No. 775,944. PATENTED NOV. 29, 1904.

A. H. STEBBINS.

ORE CONCENTRATOR.

APPLICATION FILED MAR. 22, 1901.

NO MODEL. 2 SHEETS—SHEET 1.

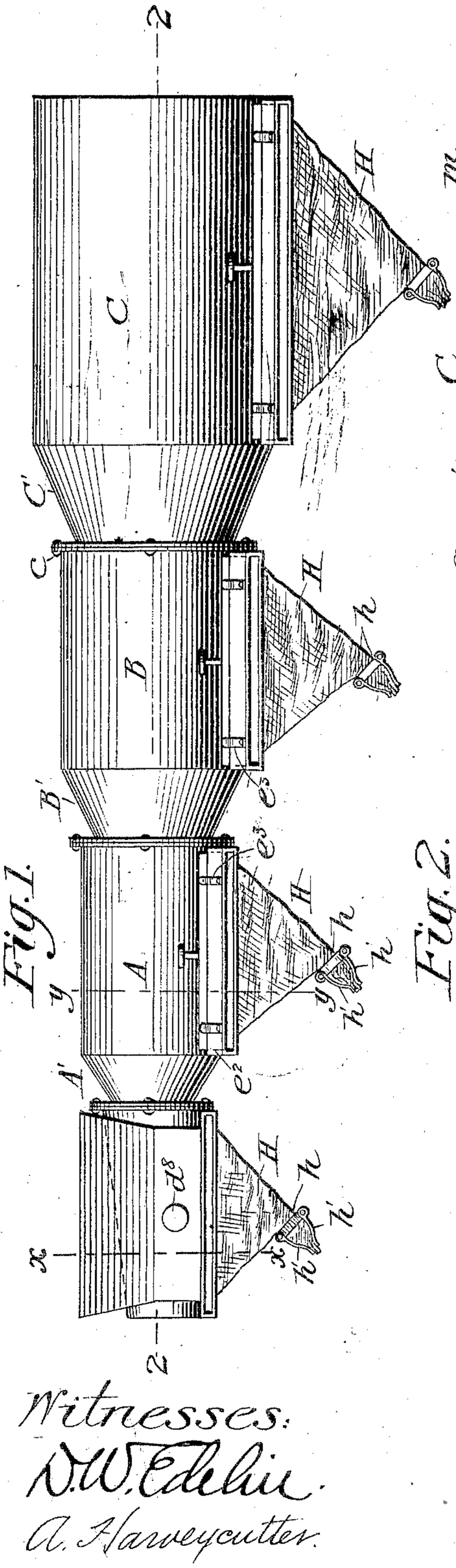

Fig. 1.

