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APPLICATION FILED OCT. 4, 1909.

1,135,304.

Patented Apr. 13, 1915.

3 SHEETS—SHEET 1.

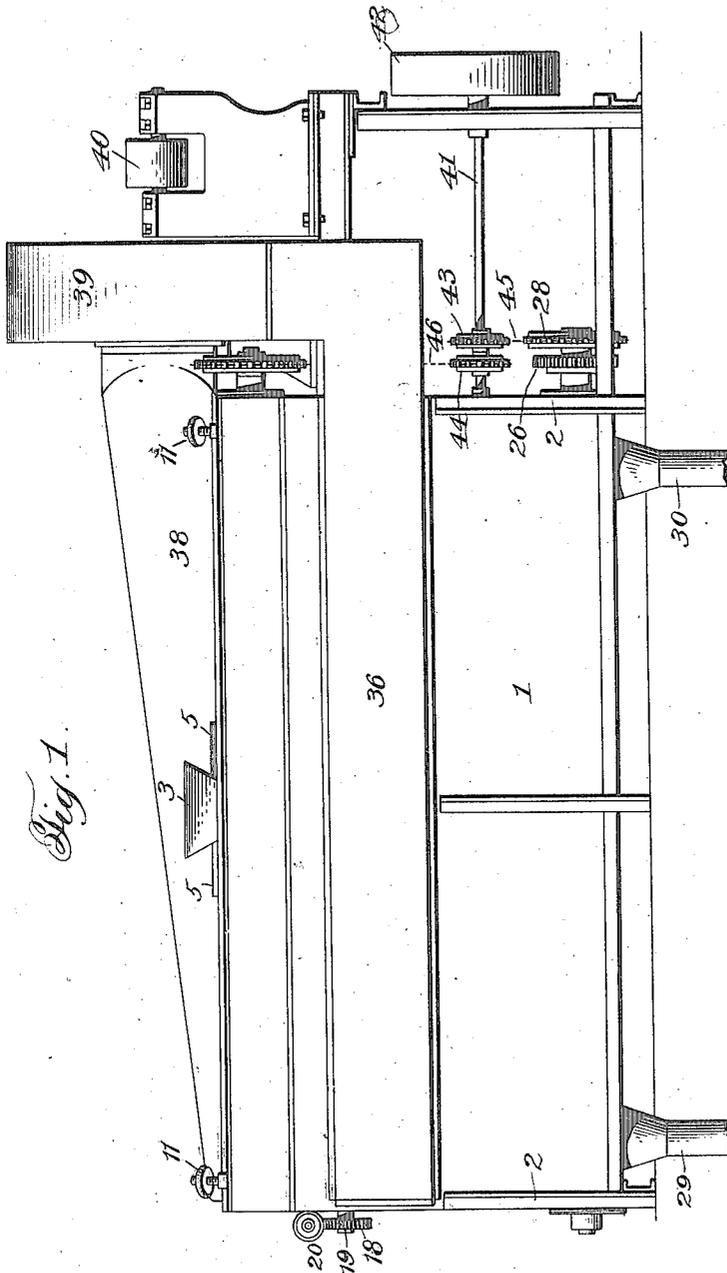


Fig. 1.

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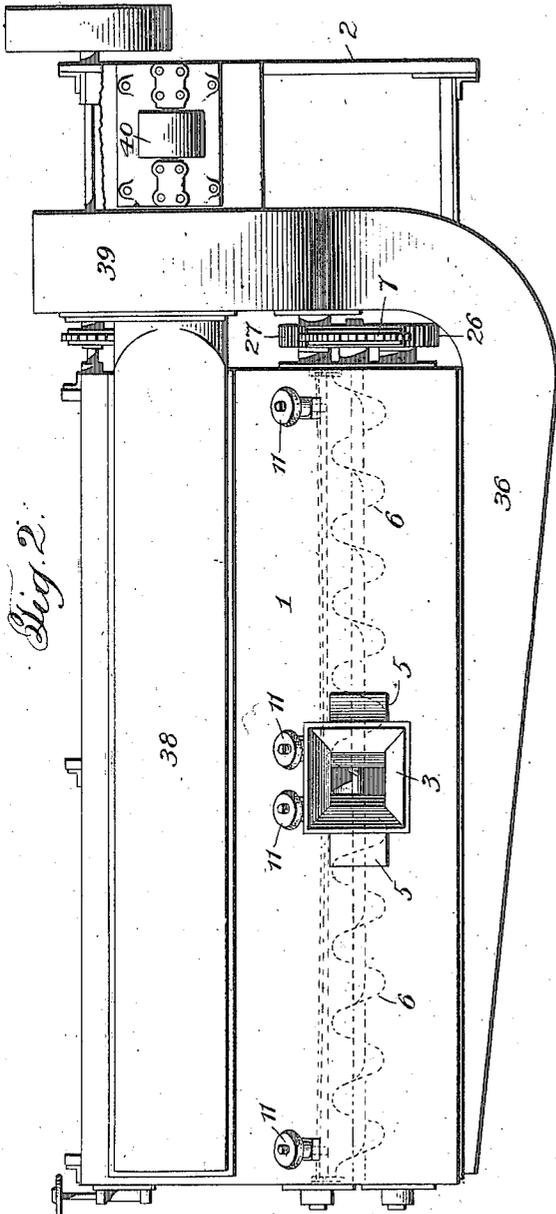


