No. 688,810. Patented Dec. 10, 1901.

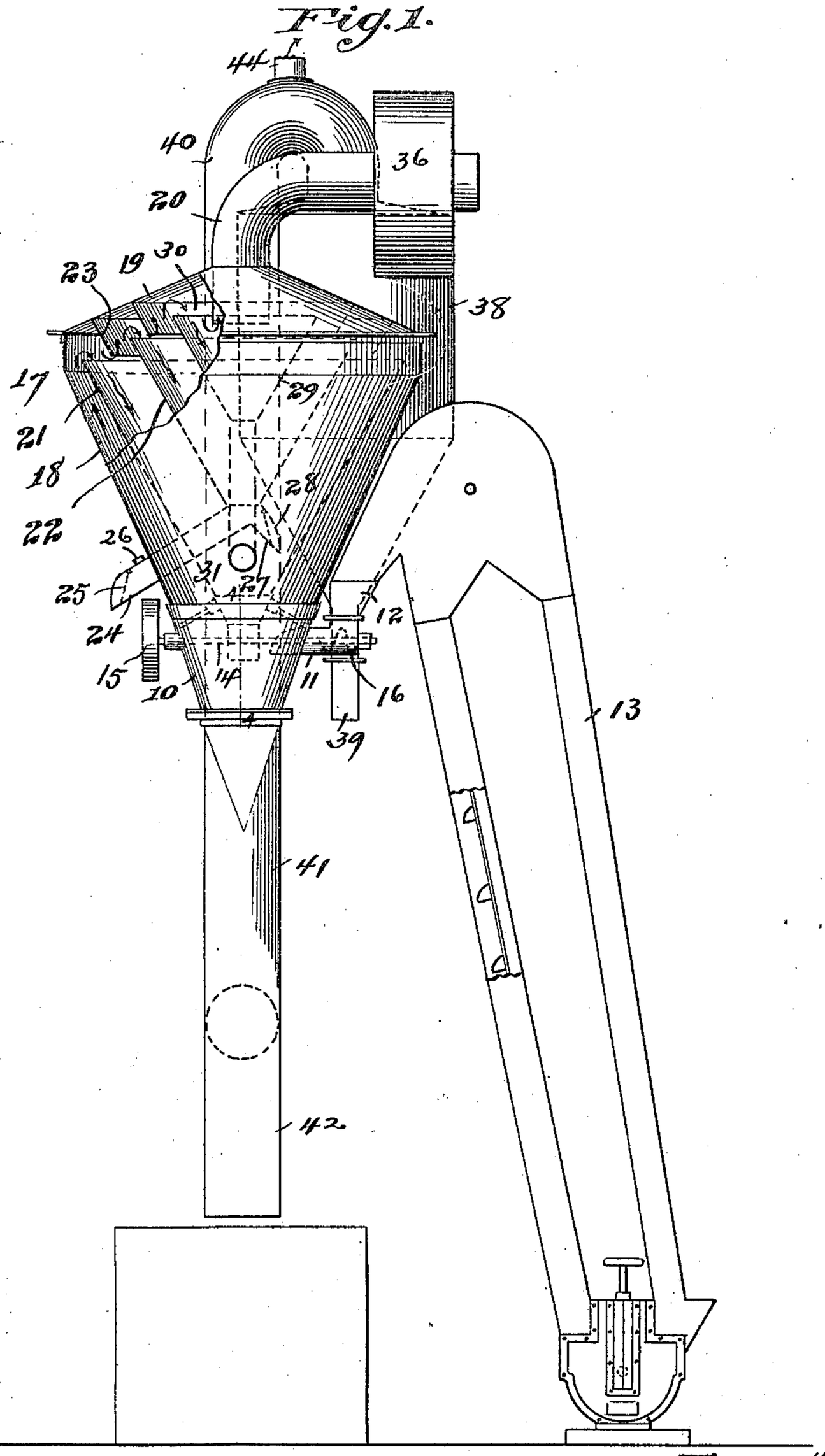
A. RAYMOND.

PNEUMATIC SEPARATOR.

(Application filed Feb. 5, 1898.)

(No Model.) 6 Sheets—Sheet 1.

Fig. 1.



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6 Sheets—Sheet 2.

Fig. 2.

