No. 711,016. Patented Oct. 14, 1902.

A. H. STEBBINS.

ORE SEPARATOR.

(Application filed Nov. 8, 1901.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

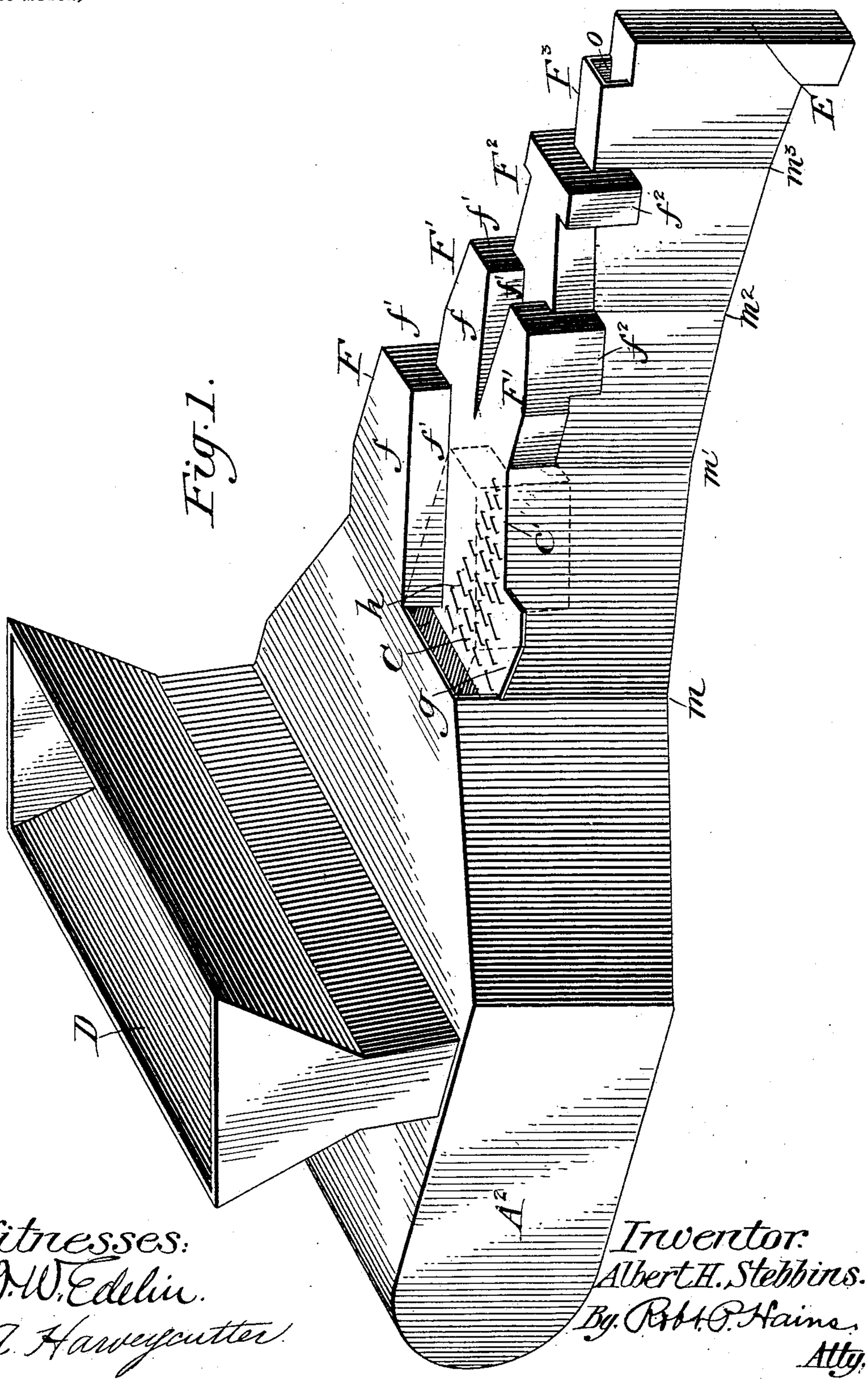

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Fig. 2.

