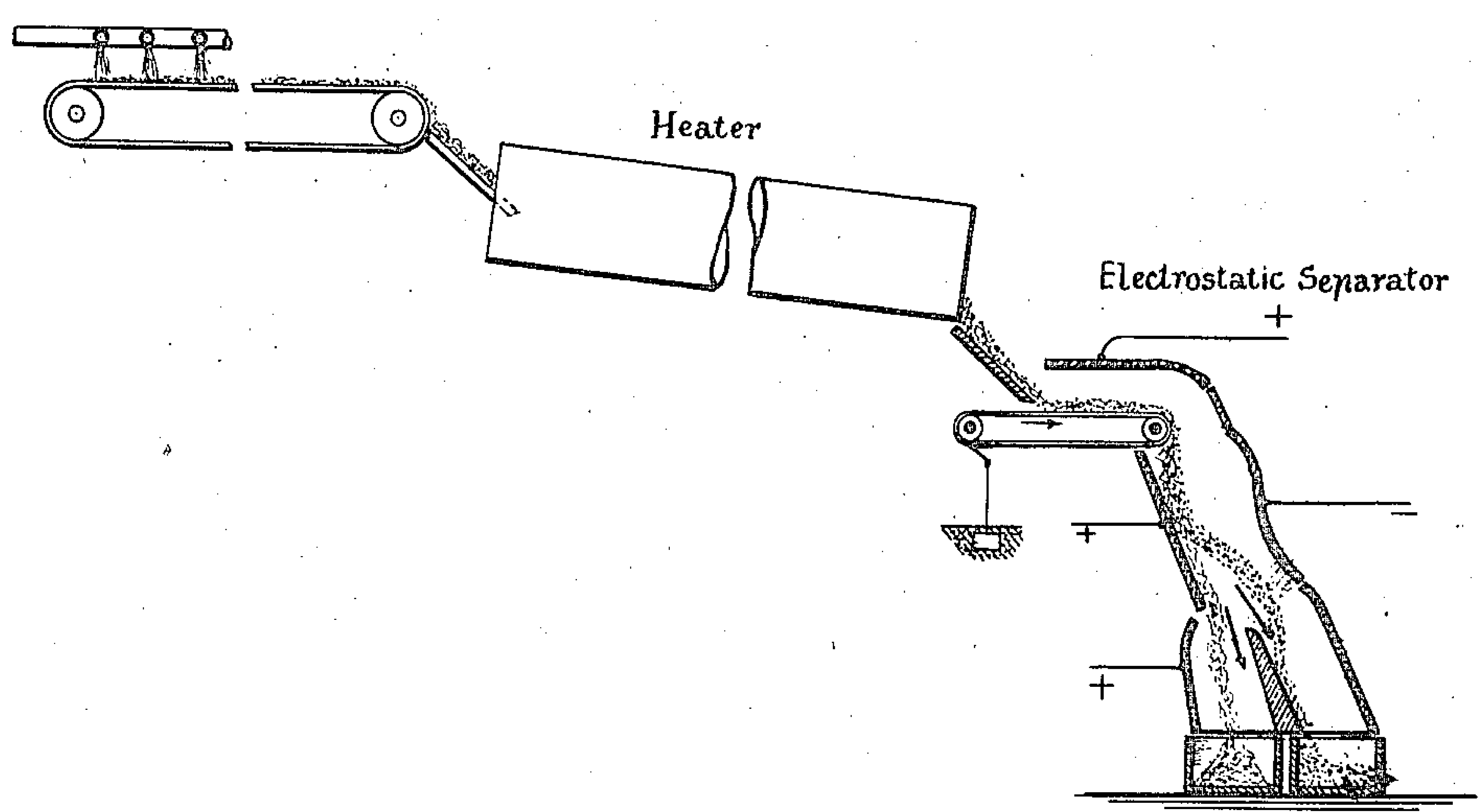
W. G. SWART.

ELECTROSTATIC SEPARATING PROCESS.

APPLICATION FILED JAN. 18, 1905.

959,646. Patented May 31, 1910.



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ELECTROSTATIC SEPARATING PROCESS.

959,646. Specification of Letters Patent. Patented May 31, 1910.