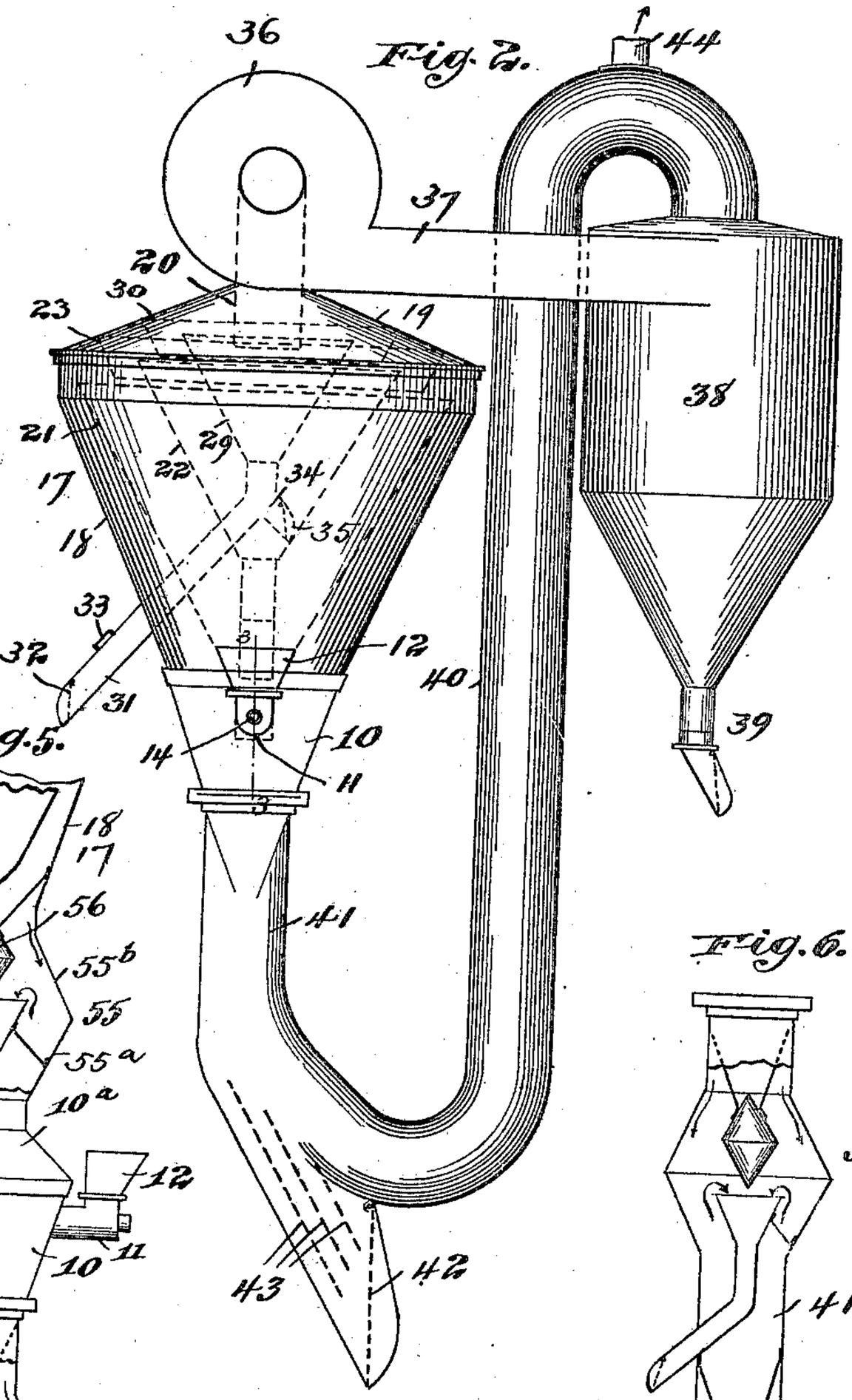


Fig. 5.