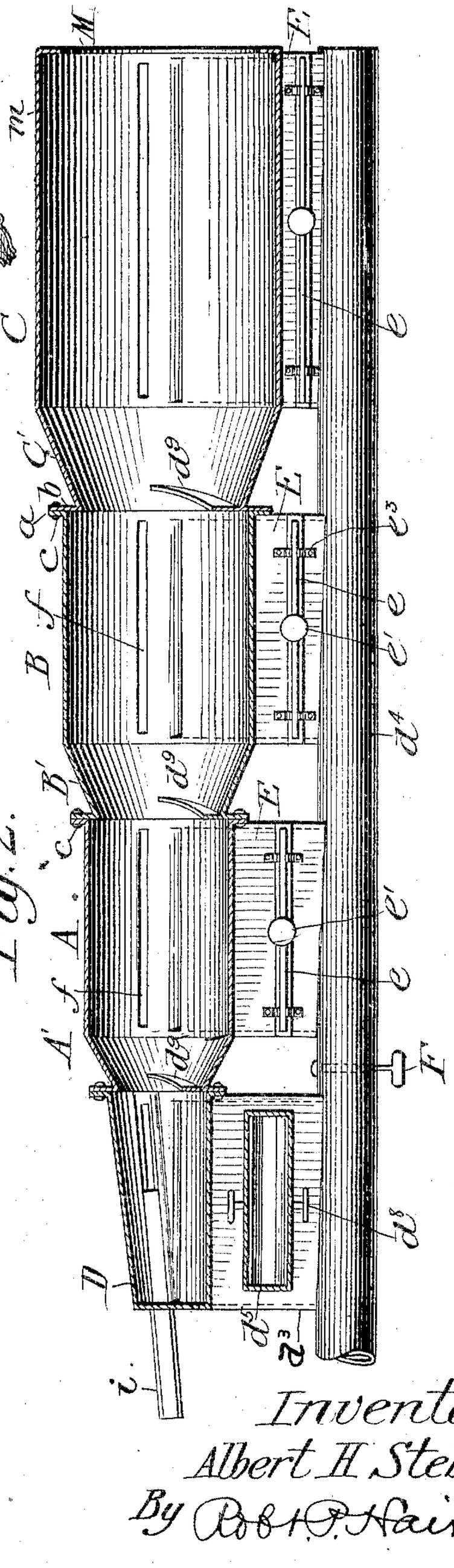

Fig. 2.

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NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.

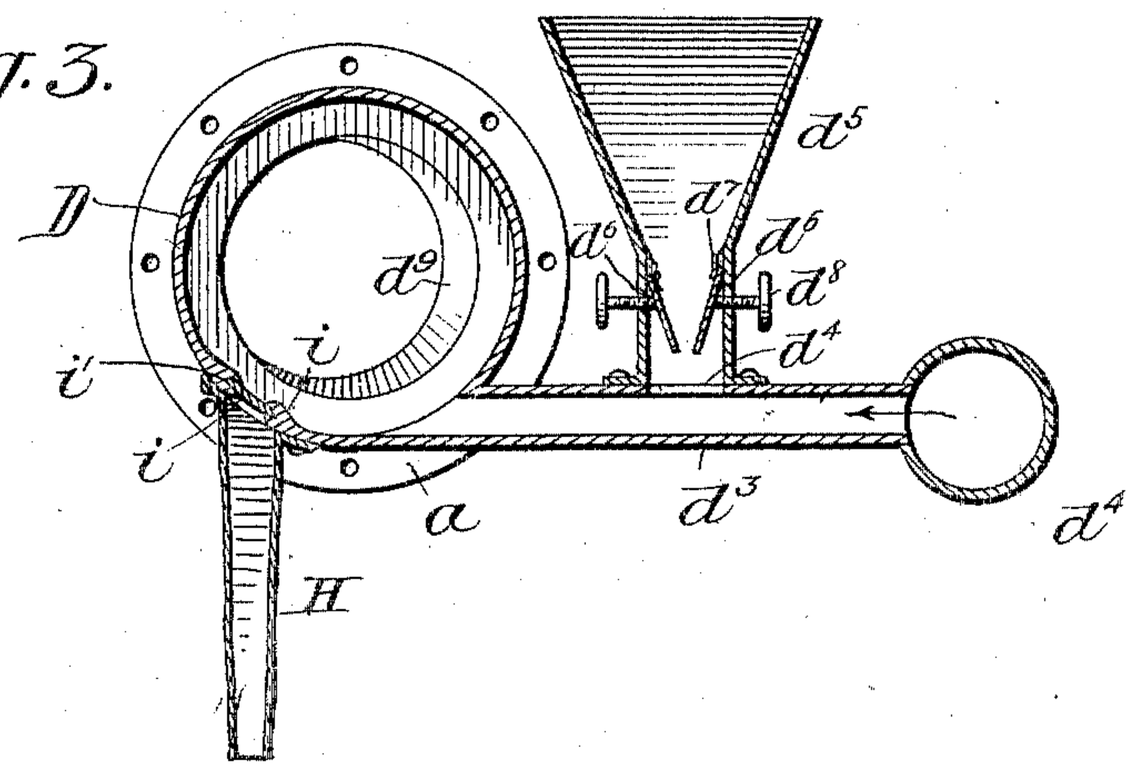


Fig. 4.

