C. Q. PAYNE.

METHOD OF AND APPARATUS FOR THE GRADING OR SIZING OF MATERIALS OF ALL KINDS.

APPLICATION FILED FEB. 18, 1919.

1,320,169. Patented Oct. 28, 1919.

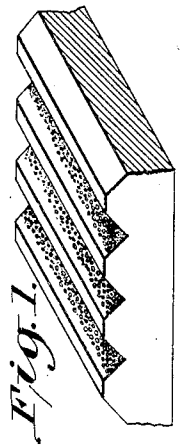


Fig. 1.

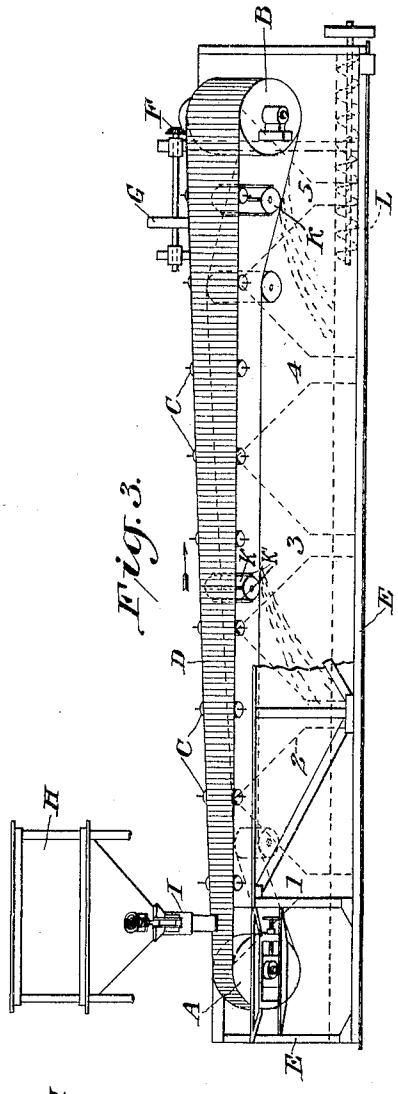


Fig. 3.

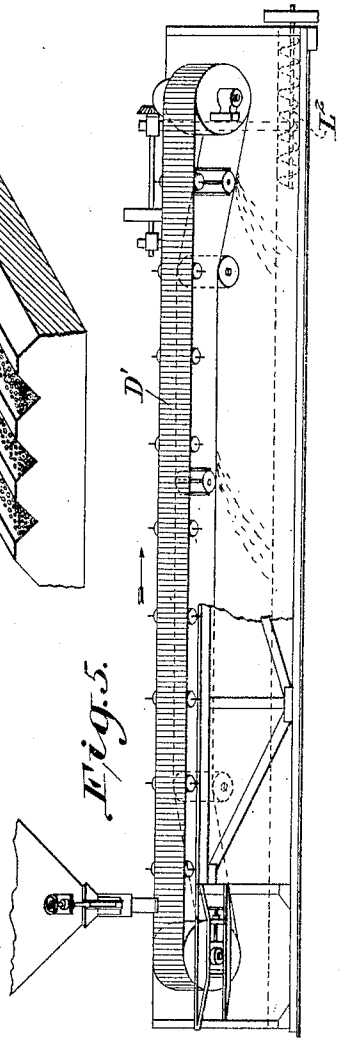


Fig. 5.

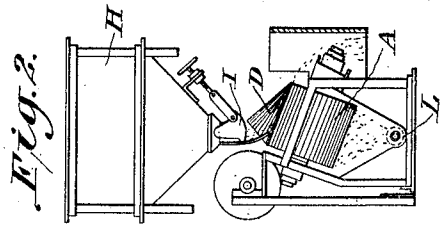


Fig. 2.

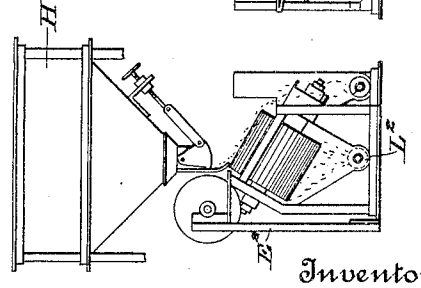


Fig. 4.

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METHOD OF AND APPARATUS FOR THE GRADING OR SIZING OF MATERIALS OF ALL KINDS.

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To all whom it may concern:

Be it known that I, CLARENCE Q. PAYNE, a citizen of the United States, residing at 82 Beaver street, in the city of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Method of and Apparatus for the Grading or Sizing of Materials of All Kinds, of which the following is a specification.

The invention relates especially to a method of and apparatus for the separation of finely comminuted materials of various kinds into a series of groups of different sized particles without the use of screens.