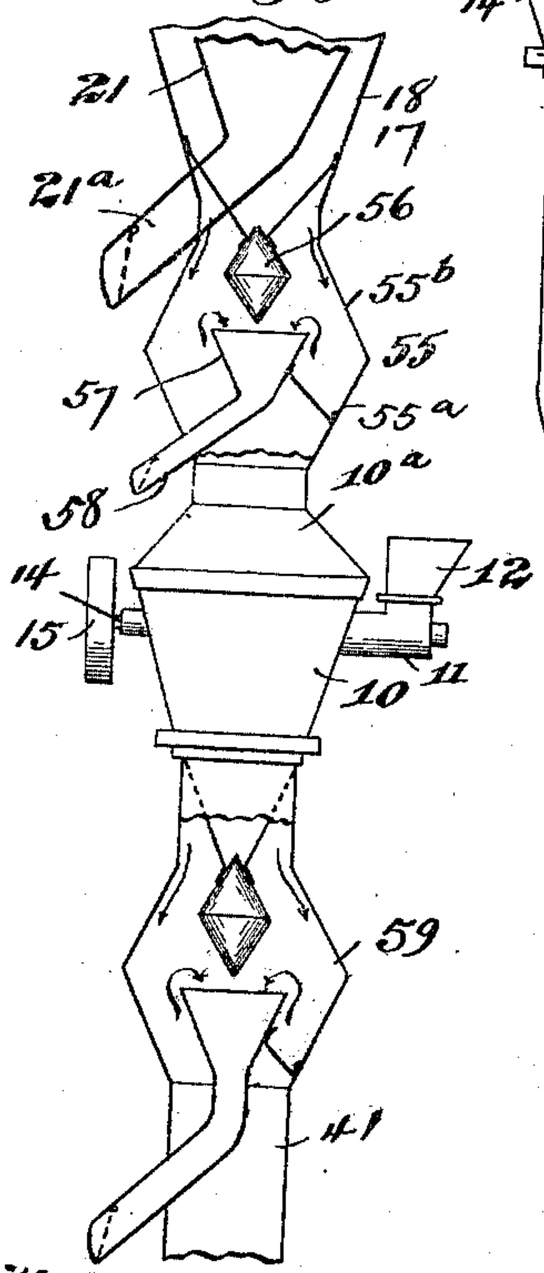
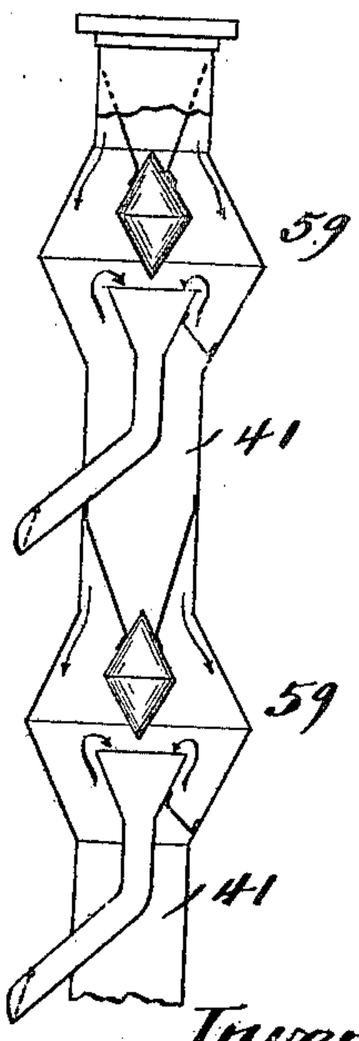


Fig. 6.



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6 Sheets—Sheet 3.