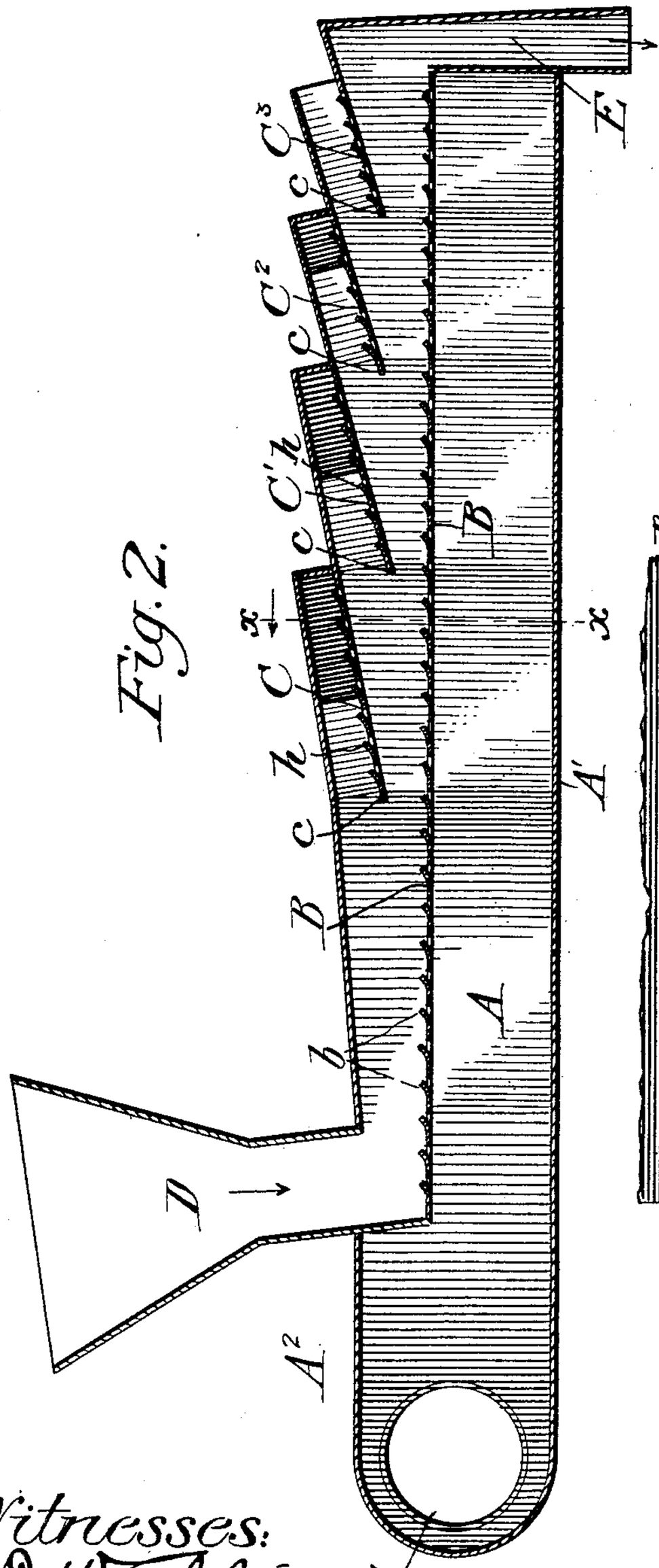
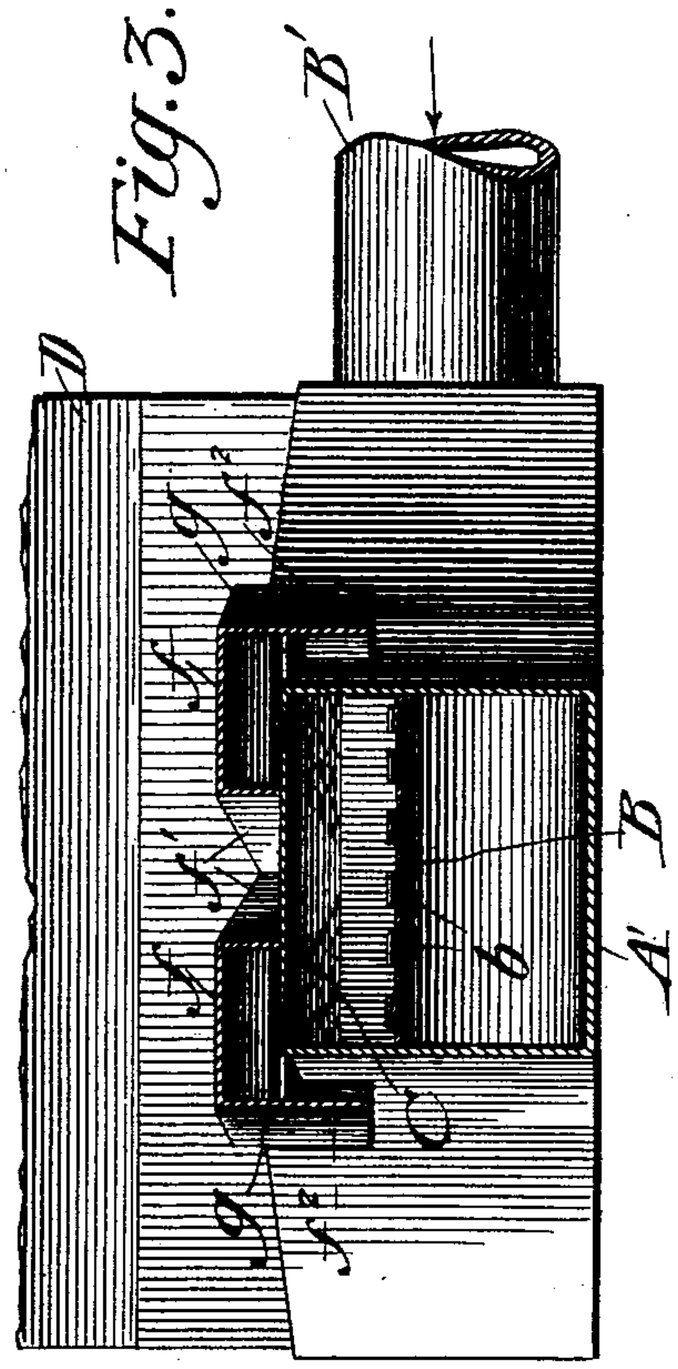


