

1,215,935.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

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1,215,935.

Specification of Letters Patent.

Patented Feb. 13, 1917.

Application filed November 22, 1915. Serial No. 62,703.

To all whom it may concern:

Be it known that I, MILTON L. HICKMAN, a citizen of the United States, residing at Rapid City, in the county of Pennington and State of South Dakota, have invented certain new and useful Improvements in Separators, of which the following is a specification.

This invention relates to certain new and useful improvements in separators, the peculiarities of which will be hereinafter fully described and claimed.

The object of this invention is to separate particles of material of substantially any degree of fineness from the air or other gas forming the vehicle or current for carrying particles of various size from the grinder or other machine reducing the material.

In the accompanying drawings, on which like reference letters indicate corresponding parts,

Figure 1 represents a vertical sectional view showing a separator embodying my improvements;

Fig. 2 is a cross-sectional view on the line $x x$ of Fig. 1 looking downward;

Fig. 3 is a detail view on a larger scale of the operating rod and ring used in adjusting a part of my separator;

Fig. 4 is another enlarged detail view showing the crank and deflector blade; and

Fig. 5 is a cross-section on the line $y y$ of Fig. 1, looking downward.

Referring to the drawings the letter A designates a drum preferably cylindrical and open at the top but having a bottom conical in shape provided with outlet spout B. Upon the open end of the drum A is mounted a corresponding drum C of larger diameter and connected by a slip joint making an easy fit with the drum A so as to have telescopic connection therewith or otherwise provide for adjusting the drums away from one another and toward each other, in order to vary the size of the chamber formed by said drums. The drum A is provided with an inlet pipe D and the drum C is likewise provided with an outlet pipe E. The current of air or other gas carrying the material in its finely divided state from the grinder or other reducing means, enters the inlet pipe D and passes through various deflecting and other means for changing the direction of the current to a rotary motion and likewise preferably

changing the direction and force of the outward whirling motion of the current as it passes upward, for purposes to be presently described. This rotary motion gives to the particles of material in the air current an outward tendency and promotes their separation. One means is shown in Fig. 1 at the upper end of inlet pipe D which is preferably provided with a conical enlargement above which is a cylindrical portion of substantially the diameter of the larger end of the conical enlargement below. Above the cylindrical portion which I designate F, is a conical flaring enlargement G extending from the upper end of the cylindrical portion upwardly and outwardly toward the wall of the drum A but not quite reaching the side wall, being held away from the inner surface by projections or spurs H Fig. 5, which contact with the inner adjacent wall and form a series of spaces producing practically a complete annulus between the upper edge of the flaring cone and wall mentioned. This space is for the discharge of the tailings which pass downward inside the drum A and out of the discharge spout B. The cone G is secured by bolts or otherwise to the adjacent wall A as shown in Fig. 1.

Referring again to the inlet pipe D and the conical enlargement, a conical core I with the point downward is mounted in said enlargement so as to provide a tapering annular passage between the upper diameter of the cone and upper end of said enlargement in which passage are mounted a plurality, preferably 4, twisted blades or scrolls K that make about a quarter turn circumferentially and connect said conical core with the inner wall of said conical enlargement, whereby the entering current of dust laden air will be given a rotary motion as it passes upward. In the upper end of the cylinder F are likewise mounted a series of spirals L in an annular passage formed by a cylindrical core J centrally located in cylinder F above the conical core I. These spirals approach each other as they proceed upward and form a closer arrangement of blades at the top whereby the dust laden air is compressed on its exit. This cylindrical core is somewhat smaller in diameter preferably than the base of the core I whereby a shoulder is formed. The top of the core I is preferably capped by a conical top upon

which rests the upper core J. Core J is likewise capped by a shallow cone as shown in Fig. 1. The lower blades K I designate helicoidal from their mounting about the conical core I. The spirals L preferably make a half turn in the same direction as the blades K and are separated from the said blades by an open space M' in which are mounted a plurality of blades N on crank shafts O extending through the cylinder F and the core J, and having the crank end outside of the cylinder F as shown in Fig. 1. These cranks, preferably six in number, are operated in unison by pins P passing through openings in the bottom ends of the cranks O, said pins being carried by a ring Q. The ring Q is operated circumferentially by means of a rod R Fig. 2, preferably screw threaded at its inner end where it passes through a pivot block S that turns freely on a vertical axis in its connection with the projecting arm T of the ring Q. (See Figs. 2 and 3). The rod R has a crank at the outer end by turning which the screw threaded connection and pivot fitting, will operate the ring and the cranks of the deflecting blades back and forth as desired. A shoulder at the point where the rod passes through the drum secures the rod from longitudinal motion and the bearing for the rod is preferably packed with felt or otherwise. These deflecting blades may thus vary their inclination so that the current passing from the blades K will be more or less deflected horizontally into the superior spirals L. Fig. 4 indicates the preferred inclination of the deflectors with regard to the crank O, whereby the blades are spread from substantially horizontal to about 30° with the horizontal in their preferred mode of operation. When the blades approach the horizontal they act to shut off the current and compress the same more into a horizontal plane which thereby retards the upward motion. When the blades are inclined they allow the passage of the current and particles therein more freely upward to the spirals L.