Fig. 2.

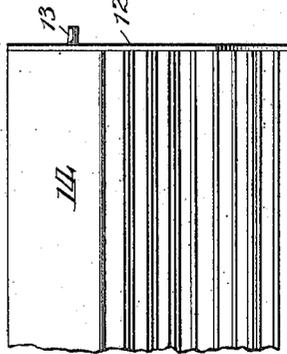


Fig. 9.

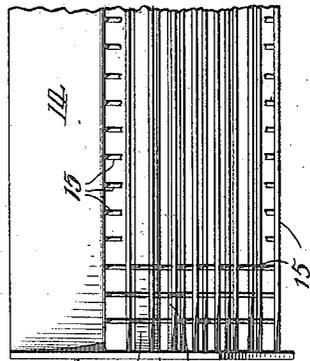


Fig. 8.

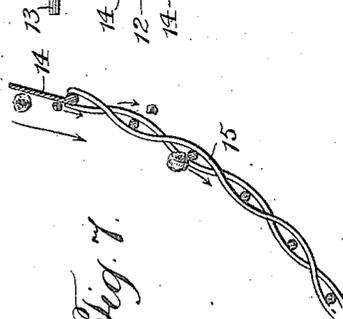


Fig. 7.

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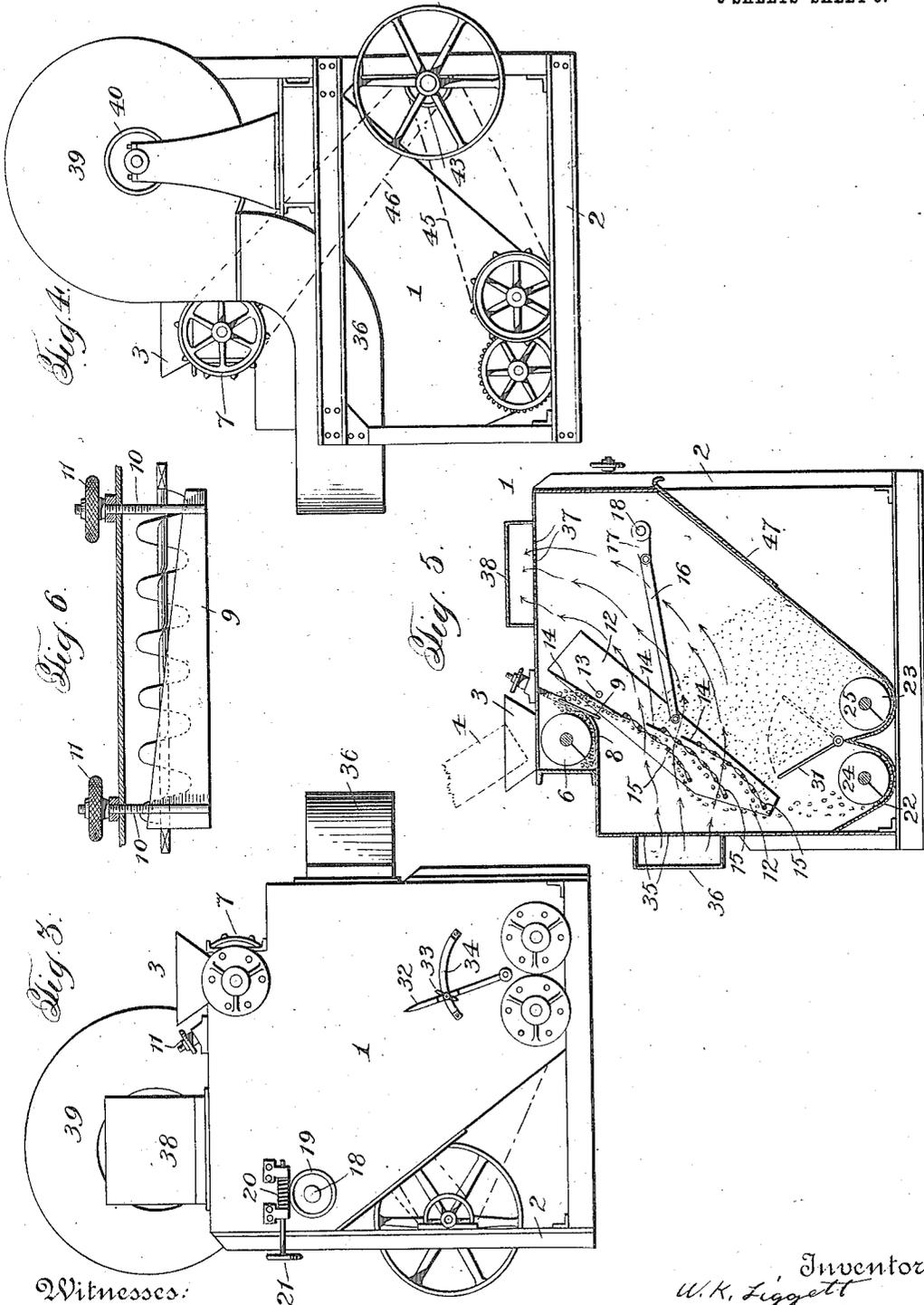
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3 SHEETS—SHEET 3.