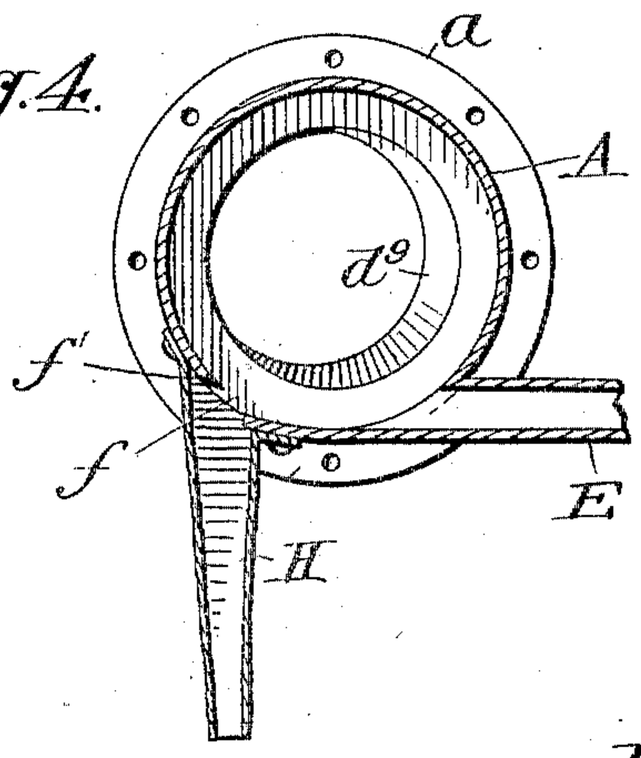


Fig. 5.

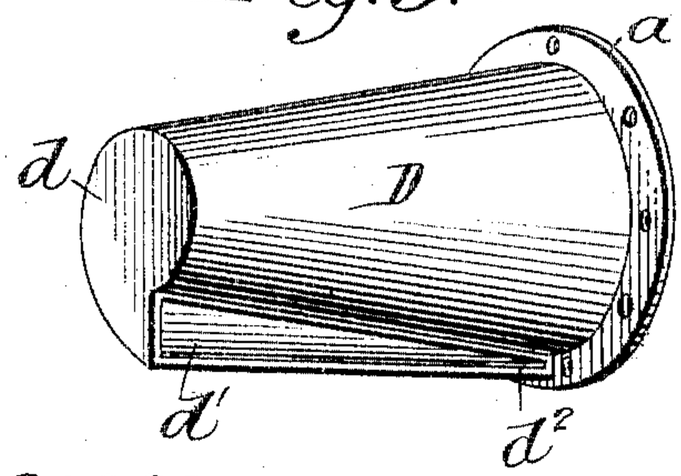
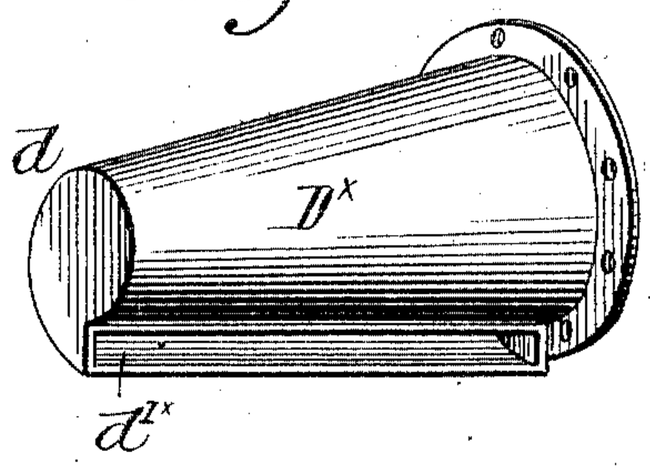


Fig. 6.



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No. 775,944. Patented November 29, 1904.

UNITED STATES PATENT OFFICE.