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To all whom it may concern:

Be it known that I, WALTER G. SWART, a citizen of the United States, and resident of Denver, in the county of Denver and State of Colorado, have invented certain new and useful Improvements in Electrostatic Separating Processes, of which the following is a specification taken in connection with the accompanying diagrammatical drawing.

This invention relates to processes of treating material so that the conductivity of the particles of material is altered and in electrostatically separating the various ingredients of such material.

In this process it is desirable to disintegrate the material to such an extent that each particle is substantially homogeneous. The finer the particles the more likely the diverse materials are to be separated so that each particle is of substantially uniform composition throughout. For this reason a preliminary disintegration by which the material may sometimes be reduced to the fineness of one hundred mesh or so, usually gives a more thorough electrostatic separation of the different materials.

Material may be treated in various ways to alter its conductivity and the change may permanently alter the conductivity of the material or its particles or the treatment may only effect a more or less temporary change which should, however, be sufficiently lasting to enable the desired electrostatic separation to be effected.

The disintegrated material may be suitably treated to alter the conductivity of some or all of the particles to increase the effectiveness of the electrostatic separation. This treatment may be such as to operate diversely upon the various ingredients of the material, so that the conductivity of the particles of one portion of material is increased while the electrostatic conductivity of another portion is decreased so as to effect a more pronounced difference in the relative conductivity of the particles of the various ingredients. In this way where a mixture consists of particles of different ingredients a treatment may be given which acts selectively upon one or more ingredients or groups of ingredients to alter their conductivity and another subsequent process may act selectively upon other ingredients so as to effect the desired diversity of electrostatic conductivity between the particles of varying character. In this way, the various ingredients may after their relative conductivities have been sufficiently altered to be readily separated to the desired extent, although the original material might have been incapable of proper separation by electrostatic methods. In some cases, however, a single selective treatment causes a sufficient diversity of conductivity between the particles, and, indeed, in some cases it is desirable to subject the material to a chemical, physical or mechanical treating process which may, for instance, cause an increase of conductivity in the particles of a number or all of the ingredients of the mixture.

The material after proper treatment may be electrostatically separated by allowing a stream of the particles to fall substantially into contact with a repelling surface electrostatically charged to the proper potential. The particles which are relatively conductive quickly acquire substantially the same electrical potential as the repelling surface and are quickly repelled thereby. The relatively non-conducting particles, however, cannot so quickly change their potential and tend to adhere longer to the electrified repelling surface, thus effecting a separation of the two classes of material, as is described in detail in the United States Patents 668,791 and 668,792, granted February 26, 1901, and 701,417, granted June 3, 1902. The electrostatic conductivity of a particle may be more or less independent of the electrical conductivity of the interior of the particle. If the skin or outer layer of a particle is rendered conductive a particle is conductive in reference to its action in an electrostatic separation and in altering the conductivity of particles it is not, therefore, necessary in all cases to effect a complete change in the conductivity of the entire mass of the particle so long as the particle as a whole has a changed conductivity for high potential electricity by a change in its outer portions or otherwise.

The conductivity of material may be altered by treatment which causes decomposition, that is, a chemical change or alteration of the molecular structure such as is caused by driving off water of crystallization, although the mere drying of material so as to drive off the hygroscopic or mechanically combined water does not of itself constitute decomposition. The material preferably after being suitably disintegrated may be subjected to heat and, for example, the mixed material may be roasted to any desired extent to drive off not only the mechanically combined water, but also more or less of the water of crystallization, affecting in this way a change in the physical condition of the material and correspondingly affecting in many instances its electrical conductivity. This heating or roasting may be carried to a red heat or higher in some instances, and may be combined with the sudden chilling or quenching of the heated material in water or by other means, preferably combined with a subsequent drying of the material so as to effect a change in its physical structure. In this way, the material may in some cases be radically changed in its physical properties and its crystalline form, thereby altering its electrostatic conductivity in some cases. Quartz can be in this manner disintegrated into particles in the form of scales and needles which materially changes the relation of superficial area to volume of the particle and also changes its electrostatic conductivity and action in electrostatic separators. Some materials may be heated after disintegration and may be passed through an electrostatic separator while hot, this heating effecting a change in the conductivity of portions of the material. If desired also material may be subjected to the action of vapors of water or other material and in this way by hygroscopic chemical or similar action the conductivity of particles may be temporarily or permanently altered. In some cases also mechanical treating processes may be used to alter the conductivity of material, for instance, pulverized graphite may be mechanically agitated with the particles, the graphite being in some instances first mixed with suitable selective adhesive material, so that the graphite will adhere selectively to particles of different composition. This mechanical graphite treatment can be used, however, to increase in a more or less uniform manner the electrostatic conductivity of all the particles.