The invention briefly stated, consists in charging the comminuted material upon an endless preferably grooved and transversely inclined belt, moving the belt at a high speed to stratify the material in the grooves and cause the finest particles to adhere to the surface of the belt, discharging groups of granular particles along the upper flight of the belt and removing the particles retained on the surface of the belt by surface adhesion from the lower flight thereof.

In the accompanying drawings, Figure 1 shows a section of the grooved belt. Figs. 2 and 3 show an application of the invention to an inclined endless belt whose upper flight is so supported that its surface is subdivided into zones of increasing and separately varying transverse inclination. Figs. 4 and 5 show an application of the invention to an endless belt whose upper flight is transversely inclined at a uniform angle.

In a previous Patent #1,283,284, granted to me, I have shown and described an invention whereby the grading or sizing is accomplished by treating the material on the smooth surface of an endless belt whose upper surface is transversely inclined at a progressively increasing angle so as to form a warped or helicoidal surface. Here the material in a thin sheet is acted on by varying gravitational effects. The individual particles are thus not constrained by mass action, but are free to move in directions determined by their statical moments and frictional resistances upon the surface of the belt, and groups of different sized particles are removed and collected along the edge of the upper flight of the belt.

The present invention is more especially concerned with the grading and sizing of material which contains a large percentage of very fine particles. Finely ground particles of many minerals, as well as of other substances, ultimately reach a degree of fineness when they no longer become active upon the slope of a 45° angle. Particles which will pass the openings of a 200 mesh screen, for example, can no longer be separated by differences due to their statical moments and their frictional resistances upon an inclined surface. Such particles will often remain attached to the supporting surface when it is raised to an angle of 90°. This effect is probably due to surface adhesion resulting from or aided by differences between the electrostatic charges generated upon the sizing surface and the particles resting upon it. This difference of charge, or of electrostatic potential, is capable of balancing or counteracting the weight of the particles when they are quite small. The above effect may, however, also be due in part or wholly to differences of tension of the air films adjoining the surface of the moving belt, or to the action of interfacial angles of minute particles in contact with the air film upon the belt surface. The present invention makes use of the force producing this effect, whatever its nature may be in separating or grading these very fine particles from granular particles with which they may be associated and for convenience it will hereafter be referred to as an electrostatic effect and assumed to be generated by air friction by the surface of the moving belt.

Moreover, in the process of grading material containing particles of varying sizes upon a smooth surface having an increasing transverse inclination, it is found that quite fine particles become more or less mechanically entangled with coarser particles and are caused to slide with them at flatter angles than would be determined by their own dimensions. This causes a certain amount of overlapping or mingling of the various grades.

In the present invention I am able to largely overcome this mechanical interference with the finer sizes and also to utilize surface adhesion resulting from or aided by the electrostatic attracting force as a means of separating the very finest particles of all, whereby mechanical grading of finely com-

minuted materials can be greatly extended, and can be more efficiently accomplished than has heretofore been possible.

In Fig. 1 is shown a section of the endless belt which I have found preferable for the purpose. The upper surface is provided with depressions or grooves, which are preferably placed transversely to the length of the belt. Any convenient flexible material may be employed for the belt, such as rubber, leather, etc., and the rapid motion of the upper flight of the belt upon its supporting guide rollers, causes it to be thrown into active vibration. When the material is fed upon the belt so as to partially or wholly fill the grooves, the particles are then caused to be stratified therein by the vibration of the belt. The finest particles thus occupy the bottoms of the grooves, while the particles of increasing sizes occupy the upper portions of the grooves, as indicated in Fig. 1. An initial separation of the different sized particles in layers or strata is thus brought about in such a way that the larger sized particles are more free to move than the smaller ones, whereby all those not acted on by electrostatic charges can be readily discharged lengthwise of the grooves transversely to the motion of the belt as its inclination increases, thereby producing varying gravitational effects upon the different sized particles. The finest particles of all which are held by electrostatic charge to the belt surface are then conveyed to a position where they can be acted on in an inverted position by a force greater than that due to the electrostatic charge and thus released. This principle or method of grading finely comminuted materials may be embodied in various types of apparatus.

In Figs. 2 and 3 are shown in end view and longitudinal side elevation an endless belt transversely inclined at a progressively increasing angle, and provided with grooves across its surface. Here the end pulleys A and B and the guide rollers CC support the conveyer belt D by means of the frame E. The belt is driven in any convenient manner in the direction shown by the arrows by means of bevel gears FF and a countershaft G operated by pulley and belt from an outside source of power. The end pulley B at the driving end of the belt is maintained at a steeper angle than the pulley A at the feed end. This disposition of the pulleys and of the intervening guide rollers CC causes the upper flight of the belt to form a warped or helicoidal surface as indicated more clearly in Fig. 2. Particles conveyed lengthwise of the belt are thus supported upon a progressively steeper angle of the belt surface. The rate of the transverse angular change of the supporting guide rollers may be made uniform or varying. The angle may also be independently varied in order that the zones of separation included between each pair of rollers may be more perfectly adjusted to the separation of the component sizes of materials to be graded.