Fig. 3.



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UNITED STATES PATENT OFFICE.

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ORE-SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 711,016, dated October 14, 1902.

Application filed November 8, 1901. Serial No. 81,594. (No model.)

To all whom it may concern:

Be it known that I, ALBERT H. STEBBINS, a citizen of the United States, residing in the city of Little Rock, county of Pulaski, and State of Arkansas, have invented certain new and useful Improvements in Ore-Separators, of which the following, taken in connection with the accompanying drawings, is a specification.

It is well known that finely divided or comminuted ores are composed of particles of different sizes and shapes and of various specific gravities, and of these particles the values or those containing the metals to be secured are the heaviest. It follows from this relation of specific gravities or weights of the particles that if a blast of air be forced through a mass thereof and of sufficient power to move or agitate the mass the values or heavy particles will gravitate to the bottom of the mass, while the lighter particles, which represent the waste material usually, will be lifted to the top, the particles thus being stratified according to their specific gravities. If when the mass of material is thus stratified the top strata are removed, it will be evident that much of the waste material in the ore will be eliminated, and should this operation be repeated upon the mass there will remain finally only the heaviest particles or values, which can then be collected for further treatment. In my present invention I have taken advantage of this action of a finely-divided mass of ore-bearing material to eliminate the waste products and secure the values free from their usual impurities and have devised means whereby the ore is fed to a surface provided with openings through which continuous or intermittent blasts of air or other fluid are made to pass to thereby stratify the material, and I have further provided means to successively cut from the said stratified material the upper strata as they are formed during the passage of the material through the separator and discharge them, while the heavy values continue to travel over the perforated surface to be collected at a suitable discharge-chute, all as will hereinafter more fully appear, and be definitely pointed out in the claims.

In the drawings, Figure 1 is a perspective view of a device embodying the present form of my invention, part of the device being indicated in dotted lines to more clearly disclose the construction beneath. Fig. 2 is a longitudinal section of the device, and Fig. 3 is a transverse section on the line $x\,x$ of Fig. 2 looking in the direction of the arrow.