Material may be treated chemically, either before or after disintegration to alter the conductivity of some of the ingredients, and thus effect a more efficient electrostatic separation. Many minerals may be subjected to a suitable reduction, this being preferably effected after disintegration by heating in the presence of carbon, sulfur, or other reducing agents. In many cases mere heating in a reducing atmosphere is sufficient. It will be apparent also that by suitable oxidation the desired alteration and conductivity of some ingredients may be effected. Roasting the material in furnaces in an oxidizing atmosphere may be resorted to for this purpose, and if desired, the material may be first mixed with suitable oxidizing or chloridizing agents, such as sodium chlorid or nitrates.

Various wet chemical processes or electrostatic treatments may be used for this purpose. By treating the material, preferably after disintegration, with various acid or other chemical solutions, the particles of some ingredients are altered as to their conductivity. Sulfuric acid, for instance, has a marked action upon particles of zinc blende by exerting a solvent action and changing the surface of particles of this material so as to materially increase their conductivity. The length of treatment in such cases should preferably be quite brief, only sufficient treatment with the acid being given to alter the zinc particles, the material being removed before any considerable action or deposition of the dissolved zinc can take place upon the other particles. For this reason the sulfuric or other acid used should be quite weak.

The material may be treated, preferably after disintegration, by exposure to a solution of an electrolyte, such, for instance, as copper or iron sulfate. Particles of zinc blende, for instance, which are treated by such a solution receive a film or deposit of copper or other metal upon their surface. This deposition may be promoted by the presence of some free sulfuric acid in the treating solution. After a sufficient electrolytic treatment the material may be removed from the solution and dried, in which case the particles of zinc blende would show a greatly increased conductivity because of the deposition of copper, iron or other material which has taken place. Their conductivity may be still further altered with respect to the accompanying silicate or other gangue material by calcining at a considerable heat which tends to convert the deposited film into a sulfid or oxid according to the furnace conditions. In employing copper sulfate depositing solutions the solution may have varying strength, a few per cent. or less of copper sulfate being sufficiently strong for most zinc blende ores. These treating solutions may, however, be used either with or without free acid, the strength and acidity of the solution being readily proportioned to give the desired deposition on the particular ore treated, the duration of the treatment being correspondingly varied. This copper deposition process may be practically carried out as follows with an ore consisting of zinc blende and quartz. The ore should be disintegrated to the proper size so as to secure the desired uniformity of composition in the particles. With many ores it is customary to reduce the particles to such size that all of them will pass through a screen having holes about a sixteenth of an inch in diameter. This disintegrated ore may now be placed in a suitable tank or other receptacle and treated with the copper sulfate solution which may be prepared by dissolving about two pounds of copper sulfate in 40 gallons of water. The treating solution is applied to the ore so as to thoroughly moisten the surface of each particle and this may be done by thoroughly sprinkling the ore with the solution, the ore being simultaneously agitated so as to thoroughly distribute the copper sulfate solution. Or, if desired, the solution may be used in such quantities that the ore is immersed therein under which conditions the agitation need not be so thorough, although it is desirable in all cases. After a sufficient duration of treatment with this copper sulfate solution, about 30 minutes being a sufficient time for ordinary zinc blende ores, the excess of solution is removed in any desired way and the ore dried by evaporation in the atmosphere or by heating in any desired form of furnace to entirely drive off the water, the heat being carried in some instances up to redness. This treatment radically changes the particles of zinc blende and renders the surfaces of such particles conductive with respect to static electricity. When this dried treated material is run through an electrostatic separator the zinc blende acts as conductive material and is separated from the substantially unchanged quartz particles, although before this treatment both materials might have been nonconductors and not electrostatically separable. Stronger zinc sulfate solutions than above described may, of course, be employed, although it is desirable from the standpoint of economy to use as weak a solution as possible and for this reason also the sprinkling method of distributing the treating solution over the ore particles is more desirable than the complete immersion of the whole mass of disintegrated material.