ALBERT H. STEBBINS, OF LITTLE ROCK, ARKANSAS.

ORE-CONCENTRATOR.

SPECIFICATION forming part of Letters Patent No. 775,944, dated November 29, 1904.

Application filed March 22, 1901. Serial No. 52,337. (No model.)

To all whom it may concern:

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

The invention to be hereinafter described relates to ore-concentrators, and more particularly to that type of such machine wherein finely-divided or comminuted ore is subjected to the action of currents of air or other fluid of gradually-decreasing force, whereby the valuable particles of the ore are separated from their accompanying impurities and divided from each other according to their size or relative specific gravities. In my researches and experiments with this class of ore-concentrators I have found it desirable to subject the finely-divided ore and the impurities that accompany it to gyratory motion or spiral currents of air, the carrying capacity of which is gradually reduced, so that while most, if not all, the material introduced may be held in suspension and carried around by the maximum strength of currents the heavier particles constituting the values will gradually be deposited as the strength of said gyratory or spiral currents is reduced, the said currents being yet sufficiently active to hold in suspension the lighter particles constituting the waste material, which are thereby eliminated.

In the present embodiment of my invention I have connected together a series of chambers, preferably in the form of drums connected end to end, said chambers or drums gradually increasing in size from end to end of the series, and I preferably introduce a blast or current of air giving it a spiral or gyratory motion, the carrying capacity of which decreases as said current of air passes into the next larger connected drum, so that the particles or values capable of being held in suspension by the force of the current in the smaller drum are no longer held in suspension, owing to the decreased strength of current, and become eliminated, and so on throughout the series, as will more fully appear hereinafter.

Where spiral or gyratory air-currents of gradually-decreasing carrying capacity are employed to separate the values from their impurities I have found it advantageous to introduce the finely-divided ore at one end of the series of connected chambers, and in order to insure the spiral or gyratory path of said material from one chamber to another I have found it desirable to provide means at the end of the series of chambers whereby as the air-currents are introduced, carrying with them the finely-divided ore, they will be given the desired spiral movement, and I have further ascertained that a single blast of air introduced into the said means at the end of the series of connected chambers may in most cases be sufficient to insure the proper movement of the material through the several chambers and the final separation of the values from the impurities. In some cases, however, it may be desirable to augment the spiral moving air-currents and material held in suspension thereby, and I have therefore devised means by which my present apparatus may be adapted to have the air-currents introduced at one end of the series of chambers or into any number of said chambers, as desired.

With the above general objects in view my invention consists of the parts and combinations as will hereinafter be fully described, and definitely pointed out in the claims.

In the drawings, Figure 1 is a side elevation of an ore-concentrator embodying my invention. Fig. 2 is a section thereof on line 2 2, Fig. 1. Fig. 3 is a cross-section on the line *x x* of Fig. 1. Fig. 4 is a cross-section on the line *y y*, Fig. 1. Fig. 5 is a perspective view of the spiral starter or head detached. Fig. 6 is a like view of a slightly-modified form of spiral starter or head detached.

In the present embodiment of my invention I have shown a series of chambers in the form of drums A B C, connected together end to end; but it is evident that the particular form of such chambers may be varied and the number thereof may be decreased or increased without departing from the spirit of my invention. Each chamber or drum preferably consists of a cylindrical wall having at one end a contracted portion, as A′ B′ C′, the said contracted portion of each drum being adapted

for connection with the larger end of the next preceding similar drum, and as a means of such connection I have provided the larger end of each drum, except the last of the series, with a flange *a* and the contracted end of the next drum with a similar flange *b*, the said flanges being connected by detachable means, as the bolts *c*.

