April 18, 1939. F. R. JOHNSON 2,154,682

METHOD OF AND APPARATUS FOR SEPARATING MATERIALS

Filed Nov. 8, 1934 2 Sheets-Sheet 1

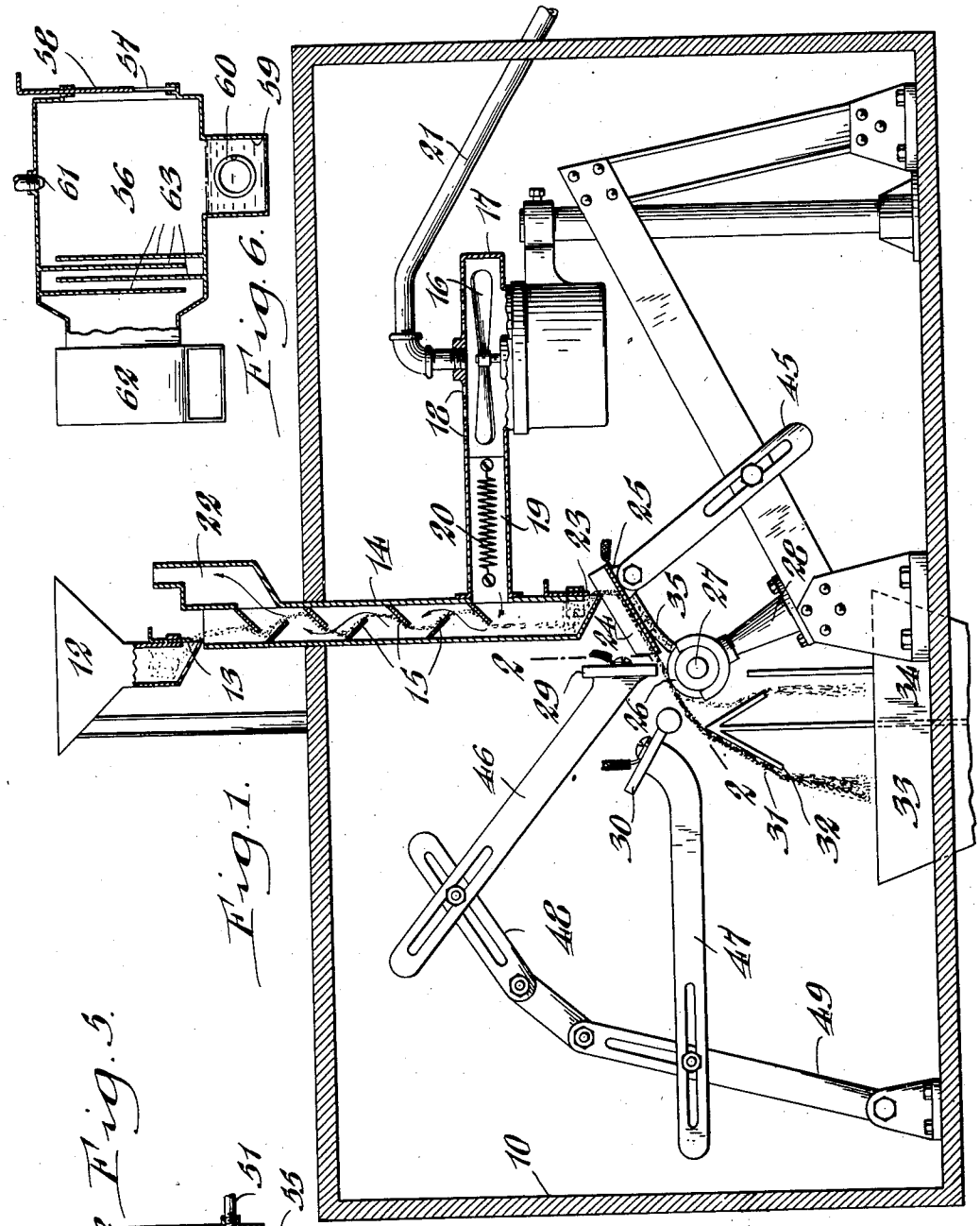


Fig. 1.