The disintegrated material treated in any such way to secure the necessary difference in conductivity between the various particles, after being sufficiently dried to be treated without undesirable adherence of the particles, is electrostatically separated, preferably by allowing a stream of the particles to fall into substantial impingement with an electrostatically charged surface of different potential as is indicated in the diagrammatic drawing. The relative conductivity of the particles determines under these conditions the time required to change the potential of the particles after coming under the influence of the plate or repelling surface and in this same manner determines their subsequent path through the machine. If freely falling after engaging the repelling surface the path of fall of the relative conductor and non-conductor particles is different and allows a separation to be effected as is set forth in detail in the United States Patents 668,791, 668,792 and 701,417.

It is, of course, understood that those familiar with this art may make many variations from the disclosure which has been made in this case, the steps of this process may be varied, various treating agents and processes may be used and the order of steps may be considerably varied without departing from the spirit of my invention or losing the advantages of the same. I do not, therefore, desire to be limited to the details of the disclosure which has been made in this case, but

What I claim as new and what I desire to secure by Letters Patent is set forth in the appended claims.

1. The electrostatic separating process which consists in treating disintegrated material with a dilute solution of copper sulfate to cause a diverse deposition upon the particles of different material, in drying said material and in electrostatically separating the same.

2. The electrostatic separating process which consists in treating zinc bearing material with a solution of copper sulfate, in drying and electrostatically separating the same.

3. The separating process which consists in treating material with a sulfate solution adapted to selectively alter the electro-conductivity of portions of said material and in electrically separating said material.

4. The separating process which consists in treating mingled ore or mineral material with copper sulfate solution to alter the electro-conductivity of some of said material, and in electrically separating said material.

5. The electrostatic separating process which consists in treating particles of material of varying composition to cause decomposition in and alter the electro-conductivity of some of said particles and in electrostatically separating said material.

6. The separating process which consists in treating material to cause decomposition in and alter the electro-conductivity of portions of said material, and in electrostatically separating said material.

7. The separating process which consists in treating material of varying composition to cause decomposition in and alter the electro-conductivity of portions of said material and in electrostatically separating said material.

8. The separating process which consists in treating particles of material of varying composition by causing decomposition in and increasing the electro-conductivity of portions of said material having similar composition, and in electrostatically separating said material while in a substantially dry condition.

9. The separating process which consists in treating mingled particles of material having varying characteristics which consists in causing decomposition in and varying the electro-conductivity of some of said particles having similar characteristics, and in electrostatically separating said material while in a substantially dry condition.

10. The electrostatic separating process which consists in treating disintegrated material with a dilute solution of copper sulfate to cause a deposition upon the particles of different material, in heating said material and in electrostatically separating the same.

11. The separating process which consists in affecting decomposition in and altering the electro-conductivity of particles of material by treating the same with a sulfate solution and roasting said particles and in electrostatically separating said material.

12. The separating process which consists in treating particles of material with a sulfate solution, and in heating the same to cause the decomposition in and alter the electro-conductivity of some of said particles and in electrostatically separating said material while in a substantially dry condition.

13. The separating process which consists in treating disintegrated material with a chemical solution adapted to selectively vary the electro-conductivity of particles of different material, and in electrostatically separating said material while in a substantially dry condition.

14. The separating process which consists in treating particles of material with a solution to cause a diverse action upon the particles of different material to alter the electro-conductivity thereof and in electrostatically separating the same.

15. The separating process which consists in treating particles of material with a chemical to cause a diverse action upon the particles of different material to alter the electro-conductivity thereof and in electrostatically separating the same while in a substantially dry condition.

16. The separating process which consists in finely crushing ore or mineral material, in treating the same with a dilute sulfate solution to cause a diverse action upon particles of different characteristics and alter the electro-conductivity thereof, and in electrostatically separating said finely divided material while in a substantially dry condition.

17. The separating process which consists in causing decomposition in and altering the electro-conductivity of some particles of a mass of divided material, and in electrostatically separating said material while in a substantially dry condition.