To the contracted end A′ of the smallest drum A of the series I preferably connect by detachable means, such as described for the connection between the drums, a spiral starter or head D. The office of this spiral starter or head D is to insure the spiral or gyratory path of the currents and divided ore as they are introduced in the apparatus, and said starter or head comprises in one form of my invention, as disclosed by Fig. 5, a chamber smaller at one end than the other, the small end of which is closed, as shown at *d*, the larger end thereof being provided with a flange *a*, by which to detachably connect it to the small end of the first drum A of the series. While the general form of spiral starter or head is of conical shape, the walls thereof are carried around in the form of a spiral, forming near the lower portion of said starter or head an inlet *d′*, by which the divided ore and air-currents are introduced. In the form of spiral starter or head shown by Fig. 5 it will be noted that the opening *d′* is enlarged near the closed end, thereby admitting at such point larger volumes of air-current and divided ore than at the opposite or contracted end d^2 of said opening, and the effect of this is that as the material and currents are introduced into the head or starter they will be most forcible at the small end of the head, and the head being closed at this end while enlarging at its opposite end, connected with the drum A, the direction of spiral and progressive movement of the air-currents and material held in suspension thereby will be insured.

The form of spiral starter or head shown by Fig. 6 differs only slightly from that shown by Fig. 5 in that the inlet-opening d'^+ is of uniform dimensions throughout the length of the head or starter D. The effect upon the movement of air-currents and suspended material in each case, however, is the same—namely, that said currents and material are given a spiral movement as they enter the head or starter, which insures the gyratory movement of the same as they progressively enter the different chambers or drums A B C.

Connected to the inlet-opening of the head or starter is the inlet-pipe d^3, which is itself connected to the air-blast pipe d^4, by which the blast of air is directed into the head or starter. Secured to the inlet-pipe d^3 over a suitable opening d^4 therein is the hopper d^5, having at its lowered part the wings or flaps d^6, which are preferably of light material, hinged at d^7 to the interior of the said hopper, and passing through the walls of the lower portion of the hopper, so as to adjust the size of opening between the flaps, are the adjusting-screws d^8. It will be evident from this construction that material fed into the hopper d^5 will gradually fall into the inlet-pipe d^3 and be carried by the incoming blast into the spiral starter or head, and the flaps d^6, resting against the ends of the adjusting-screws d^8, will serve to prevent the incoming air-currents from passing upward through the hopper, as any such tendency will at once cause the flaps d^8 to come together and close the opening between their ends.

In order to further secure the spiral or gyratory movement of the air-currents and the suspended material as the same pass from the head into the first drum of the series and on through the succeeding drums, I have preferably provided the flanged connections between the head or starter and the first drum of the series, as well as the flanges between the drums, with a spiral directing-flange d^9, which, as shown in Fig. 2, directs the spiral currents as they gradually expand to their work in passing from the head to the drums or from one drum to another into a spiral or gyratory path. These directing-flanges d^9 may extend part or all the way around the connecting-flanges between the head and first drum of the series and between the drums, as indicated more clearly in Figs. 3 and 4.

The blast-pipe d^4 preferably extends throughout the series of chambers, as indidated in Fig. 2, and each of the drums is connected to said blast-pipe by an inlet E, preferably extending the full length of the cylindrical portion of the drum and connected tangentially thereto, as indicated in Fig. 4, so that a blast of air introduced into any drum will impart to the material in said drum circular movement.

In the treatment of some characters of ores it is desirable that one or more of the drums may be cut off from the inlet-blast, and I have therefore provided in the connection E for each drum a valve *e*, having a handle *e′*, by which it may be raised to open the connection between the drum and the blast-pipe or lowered to close the said connection between them, the said valve consisting, preferably, of a loose piece of material guided in any suitable manner, as by the guides e^2, and held when in raised position by any suitable form of catch, as by the spring-clips e^3. Thus by means of the valves *e* any one or all of the chambers or drums may be cut off or opened thereto as desired.

In order to more readily cut off the entire series of drums from the increase of air through the blast-pipe d^4, I have provided in the blast-pipe d^4 a valve F between the inlet to the head or starter and that to the first drum A of the series, as indicated in Fig. 2. By turning the valve F to close the pipe d^4 it is evi-

dent that all of the drums may be at once cut from their connection with the air-blast and that under such conditions the blast will be introduced only into the spiral starter or head. Thus I have adapted my present apparatus to the treatment of a large variety of ores, as will be readily understood.