In utilizing the force of surface adhesion in the separation of particles susceptible to its action in the various applications described below, it is desirable that the belt be driven at a high speed. Since the novel separating force employed is a surface effect or phenomenon, the greater the speed of the belt, the greater is the surface exposed to the fine particles for their attraction and adhesion. At the same time the force evoked appears to increase in a certain ratio proportional to the speed of the belt by the greater air friction generated at its surface, and influencing the adhesion. My invention contemplates the use of belt speeds up to 1,000 feet per minute, and in certain cases well beyond this speed.

In operating this form of belt sizer the material to be sized is fed from a hopper H through the regulating gate I upon the upper flight of the belt, where the transverse inclination is a minimum. The material becomes stratified in the transverse grooves of the belt by vibration due to its rapid motion. The amount of the vibration may be increased when necessary by the use of bumping strips placed upon the surface of the guide rollers, and the degree of vibration may be progressively increased by correspondingly increasing the size of the bumping strips or varying their shape. There is of course considerable latitude in the selection of the rate at which the inclination or the vibratory action of the belt or both are varied. The coarsest particles of the material are thus caused to occupy the upper portions of the grooves, while decreasing sizes form strata below them, until the finest particles of all rest upon the bottoms of the grooves. With the gradual increase of the inclination of the belt surface by the advance of the upper bight, the coarsest particles of all, forming the upper layers in the grooves, are the first to start rolling and sliding across the belt, and are discharged and collected in the hoppered chute 1. With still steeper inclination of the belt surface, the next largest sized particles are discharged and collected in chute 2. In the same way, progressively finer particles as they encounter successively increasing inclinations of the belt surface, are discharged transversely from the edge of the belt, and are collected in successive chutes. The finest particles of all which remain in the bottoms of the grooves, and which are so small that their weight is counterbalanced by surface action resulting from or aided by a difference of electrostatic potential generated by air friction at the surface of the belt, are thus carried over the end conveyer pulley

B. The transverse grooves of the belt along the lower flight then occupy an inverted position. These remaining fine particles may be removed from the grooves in various ways, as for example, by vibrating the lower flight, by blowing with a series of air jets into the grooves, by high-tension alternating current, or by a series of grounded metal points. The simplest of these means is indicated in Fig. 3 at K, where inclined rollers which are provided with bumping strips K′ along their sides, are placed in such positions that they cause the lower flight of the belt to be actively vibrated by the motion of the belt itself.

This vibration exerted at one or more points by the several rollers K is sufficient to overcome the attracting force due to the electrostatic charge exerted upon these fine particles. They are then collected in the hopper extending below the lower flight of the belt, and are discharged by means of the spiral conveyer L, or equivalent means.

It thus becomes possible to secure along the upper flight of the belt a series of groups of graded particles from comminuted material, and at the same time to separate the finest dust-like particles from the lower flight of the endless belt after it has been removed from the granular portion of the material by surface adhesion to the belt surface.

In those cases where it is not necessary to divide the granular portion of the material into a series of groups of graded particles, but merely to divide the entire material into two parts, namely, an over-size and an under-size, or finished product, it is likewise possible to accomplish this result with the apparatus illustrated in Figs. 2 and 3, by collecting the graded products obtained from the upper flight of the belt in a single receptacle. It is, however, also possible in such a case to utilize the apparatus shown in Figs. 4 and 5 for this purpose. Here the endless belt D′ is transversely inclined at a uniform angle. The oversize or granular portion of the material is then removed from the upper flight of the belt, and the undersize or finished product from the lower flight in the manner described above. The angle of the transverse inclination of the belt may be varied within wide limits depending upon the nature of the material to be graded, and to the relative proportions of the oversize and undersize products to be separated which it contains.

In certain cases it is also possible to operate the endless belt in a horizontal position. Here the granular portion of the material is not discharged from the side of the upper flight of the belt, but only at the end of the belt over the conveyer pulley, while the undersize or dust-like product is stratified at the bottoms of the grooves and is removed from the lower flight of the belt when the grooves are in an inverted position by vibration or by other means as already explained above.

While I have pointed out some of the methods and means for removing the fine particles from the lower flight of the belt, other methods and means may be resorted to for that purpose. It is also quite feasible to combine various methods and means at the same time and in the same apparatus to accomplish the purpose.