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1,135,304.

Specification of Letters Patent.

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Application filed October 4, 1909. Serial No: 520,839.

To all whom it may concern:

Be it known that we, WILLIAM K. LIGGETT and WALTER J. ARMSTRONG, citizens of the United States, residing at Columbus, in the county of Franklin and State of Ohio, have invented certain new and useful Improvements in Separators, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention relates to machines for separating partly ground material.

In reducing ores and similar material to a very fine product by any attrition or impact machine, it has heretofore been the usual practice to keep such material in the machine until the whole of it was fine enough for the purpose required. This process is carried on with a great loss in both the horse-power expended and in the amount of finished product obtained, because all those particles already fine enough must be kept in the machine, along with the coarse, until the whole is sufficiently reduced. As an example of this sort of reduction, a tube mill grinding cement clinker may be cited. A slightly inclined, revolvable tube is partly filled with small, hard, rounded stones. The partly ground cement is fed in at the high end of the tube and is gradually worked along until it overflows at the low end, the mass of moving stones, in the meanwhile, reducing the particles to smaller dimensions. If the material discharged from such a mill is not fine enough, the feed is reduced, or in other words, it is left in the mill longer; and vice versa, if the material is finer than desired the feed is increased.

In grinding coals, limestones, and other friable ores, with impact machines, the fineness has been produced by using fine mesh screens and keeping the material in the pulverizer until it all passes through the small meshes. On such machines the speed or intensity of the blow may be made to largely regulate the fineness of the product. A large percentage of the material will be found small enough after the first blow of the hammer. It is, therefore, better practice to use coarse screens, pass the material once through the mill, separate that which

is fine enough from that which is too coarse, and pass the latter through the machine again for regrinding. To obtain this separation, many schemes have heretofore been employed, such as shaking or revolving screens of various forms, but they were all more or less unsatisfactory for very small sized or damp or sticky material, both by reason of the small capacity and also on account of the tendency to plug the screens.

The object of this invention, therefore, is to provide an apparatus by means of which the fine material may be rapidly and efficiently separated from the material which is coarser and must be reground.

In the drawings Figure 1 is a side elevation. Fig. 2 is a plan view. Fig. 3 is a left-hand end view. Fig. 4 is a right-hand end view. Fig. 5 is a cross-sectional view looking in the direction of Fig. 4. Fig. 6 is a detail view of the feeding device. Fig. 7 is an enlarged cross-sectional view of one of the screening elements. Fig. 8 is a detail view of one end of the screen. Fig. 9 is a detail view showing one end of a modified form of screen.