Fig. 3

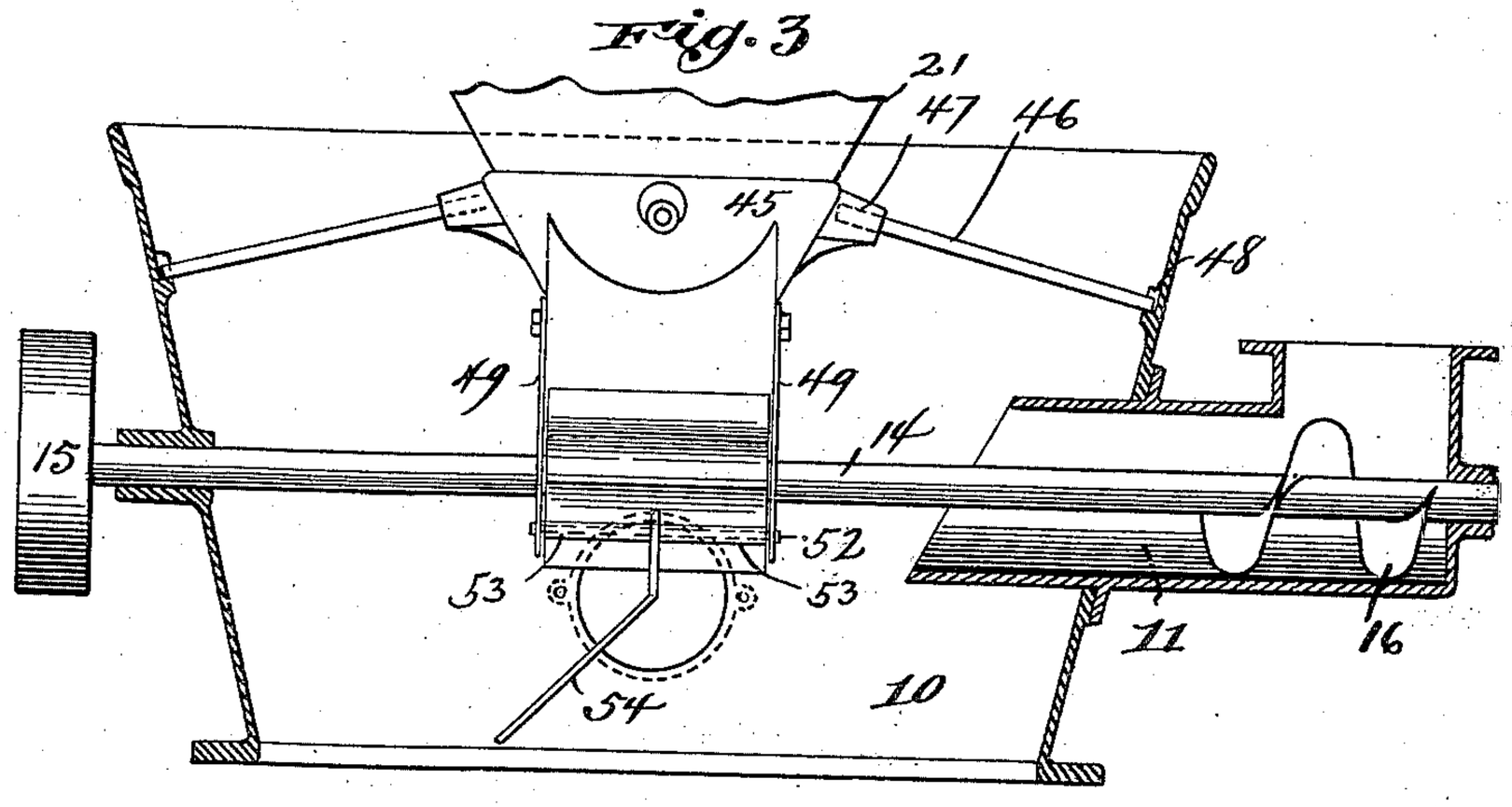