This whirling motion thus given to the entering dust laden air causes the particles to rotate around the wall of the cylinder F and when they reach the flaring cone G they slide upward, still whirling around, until they pass over the upper edge of the cone and proceed more or less upward along the inside of the expansion chamber. As they lose their upward motion the heavier particles slip backward through the annular space between the upper edge of the cone G and the adjacent wall, while the lighter particles are carried upward and out the outlet pipe E.

In order to adapt my device to various materials as well as various separations of degrees of fineness in similar materials, I provide a cylinder U of a diameter varying

in size according to the material operated on, but of larger diameter than the cylinder F, and carried by projecting legs V from the bottom of the cylinder which rest on the upper surface of the cone G. These legs space the lower edge of cylinder U a slight distance from the cone G, depending on the kind of material to be separated. The outgoing whirling particles traveling upward inside the cone G will be retarded as soon as they pass beyond the lower edge of the cylinder U and still whirling, but more slowly, will drift upward until they slip over the edge of the cone G. In other words the cylinder U acts like a fence against which snow drifts and is retarded on the opposite side due to the obstruction the fence presents to the force of the wind currents. In a similar manner the cylinder U obstructs the whirling currents of dust laden air and concentrates the current within the same, while it provides a practically dead air space outside of the cylinder which by the lessened force of the air current promotes the deposit of the particles and their passage downward through the tailings discharge opening before mentioned. The cylinder U is maintained in its location upon the cone G by brackets W which are located considerably above the lower edge of the cylinder so as to not obstruct the upwardly moving particles. For a similar reason the legs V are preferably formed on the lower edge of the cylinder and in the same plane therewith, as the edge of the said legs present little obstruction to the whirling, upwardly moving particles as they slide under the lower edge.

The concentrated currents within the cylinder U are collected by a cone 2 with the larger diameter downward and connected to a sleeve 3 slidably mounted between the outlet pipe E and a collar 4 on the drum C,—or otherwise. This cone 2, thus supported, may be adjusted up and down within the cylinder U as indicated by dashed lines in Fig. 1. When raised as shown in full lines, the cone allows more of the particles to settle as they pass upward within the cylinder U, than is the case when the cone 2 is adjusted to the position indicated by the dashed lines; in the latter position, being adjacent to the bottom edge of the cylinder U, the cone 2 will collect practically all of the particles that do not pass under the bottom edge. When an intermediate fineness of material is desired to be discharged through the pipe E, the sleeve 3 and cone 2 are adjusted a corresponding distance within the cylinder U. Particles of material that escape this cone 2 pass upward over the upper edge of the cylinder U through the annular space formed between the cylinder and bottom edge of the cone 2. Spacing fingers W' maintain the cone 2 centrally within the cylinder U.

In some material in which the particles are particularly fine and light, it is desirable to afford further opportunity for these light particles to settle. In this case it is advisable to provide a larger outlet pipe, such as one practically of the diameter of the lower edge of the cone 2. This large outlet pipe has a lower velocity of current than the smaller one shown in full lines and therefore will have less power to draw off these fine particles of the material that have escaped passing outward under the lower edge of the cylinder U. In other words it enlarges the expansion chamber so that more of these relatively heavy particles are allowed to fall and only the finest, if any, are carried upward through this enlarged pipe just described and are finally collected in the collector or other receptacle into which the outlet pipe discharges.

I do not confine myself to the exact construction herein shown and described.

I have found by practical use of merchantable separators constructed and operated on the principles above set forth, that separation of 200 mesh fineness is obtained, such as in gypsum material for instance, and that lesser degrees of fineness are obtained by the adjustment of the several parts as indicated herein.