18. The separating process which consists in chemically altering the electro-conductivity of portions of disintegrated material and in electrostatically separating the same while in a substantially dry condition.

19. The separating process which consists in disintegrating to substantially uniform fineness ore or mineral material, in treating said disintegrated material to selectively alter the electro-conductivity of particles having different characteristics and in electrostatically separating the same while in a substantially dry condition.

20. The separating process which consists in treating material to selectively alter the electro-conductivity of the portions having different composition and in electrostatically separating the same while in a substantially dry condition.

21. The separating process which consists in selectively chemically altering the electro-conductivity of portions of disintegrated material of substantially uniform size and having different characteristics, and in electrostatically separating said material while in a substantially dry condition.

22. The separating process which consists in selectively altering the electro-conductivity of material, the portions of said material having different composition being diversely altered in conductivity and in subjecting said material to an electrical separating process dependent upon the relative electro-conductivity of the material.

23. The separating process which consists in altering the electrical properties of particles of disintegrated material, the particles having different characteristics being diversely altered in electro-conductivity and in passing said disintegrated material through an electrical separating process dependent upon the relative electro-conductivity of the treated particles and in separately collecting the separated particles of material.

24. The herein described process for treating ores for the subsequent recovery of their values by electrostatic separators, which consists in first finely crushing the ore, then treating said ore with a chemical solution adapted to increase its electro-conductivity for high potential electricity, then drying the ore, and then subjecting the ore to electrostatic separation.

25. The herein described process for treating ores for the subsequent recovery of their values by electrostatic separators, which consists of first finely pulverizing the ore, then mixing ores with a chemical solution having a selective action for the mineral particles of ore that will make them susceptible to electrostatic and high potential electricity, then drying the ore, and then subjecting said ores to an electrostatic separating step.

26. The herein described process for treating ores for the subsequent recovery of their values by electrostatic separators, which con-

sists of first finely crushing said ores, then saturating and coating the ores with a solution of copper sulfate, then drying the ore, and then separating the coated mineral particles by subjecting them to the separating influence of electrostatic charges.

27. The herein described process for treating ores, which consists of first crushing the ores to the desired degree of fineness, then saturating the ore with a solution of salt adapted to selectively deposit an electroconductive film on the particles, then drying the ore, and then passing the ore through the separating influence of the electrical fields of electrically charged separators or concentrators.

28. The herein described process for treating ores for the subsequent recovery of their values by electrostatic separators which consists in first finely crushing the ore, then treating said ore with a chemical solution adapted to selectively increase its electroconductivity, then drying the ore, and then subjecting the ore to electrostatic separation.

29. The separating process which consists in treating material with a chemically active solution to selectively produce upon portions of said material a film having electro-conductivity different from that of the original material, and in electrostatically separating said material.

30. The process of separating ingredients of mixed comminuted material which consists in subjecting the mixture to contact with a substance reactive differently on different ingredients of the mixture, to produce on the particles of the mixture a superficial change to render them different in electro-conductivity from other particles, and thereafter subjecting the mixture to electrostatic separation.

31. The process of separating ingredients of mixed comminuted material which consists in subjecting the mixture to contact with a substance reactive differently on different ingredients of the mixture to produce upon the particles of the mixture a superficial change rendering them superior in electro-conductivity to other particles, and thereafter subjecting the mixture to electrostatic separation.

32. The process of separating components of mixed solid material which consists in immersing the mixture in a solution chemically reactive upon a portion of the mixture, thereafter producing a superficial change thereon to render that portion conductive, and thereafter subjecting the mixture to electrostatic separation.

33. The process of separating components of mixed solid material which consists in immersing the mixture in a solution chemically reactive upon a portion of the material, thereafter drying the mixture and subjecting it to electrostatic separation.

34. The process of separating ingredients of mixed comminuted material which consists in depositing upon some of the ingredients a superficial coating different in electroconductivity from other ingredients, and thereafter subjecting the mixture to electrostatic separation.

35. The process of separating ingredients of mixed comminuted material which consists in depositing upon a portion of the material a superficial conductive coating and thereafter subjecting the mixture to electrostatic separation.

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Witnesses:

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