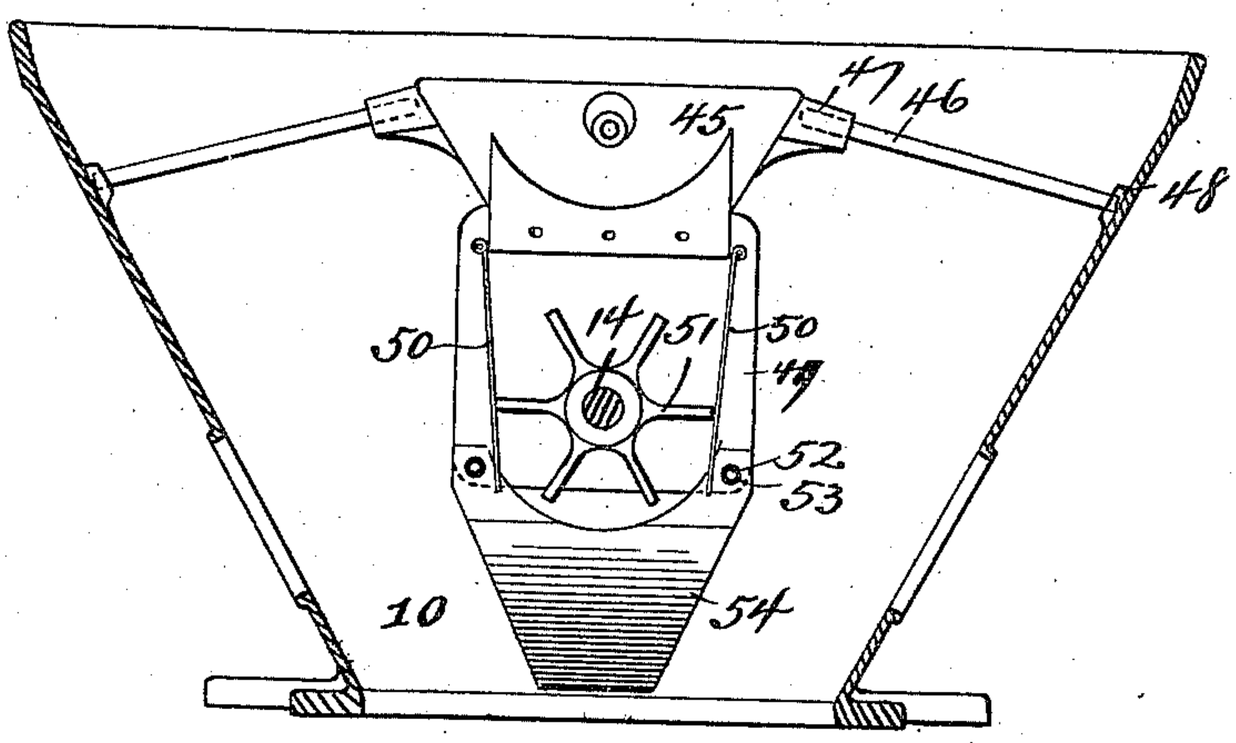