Each drum of the series is provided in its lower wall and preferably to the side of its lowest point opposite the inlet E with a discharge-opening *f*, preferably in the form of a slot extending substantially the length of the cylindrical portion of the drum or chamber. This discharge-opening is formed by interrupting the walls of the drum at this point, and I preferably turn the upper wall of the slot or opening slightly upward, as shown at *f'*, Fig. 4, so that as the material is carried around in its spiral or gyratory path the lip *f'* of the opening *f* will act to shave off from the layer of material being circulated those particles which by their weight or greater specific gravity are carried to the extreme outer layer of the circulating material, such particles being the values or the concentrates which it is desired to secure. Moreover, by forming the opening or slot *f* on the upward incline of the drum it is evident that any particles which are too heavy to be further held in suspension by the circulating currents as they rise above the said opening will fall back and slide down the wall of the drum and pass into the discharge-opening.

Secured to the several drums below the discharge-opening *f* in each I provide a discharge-chute H, preferably of flexible or textile material, and to the lower end of such discharge-chute I connect a spring closing device which in the present form of my invention, as indicated in Fig. 1, consists of a band *h*, secured to the walls of the flexible or textile material and having attached thereto spring-fingers *h' h'*, normally tending by their spring action to hold the mouth of the discharge-chute closed. From this construction of the discharge-chute and its closure it is evident that the material passing into the chute through the discharge-opening *f* will lodge in the lower end of the chute and be held at that point by the spring action of the spring-fingers *h' h'* until the amount of material contained within said chute shall be sufficient to overcome the tension of the spring action in the fingers *h' h'*, when the said fingers will yield and permit the concentrates to be automatically discharged. Not only does such form of closure provide for an automatic discharge of the concentrates, but as the spring-fingers normally hold the mouth of the chute closed any tendency to back action of the air in seeking to pass through the mouth of the chute into the drum will be overcome.

In the present embodiment of my invention I have shown the spiral starter or head D also provided with a discharge-opening, as in Fig. 3; but it is often desirable that the material to be treated be carried into the first drum of the series before separating any of the concentrates or values, and I have therefore provided in the wall of the spiral starter or head a slide *i*, which may be forced inward in suitable ways *i'* in the wall of the head to close the opening when desired, or said slide can be withdrawn either wholly or partially, as shown in Fig. 2, to expose more or less of the opening for the egress of the heaviest portion of the values or concentrates. Below the opening in the head or spiral starter I provide the same form of chute and closure as already described for the drums.

From the construction described it will be evident that material in the finely-ground state being introduced into the hopper d^5 will be carried by the incoming blast of air from the blast-pipe d^4 into the spiral starter or head and will be forced by the form of said head and by the fact that the inlet thereof is tangential to take a spiral or gyratory course progressively from the closed end of the spiral starter into the series of connected drums. As the material passes into the first drum of the series the guide-flanges d^9 continue to direct the currents and material in their spiral course, and the gradually-increasing diameter of the head A' of the first drum A will permit the currents to gradually expand and become less forcible in their carrying capacity, so that those concentrates or values which were just capable of being held in suspension by the maximum currents introduced into the spiral starter or head are now permitted to either settle in the first drum A and fall through the discharge-opening into the connected chute or be shaved off by the projecting lip *f'* of the discharge-opening. If it is desired at this point to increase the carrying capacity of the air-currents, the valve *e* in the inlet E may be raised, the valve F being also turned to permit air to flow through the length of pipe d^4. If, on the other hand, the air-currents are effectively doing their work and no additional force is desired to the currents in the several apartments, the valve F is closed, as likewise may also be the valves *e e* in the several connections E.