The body of the separator is preferably formed as a box-like frame A, wider at one end than at the other and having the solid bottom A′. Properly secured within the box-like frame A between the top and bottom thereof is a separating-surface B, formed with suitable openings or perforations *b*, which may be made by punching through the material of the surface B, and thereby forcing a portion of said material above the plane of the said surface to direct air or fluid currents not only through the separating-surface, but also over said surface and nearly parallel thereto in any desired direction, depending upon the character of the material being treated, as will hereinafter more fully appear. In the present instance I have shown the separating-surface B as formed of rigid material, such as sheet metal, with the openings or perforations *b* so punched as to direct air or fluid currents toward the narrow end of the box-like frame; but it will be understood, of course, that any suitable material may be employed and that the openings or perforations may be formed to direct the air or fluid currents in any desired direction. To the larger end A^2 of the separator is connected an air or fluid inlet B′, leading to the box-like structure A beneath the separating-surface B, and since the body of the box-like structure A is air-tight it is obvious that the entire blast of air or other fluid introduced through the inlet B′ must escape through the openings or perforations in the separating-surface. Disposed also at the large end of the separator is the hopper D, leading into the structure A above the separating-surface B, and said hopper D preferably extends across the entire width of the large end A^2, though, of course, it will be obvious that it may be somewhat modified in this respect if circumstances should render it desirable, and through said hopper the material to be treated is fed onto the separating-surface B, as will be clearly seen from Fig. 2. Communicating with the separating-surface B at the end thereof opposite the feed-hop-

per D is the discharge-chute E, through which the valuable particles of ore after having traveled over the entire length of the separating-surface B and being subjected to treatment are finally discharged and collected for further use, as will more fully appear hereinafter.

Above the separating-surface B and arranged diagonally thereto are what I term "cutting" and "conveying" boards C, C′, C^2, and C^3, of any desired number. These cutting and conveying boards have their cutting edges *c* arranged in close proximity to the separating-surface B, and they incline upwardly from this point to their discharge portions *c′*, arranged in the present instance of my invention to direct or discharge material over the side of the separator, as shown in Fig. 1. From the construction thus far described it will be seen that blasts of air or other fluid admitted to the box-like frame A beneath the separating-surface will pass through the openings *b* and acting upon the material fed to said surface through the feed-hopper D will stratify said material, the air or fluid currents not only lifting the lighter particles to form the upper stratum, but by virtue of the direction of the opening or perforations *b* serving to move the entire mass of material toward the smaller end of the apparatus. As the stratified material thus moves over the separating-surface, due to the inclination of the separator and energy of the air or fluid currents, the upper stratum composed of the lighter particles is cut off by the cutting edge of the first cutting and conveying board C. The air or fluid currents still continuing to act upon the material remaining upon the separating-surface again stratify it and move it toward the smaller end of the apparatus until the second cutting and conveying board C′ is met, when the cutting edge *c* of this board cuts the upper stratum from the material, while the remainder moves along the separating-surface for repetition of the above treatment by the succeeding cutting and conveying boards.

I do not claim the cutting and conveying boards broadly, in this case arranged above a concentrating-surface, as such forms the subject of another application filed by me, Serial No. 70,135, July 29, 1901.

In the treatment of ground or comminuted material by air or fluid currents as it moves over a surface such as B it is evident that thin pieces are liable to occur in the layer of material under treatment, the result of which would be to permit a free passage of air or fluid through the thin places without securing the results sought, and to obviate this liability I have found that a cover and chute arranged for each of the cutting and conveying boards, as will be presently described, effectually prevents the formation of thin places in the material under treatment and secures an even and equitable distribution of the material and air or fluid currents.

In the form of my present invention herein illustrated I have shown each of the cutting and conveying boards provided with means for confining the air or fluid currents and for directing the material cut off by the cutting-boards over the side of the machine, and such means I will hereinafter term a "cover" and "chute." The form of such cover and chute may vary, of course, according to the exigencies of service; but I have found in practice that at the wide portions of the machine the cover and chute may be preferably formed as at F and F′, Fig. 1—that is, the cover need not extend over the entire width of the cutting and conveying boards, but may be interrupted above the center of the cutting and conveying boards and connected thereto by suitable confining-walls *f′*, as clearly seen in Fig. 1. Thus above each cutting and conveying board is formed a confining-chamber to prevent the free passage of air or fluid currents. The width of this confining-chamber, as shown in Fig. 3, is such as to extend over the sides of the separator, at which part it is provided with a down-chute f^2, by which material traveling over the cutting and conveying board may be directed into any suitable receptacle.