From the above description, it will be observed that the dust laden air entering under pressure upwardly through the inlet pipe D is practically, at the time of its entrance, of the same density and compression, that is, the heavier particles are equally distributed among the lighter or finer particles; and as the air is deflected by the helicoidal blades K, it is given a slight twisting turn which tends to move the heavier particles toward the outer edge of the vortex thus created; and the conical range of the core tends to compress the air as it passes from the influence of the helicoidal blades K. After passing above the helicoidal blades K the air is permitted to expand slightly and thus the expansion assists the movement of the heavier particles toward the outer edge of the vortex. In passing between the deflected blades N, the air is again compressed and given a tangential movement practically in the form of upwardly directed sheets of air and is then permitted to expand again so that the heavier particles are induced to move toward the outer edge of the vortex. As the air contacts with the spiral blades L, it is not only deflected and given a whirling motion, but is compressed by the gradual approach of said blades at their upper ends until it emerges substantially in the form of a plurality of flat sheets of air (depending upon the number of blades L employed) which, upon being released in the gradually enlarging expansion chamber, causes the larger particles to hug

and be carried around on the inner surface of the flaring cone G until such larger particles pass over the upper edge of the cone beyond the direct influence of the whirling air in the expansion chamber, when they drop into the collecting chamber and pass out through the tailings pipe B.

The open-ended cylinder U, which may be described as a condensing cylinder, and which has its lower edge spaced apart from the flaring cone G, serves also in a sense as a skimming wall to collect within it the air containing the finer particles of dust which, due to the pressure of the incoming air, is forced upwardly. As the incoming air, speaking now of that air which enters the expansion chamber, is being whirled around, its motion is imparted to the rising volume of air in the condensing cylinder, so that in this cylinder I effect a second separation by collecting such heavier particles as are forced outwardly against the inner face of the condensing cylinder and permit them to pass over its upper edge and if desired, be separately collected from the tailings or returned to the reducing machine with the other tailings.

The outlet pipe whose lower end is spaced from and adjustable within the condensing cylinder enables me to control the fineness of the particles passing upwardly therethrough. When the lower end of the pipe is adjusted close to the cone G, it will be obvious that the outlet pipe, like the condensing cylinder, serves practically as a skimmer; but as the pipe is adjusted upwardly it increases the size of the expansion chamber until finally when wholly withdrawn from the condensing cylinder and located some distance thereabove, it is obvious that only the finest particles can pass therethrough.

I claim:

1. A separator comprising a casing having an inlet pipe leading into the lower portion thereof and an outlet pipe leading from the upper portion thereof, means for varying the size of the expansion chamber within the casing, a flaring wall located at the upper end of the inlet pipe within the casing, and means located in the path of the entering dust-laden air currents for spreading said currents over the edge of said flaring wall whereby the tailings drop over the outer edge thereof and the "fines" are carried upwardly and outwardly through the outlet pipe.

2. A separator comprising a pair of telescoping drums forming an adjustable expansion chamber, an upwardly extending inlet pipe, a flaring cone on the inner end of said pipe extending nearly to the side walls of the chamber, deflecting means located in the path of the entering air currents adapted to spread said currents outward and upward

and over the edge of said cone, whereby the tailings drop between the chamber wall and edge of said cone.

3. A separator comprising walls forming
5 an expansion chamber and having inlet and outlet pipes, a conical core in the inner end of said inlet pipe forming a tapering annular passage whereby the air is gradually compressed as it rises in said passage, a plu-
10 rality of helical blades located in said passage and extending from said core to the walls of said inlet pipe, and a superior flaring cone located above the upper end of said inlet pipe and extending nearly to the adja-
15 cent wall of the expansion chamber, thereby forming a discharge for the tailings.

4. A separator comprising walls forming an expansion chamber and having inlet and outlet pipes, a conical enlargement on the
20 inner end of the inlet pipe, a superior flaring cone located above said enlargement and extending nearly to the adjacent wall of the expansion chamber to provide for a tailings discharge, a cylindrical intermediate portion
25 connecting said enlargement with the upper flaring cone, a conical core having a cylindrical body and conical bottom forming a tapering conical passage within said enlargement and a continuing annular passage
30 within said cylindrical portion, helical blades mounted in said tapering passage, pivoted deflectors mounted in said annular passage, and means to adjust said deflectors.

5. A separator comprising walls forming
35 an expansion chamber and having inlet and outlet pipes, a flaring cone communicating at the bottom with the inlet pipe and at the top forming with the casing wall an annular discharge opening for the tailings, a central
40 core below said flaring cone, a double set of helical blades mounted about said central core with an intermediate space between the sets, a series of deflectors pivotally mounted in said space, and means to adjust their in-
45 clination to vary their relation to the helical blades above and below said deflectors.