I claim:

1. The method of grading material composed of finely comminuted particles of varying sizes, which consists in charging it upon the upper flight of an endless belt, rapidly moving the belt and removing the particles adhering to the surface of the belt from the lower flight thereof.

2. The method of separating the finest particles from a mass of finely comminuted material, which consists in delivering the comminuted material upon an endless belt conveyer, moving the belt at a speed sufficiently high to stratify the material and to cause the finest particles to adhere to the surface of the belt and removing the adhering particles from the lower flight of the belt.

3. The method of grading comminuted material of varying sizes including a relatively large percentage of very finely comminuted particles, which consists in charging it upon the upper flight of an endless belt, setting the belt in rapid motion to cause the very fine particles to adhere to the surface of the belt, separating the relatively coarser particles during their travel upon the upper flight from the very fine particles and removing the latter from the lower flight of the belt.

4. The method of grading comminuted material of varying sizes including a relatively large percentage of very finely comminuted particles, which consists in charging it upon the upper flight of an endless belt, setting the belt in rapid motion to cause the very fine particles to adhere to the surface of the belt and to stratify the material during its travel upon the upper flight of the belt, removing the relatively coarser particles and removing the very fine particles from the lower flight.

5. The method of grading comminuted material of varying sizes including a relatively large percentage of very finely comminuted particles, which consists in charging it upon the upper flight of an endless belt whose surface is provided with grooves, setting the belt in rapid motion to cause the very fine particles to adhere to the surface of the belt and to stratify the material with respect to the sizes of the particles in the grooves, removing the relatively coarser

particles from the upper flight of the belt and removing the very fine particles from the lower flight thereof.

6. The method of grading comminuted material of varying sizes including a relatively large percentage of very finely comminuted particles, which consists in charging it upon the upper flight of an endless belt having zones of transversely increasing and separately varying inclination, setting the belt in such rapid motion as to cause by the rapidity of movement the very fine particles to adhere to the surface of the belt and to stratify the material with respect to the sizes of the particles, removing successive groups of decreasing sized particles of said material along the upper flight of the belt and removing the very fine particles from the lower flight thereof.

7. The method of grading comminuted material of varying sizes including a relatively large percentage of very finely comminuted particles, which consists in charging it upon the upper flight of a transversely grooved endless belt having zones of transversely increasing and separately varying inclination, setting the belt in such rapid motion as to cause by the rapidity of movement the very fine particles to adhere to the surface of the belt, removing successive groups of decreasing sized particles along the upper flight of the belt and removing the very fine particles from the lower flight thereof.

8. An apparatus for grading finely comminuted material composed of varying sizes, comprising an endless belt, means for rapidly moving said belt to cause the very fine particles to adhere to the surface thereof, means for feeding the material upon one end of the upper flight of the belt and means for removing the particles adhering to the surface of the belt from the lower flight thereof.

9. In an apparatus for grading finely comminuted material composed of particles of varying sizes, an endless belt, means for rapidly moving said belt to cause the very fine particles to adhere to the surface thereof, means for feeding the material upon one end of the upper flight of the belt, means for removing the relatively coarser particles during their travel upon the upper flight of the belt and means for removing the very fine particles adhering to the belt from the lower flight thereof.

10. In an apparatus for grading material composed of comminuted particles of varying sizes, including a relatively large percentage of very fine particles, an endless belt having grooves upon its surface, in combination with means for rapidly moving said belt to cause the very fine particles to adhere to the surface thereof, means for feeding the material upon one end of the upper flight of said belt, means for collecting the relatively coarser portion of said material from the upper flight of the belt, and means for discharging the relatively fine particles adhering to the belt from the lower flight thereof.

11. In an apparatus for grading material composed of comminuted particles of varying sizes, including a relatively large percentage of very fine particles, in combination with an endless belt having grooves extending transversely of the length of its surface, means for causing the upper flight of the belt to present a surface of transversely increasing and separately varying inclinations, means for rapidly moving the belt, means for charging the material upon the belt having the least inclination, means for collecting the relatively coarser particles from the upper flight, and means for removing the relatively fine particles adhering to the surface of the belt from the lower flight thereof.

12. In an apparatus for grading material composed of particles of varying sizes including a large percentage of very fine particles, an endless belt, means for rapidly moving said belt to cause the very fine particles to adhere to the surface, means for feeding the material upon one end of the upper flight of the belt, means for removing the relatively coarser particles during their travel upon the upper flight of the belt, and means for removing the relatively fine particles adhering to the belt, said means comprising mechanism for vibrating the lower flight thereof.

In testimony whereof I affix my signature.

CLARENCE Q. PAYNE.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents. Washington, D. C."