It will be noted, as shown in Figs. 1 and 3, that the cutting and conveying boards are extended somewhat over the sides of the separator, as at *g g*, so that the down-chutes may be made of proper width to accommodate the material passing over the cutting and conveying boards and yet be located remote from the cutting edge of the cutting and conveying boards to thereby insure proper confinement of the air or fluid currents to do the work of stratification before they are allowed ready escape.

At the more narrow portion of the machine the cover and chute may preferably be formed as at F^2—that is, the cover may extend over the entire width of the separator at that point without interruption and the down-chutes f^2 may extend downward from either side thereof, all as will be readily evident from Fig. 1. The last cutting and conveying board C^3 may simply have the cover F^3, Fig. 1, the down-chutes being omitted, since the material will be discharged over the end of the machine and properly collected, if desired.

After the top stratum of material has been cut off by any cutting and conveying board it is necessary that the material on the cutting and conveying board be moved toward and into the down-chutes at the side of the separator and at the same time that there be no ready escape open to the air or fluid currents passing through the separating-surface B, and to this end the small openings or perforations *h* are provided in the cutting and conveying boards similar to those in the separating-surface hereinbefore described, and such perforations direct the air or fluid currents over and nearly parallel to the surface of the cutting and conveying boards in a direction to

secure the final movement of the light material into the down-chute.

It will be noted from an inspection of Fig. 1 that while the separator is larger at one end than at the other it does not taper in the form of a true triangle, but that the taper or convergence of the sides becomes less toward the smaller end of the separator, and the object of this is to enable the cutting and conveying boards to be made longer than they could be made if the sides of the machine were formed as a true triangle. Viewing Fig. 1 it will be seen that the sides of the separator between the points *m m'* converge less rapidly than from the wide portion A^2 of the machine to the point *m* and that the sides between the points *m' m²* are less convergent than between *m m'*. Likewise the sides between the points m^2 m^3 are less convergent than between the points *m' m²*, and since the active part of the cutting and conveying boards extends between the points *m m' m² m³* it will readily be seen that to maintain a certain width at the discharge end of the machine these cutting and conveying boards can be made longer than would otherwise be possible. The objects of thus making the cutting and conveying boards of increased length are, first, to enable their lower or cutting edges to be brought within the desired distance from the concentrating or separating surface B and to extend diagonally upward therefrom without increasing the upward pitch or angle too much, a condition which would seriously interfere in the proper separation of some forms of ore, and, second, it enables the necessary distance of travel to be given to comminuted ore or pulp on the concentrating or separating surface B between the cutting edge of one board and the cutting edge of the next succeeding board to thereby enable the said material to bunch and rise up with proper slowness and uniformity during the stratification thereof on the concentrating or separating surface.

In the practical application of my invention I have found it desirable that the cutting and conveying boards be arranged at slightly-increasing angular relation to the separating or concentrating surface B progressively toward the discharge end of the machine, and this arrangement is clearly illustrated in Fig. 2, wherein the angular relation of the cutting-board C to the concentrating or separating surface B is less than the angular relation of the second cutting and conveying board C' to said surface B, and so on with each successive cutting and conveying board, so that at the discharge end the cutting and conveying board C^3 has the greatest angular relation with the concentrating or separating surface B. By this arrangement of gradually-increasing angular relation of the cutting and conveying boards to the concentrating or separating surface B the material as it nears the discharge end of the machine being as a whole of greater specific gravity than that first placed upon the concentrating or separating surface through the feed-hopper D is more effectually confined, so as to become stratified under the strong blasts of air or fluid passing through the narrow portion of the concentrating or separating surface B, since the said blasts of air or fluid at the said narrow portion of the separator would naturally increase in force, and were it not for the increased inclination of the cutting-boards the effect of stratification would be liable to place some of the lighter values in position to be cut off and conveyed away by the cutting and conveying boards in the operation of the device.