Referring to the drawings 1 represents a casing, preferably formed of sheet metal. This casing is entirely inclosed except for the various apertures hereafter to be described. It is supported and reinforced by the framework 2, which may be of any suitable design, and preferably formed of structural rolled steel.

3 is a feed hopper in which the material to be separated is delivered, preferably through a chute such as is indicated by 4 in Fig. 5. This feed hopper is provided with a bottom comprising the two slides 5 which may be adjusted to regulate the aperture through which material is fed to the machine. The material passes between the slides 5—5 and is engaged by the two helioid conveyers 6—6, which are made right and left to convey the material in opposite directions from the hopper. These two conveyers are preferably connected together and are driven by the sprocket wheel 7 in a manner to be hereafter described. These conveyers work in a trough 8 which is provided with two adjustable side plates 9, one

for each conveyer. These side plates are best shown in Fig. 6. The upper edge of each of the plates is inclined downward relative to the axis of the conveyer, the higher end being near the feed hopper. It will be readily seen that this inclination of the upper edge of the side plate will permit material to overflow the side plate throughout the length of the conveyer. In order that this overflow may be properly regulated and evenly distributed, we make the side plates adjustable. The means which we prefer for adjusting them is shown in Fig. 6. To each end of each side plate is attached a stud 10 which extends upward through suitable apertures in the casing. These apertures in the casing are made somewhat larger than the studs in order that the latter may have perfect freedom of movement. Each of the studs is engaged near its upper end by a threaded hand-wheel 11. By turning the hand-wheels 11 it will be seen that the side plates may be raised or lowered and the inclination of their top edges adjusted to give a uniform discharge of the material along the whole length of the conveyers.

Immediately below the feeding device, above described, is located the screen which is indicated as a whole by 12. This screen is pivotally mounted at 13 and is preferably made up of a plurality of separate screening elements. Each of these screening elements comprises preferably a receiving plate 14 of sheet metal or other suitable material and a woven wire screen 15. Each of the screens 15 is made tangent to its receiving plate 14 at the upper end, and at its lower end curves slightly upward. In the drawings we have shown three of these screening elements, one located above the other, but it will be understood that any desired number may be used.

In some machines for certain classes of work, it may be found desirable to considerably modify the construction of the screening elements, as above set forth. For instance, the screen may consist merely of a series of horizontal bars or of wires under tension, as shown in Fig. 9. The screen, as a whole, is made adjustable so that the angle of inclination may be varied. The mechanism which we prefer for effecting this adjustment is the crank and pitman construction shown in Fig. 5. The pitman 16 forms a connection between the screen and the crank 17. This crank is secured to the shaft 18 which is mounted in suitable bearings in the casing wall and at its outer end carries the worm-wheel 19. The worm 20 is suitably mounted to engage the worm-wheel 19 and may be turned by means of the hand-wheel 21. It will be readily understood that any movement of the hand-wheel 21 will change

the position of the screen. The worm and wheel connection makes this adjustment self-locking and no amount of load on the screen can possibly affect its position.

In the bottom of casing 1 are formed two conveyer troughs 22 and 23, in which operate the two helicoid conveyers 24 and 25 which are connected together by the gear wheels 26 and 27 and are driven by the sprocket wheel 28. It will be noted that the two conveyers turn in opposite directions and will, therefore, convey material in opposite directions. The conveyer 24 receives the material which does not pass through the screen and conveys it to one end of the machine, discharging it through the pipe 29. The conveyer 25 receives the finely divided material which passes through the screen and conveys it to the discharge pipe 30 at the opposite end of the machine from the pipe 29.

Between the two conveyers we prefer to place a deflecting plate 31, which is pivoted at its lower end. This deflecting plate may be moved by means of the lever 32 and may be locked in position by the clamping screw 33 which engages the segment 34. When properly adjusted, this deflecting plate serves to separate the fine from the coarse material with a greater degree of certainty than would otherwise be possible. The degree of fineness or coarseness of the separated material may also be regulated, within certain narrow limits, by means of this plate.

At the side of the casing, preferably on a level with the screen, are provided a large number of small apertures 35 distributed over substantially the whole length of the casing. These apertures all connect with the air trunk 36, which is located along the side of the casing. At the top of the casing is another group of apertures 37, similar to the apertures 35. These all communicate with the air trunk 38.