The air-currents and material in their spiral or gyratory course pass from the drum A in a similar manner as described for the head D, into the next larger drum, B, where a similar action takes place until at the end of the several drums of the series the values or concentrates have been separated from their mixed impurities and are eliminated from the end of the last drum, an opening M, having the flange *m* in the last drum, C, of the series, being provided for this purpose.

While I have thus described my invention as consisting of the several connected drums or chambers of varying sizes, having the spiral starter or head D connected thereto, it is evi-

dent that the said spiral starter or head may be employed in any form of separator where spiral or gyratory currents of air are desired.

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

1. In an ore-concentrator, the combination of a series of cylindrical chambers varying in size from end to end of the series and each having at one end a reduced connecting portion joined to the larger end of the next preceding chamber, means for introducing spiral or gyratory air-currents into the first of said series of chambers, a discharge-opening in the wall of each of said chambers and a separate tangential inlet for each of said cylindrical chambers.

2. In an ore-concentrator, the combination of a series of stationary cylindrical chambers varying in size from end to end of the series, and each having at one end thereof a reduced connecting portion, spiral guiding-flanges between the several chambers, means for connecting the reduced connecting portion of one chamber to the large end of the next preceding chamber, a discharge-opening for the concentrates in the wall of each chamber and a separate tangential inlet for directing currents of air or fluid into each of said chambers.

3. In an ore-concentrator, the combination of a series of drums of varying sizes connected end to end, with a spiral starter or head connected to the end drum of the series, and means for introducing ore and currents of air into said spiral starter or head to thereby impart spiral or gyratory movement to said ore and air-currents as they pass through said series of drums and means for introducing tangential currents of air separately into each of said drums.

4. In an ore-concentrator, the combination of a series of drums varying in size from end to end of the series, with a spiral starter or head connected to the end drum of the series, and means for introducing ore and currents of air into said spiral starter or head to thereby impart spiral or gyratory movement to said ore and air-currents as they pass through said series of drums and separate discharge-openings and tangential inlets for each of said drums.

5. In an ore-concentrator, the combination of a series of drums each having a conical end portion connected to the large portion of the next drum of the series, a spiral guide between said drums in the conical portion thereof, a spiral starter or head connected to the end drum of the series, and means for introducing into said spiral starter or head ore and air-currents.

6. In an ore-concentrator, a spiral starter or head comprising a chamber of substantially conical form and closed at its smaller end, the walls of said chamber being arranged as a spiral, and an inlet leading to the interior of said chamber and tangential thereto, said inlet being larger at the smaller end of said spiral starter or head and diminishing in size toward the larger end of said starter or head.

7. In an ore-concentrator, a spiral starter or head comprising a chamber closed at one end, the interior of said chamber having a spirally-formed wall, and an inlet leading to the interior of said chamber and said inlet being tangential thereto, in combination with a series of drums varying in size from end to end of the series, said spiral starter or head being connected to the end of the smallest drum of the series, each of said chambers being provided with a tangential inlet.

8. In an ore-concentrator, a spiral starter or head comprising a chamber closed at one end, the interior of said chamber having a spirally-formed wall, and an inlet leading to the interior of said chamber and said inlet being tangential thereto, in combination with a series of drums varying in size from end to end of the series, each drum having a reduced portion connecting it with the larger end of the next smaller drum, said spiral starter or head being detachably connected to the end of the smallest drum of the series, each of said chambers having a discharge-opening in its wall for the concentrates and a tangential air-inlet.

9. In an ore-concentrator, the combination of a series of drums of varying sizes connected end to end, a spiral starter connected to the end of the smallest drum of the series, a blast-pipe, a tangential inlet connecting each of said drums and the spiral starter to the said blast-pipe, a discharge-opening in each of said drums, and means for interrupting the connection of any one of said drums with the blast-pipe.

10. In an ore-concentrator, the combination of a series of cylindrical chambers varying in size from end to end of the series, and each having at one end a reduced portion connecting the chamber with another of the series, a discharge-opening in the walls of said chambers and a tangential inlet for the introduction of fluid-currents into each of said chambers.

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