The operation of the machine may be described as follows: Finely-divided or comminuted ore is fed to the concentrating or separating surface through the feed D, extending across the wide portion of the separator, and the device as a whole being placed in an inclined position either continuous or intermittent blasts of air or fluid are introduced through the inlet B' below the concentrating-surface B, and rising through the perforations in the concentrating-surface B the said air or fluid currents serve to lift the material placed on said surface and to stratify the same, with the lighter waste particles on top, and to simultaneously move the mass of material toward the discharge end E of the machine. As such stratified ore reaches the cutting edge *c* of the first cutting and conveying board C the upper layer or stratum of light particles is cut off and travels up the inclined surface of the said cutting and conveying board, being assisted in its travel by the air or fluid currents passing through the perforations *h* in the cutting and conveying board until it meets the down-chute f^2, when the said waste material contained in the first or upper stratum of material is discharged over the side of the machine into suitable receptacles as desired. As the air or fluid blasts pass through the perforations in the cutting and conveying board the cover and chute F F confine the said air or fluid currents, so as to prevent the ready escape thereof without the performance of the work intended. The remaining strata of material pass below the first cutting and conveying board C, and owing to the construction of the machine at this place the material becomes bunched and rises slowly and uniformly into greater thickness as it approaches the cutting edge *c* of the second cutting and conveying board C', being acted upon simultaneously by the air or fluid currents, which stratify the said material prior to its reaching the cutting edge of the board C'. At this point again the upper stratum of the ore is cut off and moves up the inclined surface of the cutting and conveying board C', being, as before described, assisted in this movement by the perforations *h*, which exist preferably in all of the cutting and conveying boards, until finally the said upper stratum of light material passes into the confined space above the second cutting and

conveying board C′ and through the down-chute, to be collected as desired. It will be evident that the material now remaining in the machine is as a whole of greater specific gravity than that which was first fed to the machine, since many of the lighter particles as contained in the upper stratum have been removed, and as the machine narrows at this point the material is again formed into a thick mass and stratified, as before, by the air or fluid currents passing through the concentrating or separating surface B. As the stratified material continues to travel along the concentrating-surface the upper and lighter strata are successively removed and may be collected in suitable receptacles for further treatment, and the action of the machine continues until the concentrates or values pass under the last cutting and conveying board C^3 into the discharge-chute E, to be collected as desired. It will be noted that the cutting and conveying boards toward the narrow end of the machine are of less length than at the wider portion and that in consequence the material passing over the shorter cutting-boards would offer less resistance to the movement of material thereon and would be liable to cause thin places, to overcome which and to compensate for the decrease in length of the successive boards I increase the angular arrangement of the short cutting and conveying boards.

While I have shown in this case a series of four cutting and conveying boards, it is to be understood, of course, that any number may be employed and that the confining-space above each of the cutting and conveying boards formed by the cover and chute may be varied in their character and shape according to the desires of the operator. Such a machine as described may be used, of course, either as a dry washer or concentrator. It will be noted also that the cutting and conveying boards are preferably of different lengths and vary progressively from the longest at the wider portion of the separator to the shortest at the smaller end. Thus the cutting and conveying board C is longer than C′ and C′ is longer than C^2, &c. This arrangement is desirable, since the great mass of relatively light material stratified as it passes beneath the cutting and conveying board C requires a longer time and action of the air or fluid currents than does the relatively heavier mass passing under the succeeding cutting and conveying boards, the distinctive characteristics of the machine in this respect being, first, the variation in length of spaces between the cutting edges of successive boards, which permits the adjustment of the concentrating steps to the decreased volumes of material treated on the successive sections, and, second, the progressively-increasing angular relations between the concentrating-surface and the successive boards.

One of the important features of structure is the cover and chute arranged over each of the cutting and conveying boards to confine the air or fluid currents and to maintain an even and uniform distribution of material on the separating-surface by virtue of preventing the too-rapid passage of said currents.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a machine of the character described, the combination of a box-like frame, a separating-surface provided with openings and supported above the bottom of said box-like frame, means for directing a blast of air or other fluid into said frame below the separating-surface, and a series of cutting and conveying boards arranged above and diagonally to the said separating-surface, said cutting and conveying boards being arranged with the cutting edges of adjacent boards at varying distances apart, as and for the purpose set forth.