Fig. 6.

Fig. 3.

Inventor,
Fred R. Johnson,
by Walter P. Geiger
Attorney.

April 18, 1939. F. R. JOHNSON 2,154,682

METHOD OF AND APPARATUS FOR SEPARATING MATERIALS

Filed Nov. 8, 1934 2 Sheets-Sheet 2

Fig. 2.

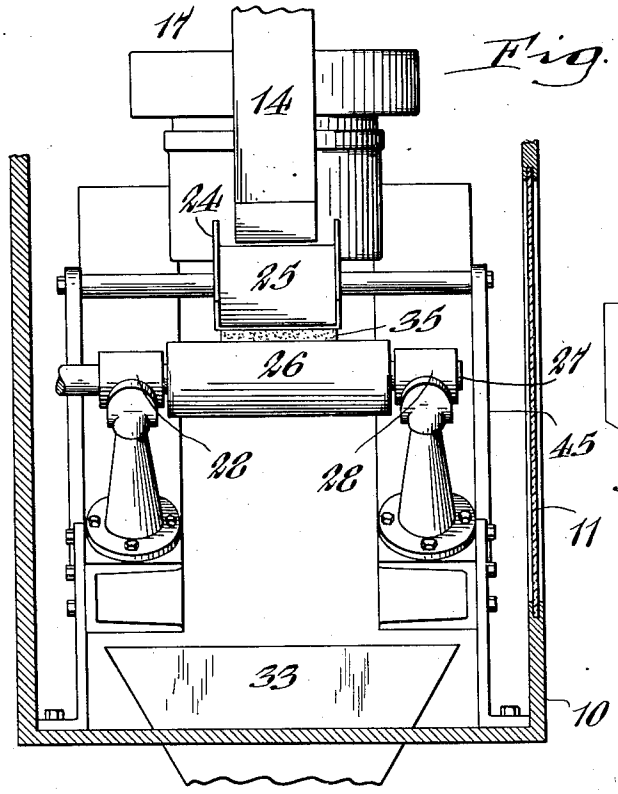


Fig. 3.

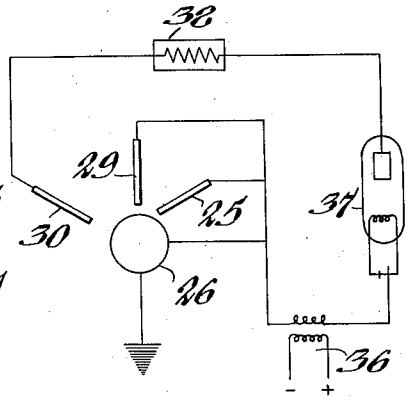
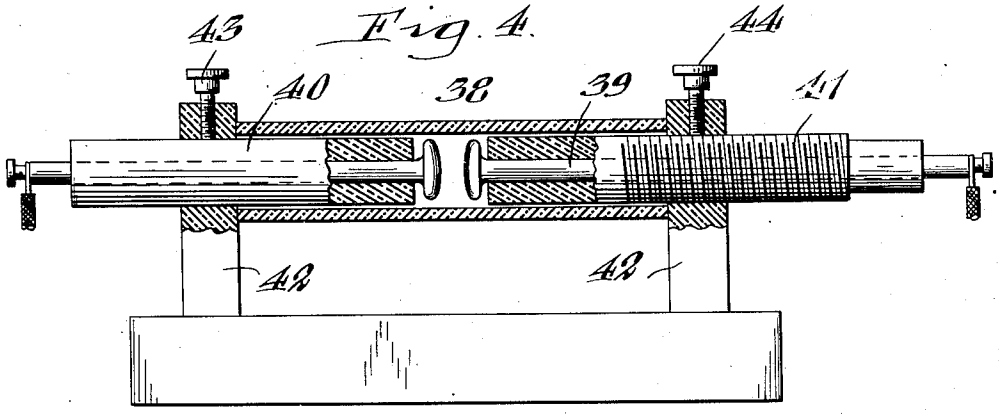


Fig. 4.



Inventor,
Fred R. Johnson,
by Walter P. Geyer
Attorney.