39 is a fan, to the suction side of which is connected the air trunk 38 and to the discharge side of which is connected the air trunk 36. The fan is driven by means of the belt pulley 40. The air trunk 38 gradually increases in cross-sectional area toward the fan, the cross-sectional area at any plane having a definite ratio to the added area of all of the apertures in the casing lying in front of the plane in question. This ratio is always less than one so that the velocity of air in the trunk will be greater than that through the apertures. The cross-sectional areas through the fan and at the intake end of the trunk 36 are substantially equal to that at the end of the trunk 38. The trunk 36 is similarly shaped to the trunk 38, but the ratio between the cross-sectional area of the trunk and of the apertures in the cas-

ing is different, so that the air velocity through the apertures 35 will be greater than the velocity in the trunk 36.

41 is a power shaft driven by the belt wheel 42. The shaft 41 carries the two sprocket wheels 43 and 44 which drive the conveyers by means of the chains 45 and 46.

47 is a sliding door in the casing, by means of which access may be had to the interior for purposes of inspection or repair.

The operation of this machine is as follows: Material is delivered to the hopper 3 through the chute 4, whence it passes to the conveyers 6-6. By a proper adjustment of the side plates 9-9, the material is made to overflow in a thin continuous film or sheet extending throughout the length of the machine. This film or sheet of material, after leaving the feeding device, first strikes the receiving plate 14 of the upper screening element of the screen 12. The action of this screening element will be best understood by a reference to Fig. 7. Let it be assumed for the moment that there is no air current passing through the screen. It will be noted that the screen is inclined at an angle, preferably more than forty-five degrees from the horizontal, and that material sliding down the receiving plate will acquire a considerable velocity. As the various separate particles pass the apertures in the woven screen, each of them will be deflected a certain amount. This deflection will be sufficient to permit the smaller of the particles to pass entirely through the screen. The larger particles, on account of their larger bulk, will strike against one of the horizontal wires of the screen and will be deflected back toward the upper side of the screen. In this way we are enabled to use a much coarser and heavier screen than would otherwise be possible. We have, in fact, found that by inclining the screen at an angle of about sixty-five degrees from the horizontal a four-mesh may be made as effective as a forty-mesh screen used in the ordinary substantially horizontal position. In order to make the effect of the screen uniform throughout its length, we have found it preferable to curve the lower end slightly upward. The object of this is to retard the flow of the material so that the velocity will be substantially the same throughout. If this were not done, the velocity at the lower end would be so great that practically none of the material would pass through. In order to make sure that none of the larger particles by any chance pass entirely through the screen, we prefer to add a second and a third screening element below the first one. We construct these similar to the first screening element, above described, and a detailed description

of them or of their action is not necessary. It will be understood that by changing the angle of inclination of the screen, the degree of fineness of the screened product may be regulated. This may be seen by referring again to Fig. 7. It will be noted that the amount of deflection of each particle necessary to cause it to pass through the screening is dependent on the angle of inclination of the screen.

We have, heretofore, described the action of the screen as entirely independent of the air current. The air current may, in fact, be considered as auxiliary, to a certain extent, to the action of gravity in causing the deflection of the particles of material. It will be noted that the air passes directly across the path of the descending material and through the elements of the screen so that each particle is acted upon by the air. Viewed from another standpoint, the air current may be considered as the principal agent in effecting the separation. It would be theoretically possible to merely drop the material from the feeding device and subject it to the air current which would deflect the finer material into the trough 23. Viewed from this standpoint, the screen may be considered as merely a baffle or retarding device adapted to cause the material to pass across the air current at a slower rate and thereby be more effectively acted upon.

As before described, the various air passages of the machine are so designed that there is no decrease in velocity from the time the air leaves the casing at the top until it enters again at the side. On this account there is no possibility of any material being picked up from the casing and deposited elsewhere. Because of the large cross-sectional area of the casing, the air velocity across it is comparatively slow and very little material will be held in suspension. Any material that is held in suspension and is carried out through the apertures 37 will be caught by the increased air currents in the trunk 38 and returned again through the fan and the trunk 36 to the casing. As before described, material after leaving the screen 12 passes either into the trough 22 or the trough 23, the two grades of material being separated by the adjustable plate 31.

It will be noted that this machine permits of a wide range of adjustments, it being possible in fact to regulate the fineness of the screened material by changing the angle of inclination of the screen, by changing the strength of the air current, or by adjusting the deflecting plate 31. An almost infinite number of combinations of adjustments of these three elements may be obtained.