6. A separator comprising walls forming an expansion chamber and having inlet and outlet pipes, a flaring cone within the cham-
50 ber and located at the upper end of the inlet pipe, means located in the inlet pipe below said cone to effect rotation of the entering dust laden air, and a skimming wall located within the edges of the flaring cone, and
55 spaced therefrom to establish a marginal area at the outer edge of the cone which is beyond the direct influence of the rotating dust laden air.

7. A separator comprising walls forming
60 an expansion chamber and having inlet and outlet pipes, a flaring cone within the chamber and located at the upper end of the inlet pipe, the outer edge of said flaring cone being spaced from the walls of the chamber to
65 provide an annular space at the upper outer

edge of the cone for tailings discharge, a skimming cylinder having its lower edge located within the outer edges of and spaced from said flaring cone, said skimming cylinder being adapted to accommodate the lower
70 end of the outlet pipe, and means for adjusting the lower end of said outlet pipe within the skimming cylinder.

8. A separator comprising walls forming an expansion chamber, an inlet pipe to said
75 chamber, a flaring cone at the upper end of said inlet pipe and whose outer edge is spaced from the walls of said chamber, thereby forming a discharge for tailings at the upper edge of said flaring cone, a set of
80 deflectors located within the inlet pipe and consisting of pivoted overlapping blades, a crank shaft for each deflector, and means connected to said crank shafts for simul-
85 taneously operating said blades.

9. In a separator of the character described, the combination with a suitable drum forming an expansion chamber, inlet and discharge pipes, a flaring cone at the
90 upper end of the inlet pipe, said cone being provided with outward projections at its upper edge whereby an annular discharge space for tailings is formed in connection with the wall of said chamber, and means
95 for imparting a whirling motion to the dust laden air as it leaves said inlet pipe.

10. A separator comprising an adjustable expansion chamber composed of two telescoping drums, a conical bottom and discharge spout for the lower drum, an inlet
100 pipe passing upward through said bottom, a flaring cone at the upper end of said inlet pipe and located within the chamber above the conical bottom thereof, said flaring cone being supported from the wall of said lower
105 drum at its upper end, the upper edge thereof being spaced from the wall of said drum thereby forming an annular discharge opening for tailings, means in the inlet pipe for effecting the rotation of entering dust-laden
110 air, a skimming cylinder supported above said flaring cone with its lower edge spaced therefrom, and an adjustable outlet pipe co-operating with the said cylinder, substantially as described.
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11. A separator comprising walls forming a chamber having an inlet pipe, and separate series of deflecting blades arranged therein, one of which series is adjustable.

12. A separator comprising walls forming
120 an expansion chamber, an inlet pipe leading into the lower portion of said chamber, a flaring cone within the chamber and located at the upper end of the inlet pipe, the outer edges of said flaring cone extend-
125 ing nearly to the walls of the expansion chamber thereby forming a discharge for the tailings, means located in the inlet pipe below said cone to effect rotation of the entering dust-laden air, and a discharge pipe
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leading from the upper portion of said expansion chamber.

13. A separator comprising walls forming an expansion chamber, an inlet pipe leading into the lower portion of said chamber, a flaring cone within the chamber and located at the upper end of the inlet pipe, the outer edges of said flaring cone extending nearly to the walls of the expansion chamber thereby forming a discharge for the tailings, means located in the inlet pipe below said cone to effect rotation of the entering dust-laden air, and a discharge pipe leading from the upper portion of said expansion chamber, said discharge pipe having an adjustable extension extending down into the expansion chamber and being provided with a flaring conical portion at the lower end thereof.

14. A separator comprising walls forming an expansion chamber, an inlet pipe leading into the lower portion of said chamber, a flaring cone at the upper end of said inlet pipe and over whose outer edges the heavier

particles are discharged, means located in the inlet pipe below said cone to effect rotation of the entering dust laden air, and a discharge pipe leading from the upper portion of said expansion chamber.

15. A separator comprising walls forming an expansion chamber, an inlet pipe leading into the lower portion of said chamber, the upper inner end of said inlet pipe being enlarged, a flaring cone located at the upper end of the inlet pipe over whose outer edges the tailings are discharged, spiral blades located in the enlarged portion of said inlet pipe below the cone to effect rotation of the entering dust laden air, and a discharge pipe leading from the upper portion of said expansion chamber.

In testimony whereof I have affixed my signature in presence of two witnesses.

MILTON L. HICKMAN.

Witnesses:

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H. M. PLAISTED.