Patented Apr. 18, 1939 2,154,682

UNITED STATES PATENT OFFICE

2,154,682

METHOD OF AND APPARATUS FOR SEPARATING MATERIALS

Fred R. Johnson, Buffalo, N. Y.

Application November 8, 1934, Serial No. 752,055

5 Claims. (Cl. 209—127)

This invention relates to certain new and useful improvements in the art of separation and more particularly to the separating of natural and artificial materials having a particle-content which is susceptible to or has the ability to acquire an electrostatic charge.

It has been recognized from the initiation of the art of electrical separation that the processes thereof are materially assisted by presenting the materials to be treated in a perfectly dry state and consequently it has been the practice for a long time to heat the materials before they are introduced to the separator. It has also been known that a heated electrode or feed roll would have a beneficial effect in the electro-separating process.

One of the objects of my invention is to effect an initial treatment of the material to be separated by conditioning the material previous to separation through the medium of hot or cold and/or with a high or low moisture content.

Another object is the provision of an electro-separating apparatus which is so designed and constructed as to effect an increase in its selective action, whereby a more thorough and efficient separation can be effected on those materials which have heretofore resisted effectual separation and furthermore, to reduce the number of separating units required on other varieties of materials.

A still further object of the invention is to provide a separating apparatus of this character having a novel arrangement of electrodes to insure efficient separation.

Other features of the invention reside in the construction and arrangement of parts hereinafter described and particularly pointed out in the appended claims.

In the accompanying drawings:—

Figure 1 is a sectional elevation of the separating apparatus embodying my invention. Figure 2 is a cross section on line 2—2, Figure 1. Figure 3 is a diagrammatic view of the electric circuit of the electrodes. Figure 4 is an enlarged sectional elevation of the voltage regulator employed. Figure 5 is a sectional view of a modified form of conditioning device. Figure 6 is a side view, partly in section, of a further modification of a conditioning unit which may be used.

Similar characters of reference indicate corresponding parts throughout the several views.

In the particular embodiment of the invention chosen for the purpose of its illustration, the numeral 10 indicates a substantially airtight structure or casing in which the various elements of the separating apparatus are housed, one wall of the casing having a window 11 through which the operation of the apparatus may be observed. Disposed above the casing is a feed hopper 12 for receiving the material to be treated, the discharge end of this hopper having a suitable valve or gate 13 for regulating the feed of the material in a comparatively thin stream into the upper end of a substantially upright conditioning chamber or conduit 14 which extends downwardly through and into the casing 10 for delivering the material to the separating units. This conditioning chamber is adapted to have circulated through it a current of air treated with a proper moisture content so as to prepare the material in the most satisfactory condition for efficient separation.

For the purpose of effecting a maximum exposure of the material to the conditioning process to which it is subjected while passing by gravity through the conditioning chamber 14, I provide the latter with a plurality of inclined baffles 15 to compel the material to take a sinuous or zig-zag course through said chamber.

While any suitable means may be employed for introducing a properly conditioned current of air through the chamber 14, that shown in the drawings is illustrative and consists of a fan 16 driven by an electric motor or like source of power and having its casing 17 provided with air inlet openings 18 and a discharge passage 19 leading to and connected with the conditioning chamber adjacent its lower end. If desired, an electric heating element 20 may be located within the conduit 19 to heat the air as desired and if required, depending upon the particular material undergoing separation. The moisture content to be circulated with the air through the conditioning chamber may be in the form of steam or vapor introduced into the fan-casing 17 through a pipe 21. The conditioned air delivered by the fan into the lower portion of the conditioning chamber is circulated upwardly through the latter and is brought into intimate contact with the material flowing downwardly through the chamber to effectually condition it for separation. The upper end of the conditioning chamber is provided with an outlet 22 for the discharge of the conditioned air.