We do not desire to restrict ourselves to

the exact construction herein shown and described, and it will be understood that many changes in detail and in arrangement of parts may be made within the scope of our invention.

What we claim is:

1. The combination in a separator, of a plate inclined at an angle to the horizontal of at least 60° and adapted to receive the material to be treated, a device for feeding the material in a broad uniformly thin stream to the plate along a horizontal line remote from the lower edge thereof, a material-separating screen at its upper part tangential to the plane of the plate and at its lower part curving upward away from the said plane to retard the flow of material, and two receptacles below the screen one for material passing through it and the other for material discharged from the lower edge thereof.

2. The combination in a separator, of a plate inclined at an angle to the horizontal of at least 60° and adapted to receive the material to be treated, a device for feeding the material in a broad uniformly thin stream to the plate along a horizontal line remote from the lower edge thereof, a material-separating screen at its upper part tangential to the plane of the plate and at its lower part curving upward away from the said plane to retard the flow of material, a second screen immediately below and substantially parallel to the first and similarly curved, and two receptacles below the screens one for material passing through them and the other for material discharged from the lower edges thereof.

3. The combination in a separator, of a plate inclined at an angle to the horizontal of at least 60° and adapted to receive the material to be treated, a device for feeding the material in a broad uniformly thin stream to the plate along a horizontal line remote from the lower edge thereof, a material-separating screen at its upper part tangential to the plane of the plate and at its lower part curving upward away from the said plane to retard the flow of material, means for adjusting the plate and screen together to change the angle of inclination, and two receptacles below the screen one for material passing through it and the other for material discharged from the lower edge thereof.

4. The combination in a separator, of a plate inclined at an angle to the horizontal of at least 60° and adapted to receive the material to be treated, a device for feeding the material in a broad uniformly thin stream to the plate along a horizontal line remote from the lower edge thereof, a material-separating screen at its upper part tangential to the plane of the plate and at

its lower part curving upward away from the said plane to retard the flow of material, means for adjusting the plate and screen together about a horizontal axis near the line of delivery of material to the screen to change the angle of inclination, and two receptacles below the screen one for material passing through it and the other for material discharged from the lower edge thereof.

5. The combination in a separator, of a plate inclined at an angle to the horizontal of at least 60° and adapted to receive the material to be treated, a device for feeding the material in a broad uniformly thin stream to the plate along a horizontal line remote from the lower edge thereof, a material-separating screen at its upper part tangential to the plane of the plate and at its lower part curving upward away from the said plane to retard the flow of material, means for adjusting the plate and screen together about a horizontal axis near the line of delivery of material to the screen to change the angle of inclination, two receptacles below the screen one for material passing through it and the other for material discharged from the lower edge thereof, and a division plate between the two receptacles adjustable in accordance with the position of the lower edge of the screen.

6. In a separator, the combination of a feeding device, a screen arranged to receive material from the feeding device, means for causing a current of air to pass downward through the screen and across the path of material on the screen, and means for adjusting the inclination of the screen to change the effective area of the openings therethrough in the direction of the air current, substantially as set forth.

7. In a separator, the combination of a feeding device adapted to supply material in a broad thin stream, a casing into which the feeding device discharges, the said casing having at one side of the feeding device a plurality of air outlet apertures uniformly distributed in a direction parallel to the breadth of the incoming stream of material, and having on the other side of the feeding device a plurality of air inlets uniformly distributed in a direction parallel to the breadth of the stream of material, an inclined screen positioned to receive the material, a closed air conduit exterior the casing connecting the inlet and the outlet apertures, and means for forcing air through the said conduit.

8. In a separator, the combination of a feeding device, a casing into which the material is discharged, the said casing having at one side of the feeding device a plurality of air outlet apertures and having at the opposite side of the feeding device a plurality

of air inlet apertures, the said outlet apertures having an area greater than that of the inlet apertures, a screen positioned in the casing between the apertures and with its operative face directly toward the inlet apertures, a closed air conduit exterior of the casing and connecting the said inlet and the said outlet apertures, and means for propelling air through the said conduit.

In testimony whereof we affix our signatures, in presence of two witnesses.

W. K. LIGGETT.
WALTER J. ARMSTRONG.

Witnesses:

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F. A. WHITEMAN.