2. In a machine of the character described, the combination of a box-like frame, a separating-surface provided with openings and arranged within said frame above the bottom thereof, means for directing a blast of air or other fluid into said frame below the separating-surface, a series of cutting and conveying boards arranged above said separating-surface at an inclination thereto, and a cover and chute for each of said cutting and conveying boards for confining the air or fluid currents and delivering the material cut off by said cutting and conveying boards out of the machine.

3. In a machine of the character described, the combination of a box-like frame, a separating-surface provided with openings and supported above the bottom of said box-like frame, means for directing a blast of air or other fluid into said frame below the separating-surface, and a series of cutting and conveying boards arranged above and diagonally to the said separating-surface, the cutting edges of said cutting and conveying boards being separated by progressively-smaller spaces, and a cover and chute for each of said cutting and conveying boards for confining and equalizing the air or fluid currents and delivering the material cut off by said cutting and conveying boards out of the machine.

4. In a machine of the character described, the combination of a box-like frame, a separating-surface provided with openings and supported above the bottom of said frame, means for directing a blast of air or other fluid into said frame below the separating-surface, a series of cutting and conveying boards arranged above and over the separating-surface and at different angles thereto for delivering the material cut off by said cutting and conveying boards out of the machine, the cutting edges of the cutting and conveying boards being substantially the same distance above the separating-surface.

5. In a machine of the character described,

the combination of a box-like frame wider at one end than the other, a separating-surface provided with perforations and supported within the box-like frame above the bottom thereof, means for directing a blast of air or other fluid into the box-like frame beneath the separating-surface, and a series of cutting and conveying boards arranged above and at an inclination to the separating-surface, said cutting and conveying boards being progressively of less length from the wide to the narrow portion of the box-like frame to provide progressively-decreased spaces between the cutting edges for the purpose set forth.

6. In a machine of the character described, the combination of a box-like frame wider at one end than the other, a separating-surface arranged within said frame above the bottom thereof, and a series of cutting and conveying boards located above the separating-surface at an inclination thereto, the sides of said box-like frame being less convergent toward the narrow end of said frame, whereby the cutting and conveying boards may be made of increased length for the purpose set forth.

7. In a machine of the character described, the combination of a box-like frame wider at one end than the other, a separating-surface arranged within said frame above the bottom thereof, and a series of cutting and conveying boards located above the separating-surface at an inclination thereto and a cover and chute for each of said cutting and conveying boards, the sides of said box-like frame being less convergent toward the narrow end of said frame, whereby the cutting and conveying boards may be made of increased length for the purpose set forth.

8. In a machine of the character described, the combination of a box-like frame wider at one end than the other, the sides of which frame are formed of sections of less convergence toward the smaller end of the machine, a separating-surface arranged within said frame above the bottom thereof and provided with perforations, means for directing a blast of air or other fluid into said box-like frame below the separating-surface, and cutting and conveying boards arranged above said separating-surface and of lengths corresponding to the side sections of the box-like frame.

9. In a machine of the character described, the combination of a box-like frame wider at one end than the other, the sides of which frame are formed of sections of less convergence toward the smaller end of the machine, a separating-surface arranged within said frame above the bottom thereof and provided with perforations, means for directing a blast of air or other fluid into said box-like frame below the separating-surface, and cutting and conveying boards arranged above said separating-surface and of lengths corresponding to the side sections of the box-like frame, and a cover and chute for each of said cutting and conveying boards.

10. In a machine of the character described, the combination of a box-like frame wider at one end than the other, a feed-hopper at the large end of the machine, a discharge-outlet at the narrow end of the machine in communication with the separating-surface, a separating-surface provided with openings and arranged within said frame above the bottom thereof, means for directing a blast of air or other fluid into said frame below the separating-surface, a series of cutting and conveying boards arranged above said separating-surface at an inclination thereto, and a cover and chute for each of said cutting and conveying boards for confining the air or fluid currents and delivering the material cut off by said cutting and conveying boards out of the machine.

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