At its lower or discharge end the conditioning chamber 14 has a valve or gate 23 for regulating the flow of material in a comparatively thin stream onto an inclined chute 24 whose bottom wall is preferably in the form of an electrode 25. Disposed below and adjacent to the discharge end of this chute is a revolving roll-type electrode 26

which is mounted on a shaft 27 journaled in suitable bearings 28 and driven in any approved manner. A third electrode 29 is positioned substantially axially above the revolving electrode 26 in proximity to the periphery thereof, and a fourth or separating electrode 30 is positioned forwardly of the third electrode and substantially radially of the revolving electrode 26. These several electrodes form an electrostatic field through which the material is directed by the chute 24 and the revolving electrode 26, the electrodes 25, 26 and 29 being charged to either a positive or negative potential and the electrode 30 being oppositely charged to a negative or positive potential to meet the requirements of the materials being treated. As the material passes through this electrostatic field, those particles in the material which are susceptible to or have the ability to acquire an electrostatic charge will be charged, say positively, by the electrodes 25, 26 and 29, the latter functioning on the top layer of the material. The companion electrode 30 is of opposite polarity or negative and as the material passes the zone between this electrode and the revolving electrode 26, the charged particles are attracted toward the electrode 30 and take the deflected or outer course indicated at 31 in Figure 1. The rest of the material which is not affected by the electrostatic field takes the inner course and drops by gravity from the surface of the revolving electrode 26. The separated material drops onto an inclined chute 32 and is directed into a suitable receptacle 33 for receiving it, while the remaining material drops by gravity into a suitable receptacle 34 for receiving it. A brush 35 may be provided for removing any material adhering to the roll-type electrode 26.

The electrode 29 also acts as a shield for the mass and no separating action takes place until the mass is on the repelling surface of the electrode 26 and between the electrodes 29 and 30.

The circuit arrangement of the electrodes, which is shown in Figure 3, includes a transformer 36 connected at one side through a vacuum rectifier 37 and a voltage regulator 38 to the separating electrode 30 and at the other side to the electrodes 25, 26 and 29, it being understood that these connections may be reversed depending upon the polarity desired in the electrodes in separating certain kinds of materials. As seen in Figure 4, the voltage regulator preferably has its terminal posts 39 fitted in adjustable sleeves 40, 41 fitted in supports 42, the sleeve 40 being free to slide in its support and a screw 43 being provided for holding it in a set position of adjustment. The other sleeve 41 is threaded and engages a correspondingly threaded opening in its support, whereby a fine adjustment of the terminal 39 toward and from the companion terminal may be effected, a screw 44 serving to hold it in a set position.

The electrodes 25, 29 and 30 are preferably mounted for independent adjustment relative to one another and to the revolving electrode 26, and for this purpose the electrode 25 is applied to an adjustable arm 45, the electrode 29 is applied to an adjustable arm 46 and the electrode 30 to an adjustable arm 47, the two last-named arms being connected to relatively adjustable links 48 and 49, respectively.

By this construction and arrangement of parts it is possible to effect a more thorough and continuous separation of material, the conditioning of the material prior to separation being accomplished in a simple and effective manner and the electro-separating unit or units are so arranged as to insure the material receiving the maximum positive or negative charge depending on the connections to the rectifier tube 37, especially when the material is more than a single layer deep. This method and apparatus is very effective in the separation of rutile from zircon, kyanite from quartz, felspar from quartz, etc., as well as in the purifying of seeds. To properly effect some separations, the material must not only be hot but all moisture removed from the surface and I have found the most effective method is to pass the material while hot through the conditioning chamber where hot air having a low moisture content comes in contact with each particle several times before it reaches the separating zone.

Some separations require that the material be hot and contain a small percentage of surface moisture and the most effective results, again, can be obtained by my invention, as by passing the hot material through the conditioning chamber where air having a high moisture content comes in contact with the individual particles to thoroughly treat them.

Then again, other separations require that the material be cool but to contain no surface moisture and efficient results are obtained by passing cold material through the conditioning chamber where warm air low in moisture content effectually treats the material before entering the separating zone.

In the modified form of conditioning device shown in Figure 5, the same consists of a chamber 50 having an inlet 51 for moisture, which may be steam, vapor or the like and an inlet 52 at its upper end for receiving the material from the hopper 53 and an outlet 54 at its lower end for delivering the conditioned material to the electrostatic separating means. Any condensed moisture may be discharged through a drain 55.

Referring now to the modification of the conditioning device shown in Figure 6, which may be connected to the lower end of the conditioning chamber 14 in the same manner as the first-described structure, the numeral 56 indicates a chamber having an air inlet 57 at one end regulated by a valve 58 and a well 59 in its bottom for water which may be heated by an electric coil 60. In its top this chamber has a jet 61 for steam or vapor. At its discharge end this chamber has a fan 62 for directing the treated air to the conditioning chamber 14, such air passing in a sinuous course between baffles 63 before entering the fan. By this device, the air is thoroughly treated with moisture from the well 59 and the jet 61.

In the separation of certain materials, I have found that if the material is treated or conditioned with fumes from organic and inorganic matter, very favorable results are obtained. For example, in the separation of ilmenite from zircon, I have introduced fumes from sulphur into the conditioning chamber, and in this case such fumes may be introduced into the conditioning chamber in any suitable manner.

I claim as my invention:

1. A separating apparatus of the character described, comprising means for providing an electrostatic field through which the material to be separated is passed, said means consisting of a feed chute including a charging electrode, a revolving, drum-like charging electrode disposed at the discharge end of the chute to conduct the material through the electrostatic zone, a third charging electrode disposed immediately over said

revolving electrode, all of the aforesaid electrodes being of the same sign, and a separating electrode for effecting the attraction of the charged material thereto, the material upon leaving the chute passing between said third electrode and the revolving electrode, whereby the top and bottom layers of the material are in conductive relation to said electrodes, respectively.

2. In a separating apparatus, a feed hopper, a conditioning chamber in communication therewith and through which the material to be separated is passed, said chamber having a discharge at its lower end and an inlet above said discharge for the introduction of a fluid having characteristics to render the material susceptible to receive an electric charge, means for heating and circulating the treating fluid upwardly through said chamber in intimate contact with the material, and means below and exterior of the conditioning chamber to provide an electrostatic separating field for the conditioned material, said means consisting of a plurality of stationary and movable material charging electrodes of one potential disposed in opposing relation and between which material passes so as to act on the top and bottom layers of the material, and a separating electrode of opposite potential for effecting the attraction of the charged material thereto.

3. A separating apparatus of the character described, comprising means for providing an electrostatic field through which the material to be separated is passed, said means consisting of a feed chute including a charging electrode, a revolving, charging electrode disposed at the discharge end of the chute to conduct the material through the electrostatic zone, a third charged electrode disposed immediately over said revolving electrode, all of the aforesaid electrodes being of the same sign, a separating electrode for effecting the attraction of the charged material thereto, the material upon leaving the chute passing between said third electrode and the revolving electrode, whereby the top and bottom layers of the material are in conductive relation to said electrodes, respectively, and means for adjusting said feed chute electrode, said third electrode and said separating electrode relative to each other and to said revolving electrode.

4. A separating apparatus of the character described, comprising a conditioning chamber having an inlet at one end for introducing the material to be treated thereto and an outlet at its other end for the discharge of the treated material, baffling means disposed in said chamber for causing the material to flow in a substantially sinuous course therethrough, said chamber having an intake therein between its inlet and outlet for the introduction of a conditioning medium thereto, said medium being adapted to circulate through said chamber in intimate contact with the material passing therethrough, means for introducing the conditioning medium to said chamber, and means disposed below and in operative communication with the conditioning chamber outlet for producing an electrostatic separating field for the conditioned material, said means consisting of a plurality of stationary and movable material charging electrodes of one potential disposed in opposing relation and between which material passes so as to act on the top and bottom layers of the material, and a separating electrode of opposite potential for effecting the attraction of the charged material thereto.

5. The method of separating unlike particles from a comminuted mass of materials having different characteristics, which consists in treating the surface of the materials with fumes of a nature to render the material more or less susceptible to an electrical charge, in subjecting the top and bottom layers of the material to the influence of electrostatically charge electrodes of one potential whereby the susceptible material particles are subjected to a like charge, and then subjecting the charged particles to the influence of an oppositely-charged electrode to separate the same from the remainder of the material.

FRED R. JOHNSON.