Fig. 4.



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(No Model.) 6 Sheets—Sheet 4.

Fig. 7.

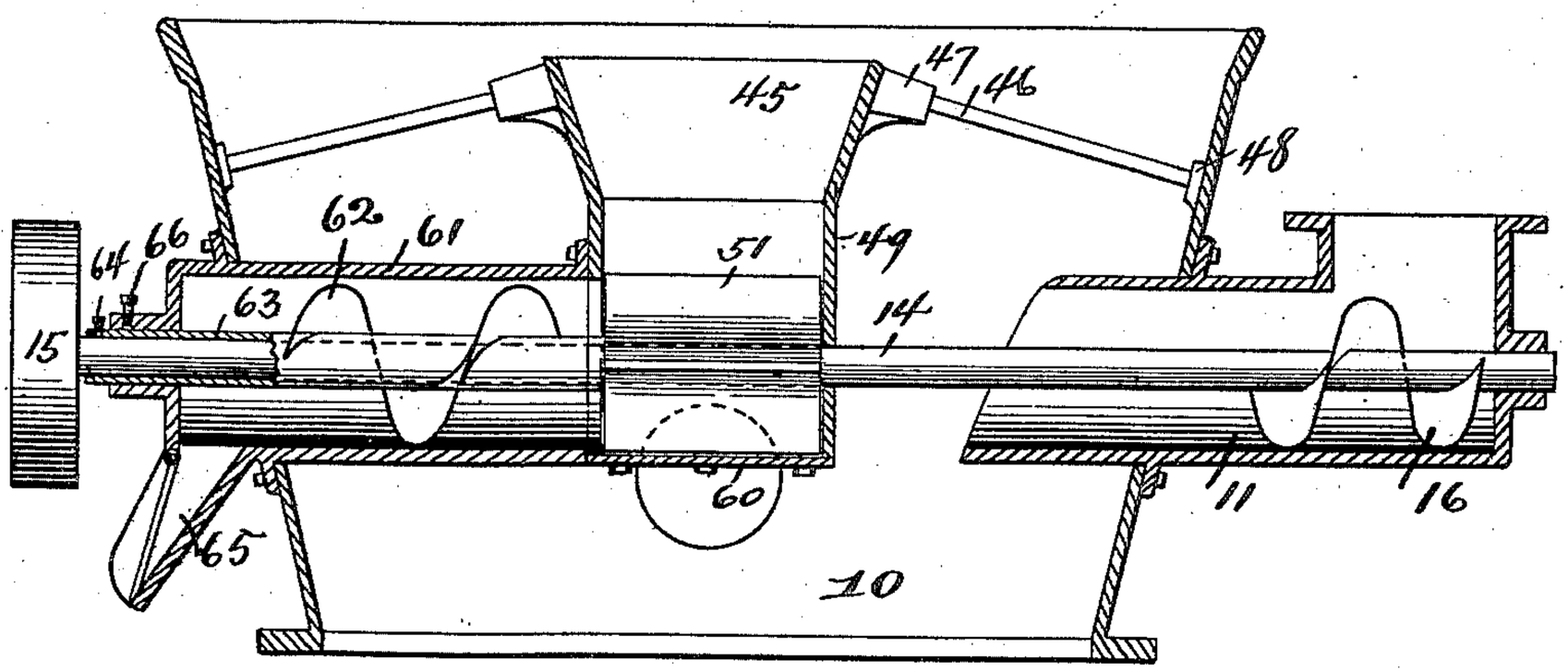
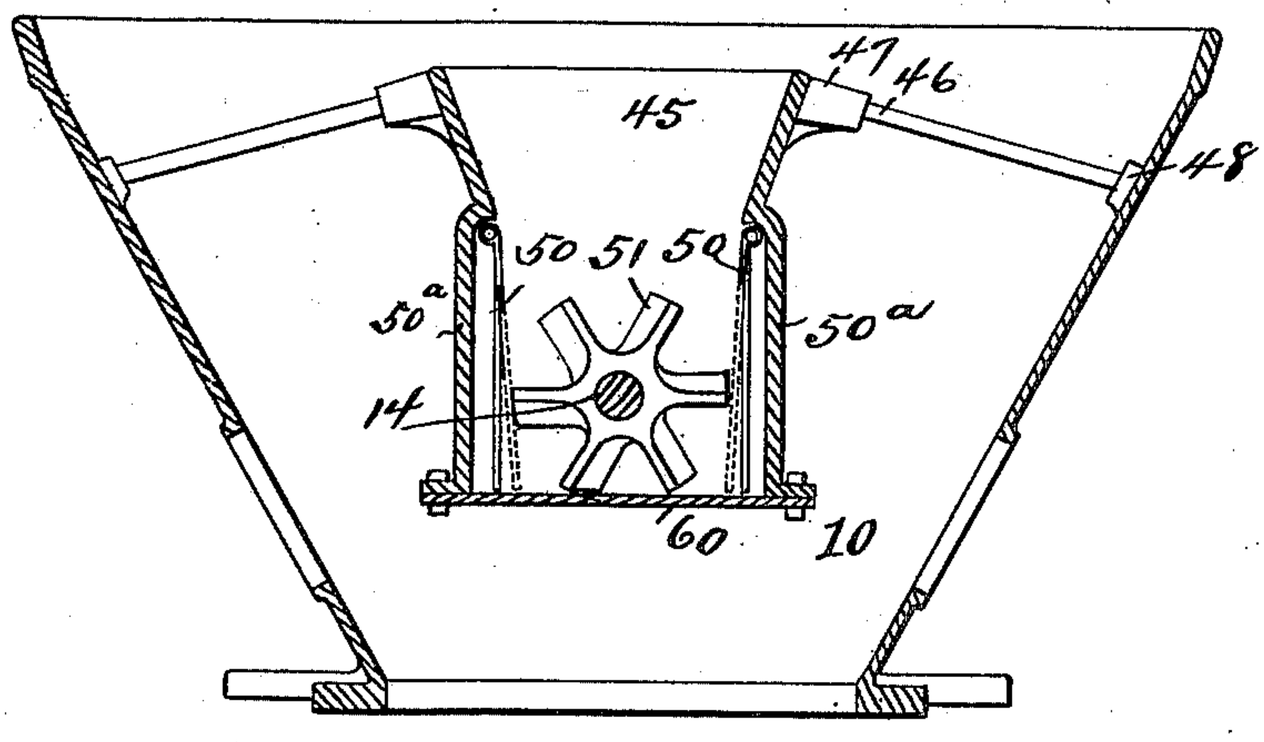


Fig. 8.



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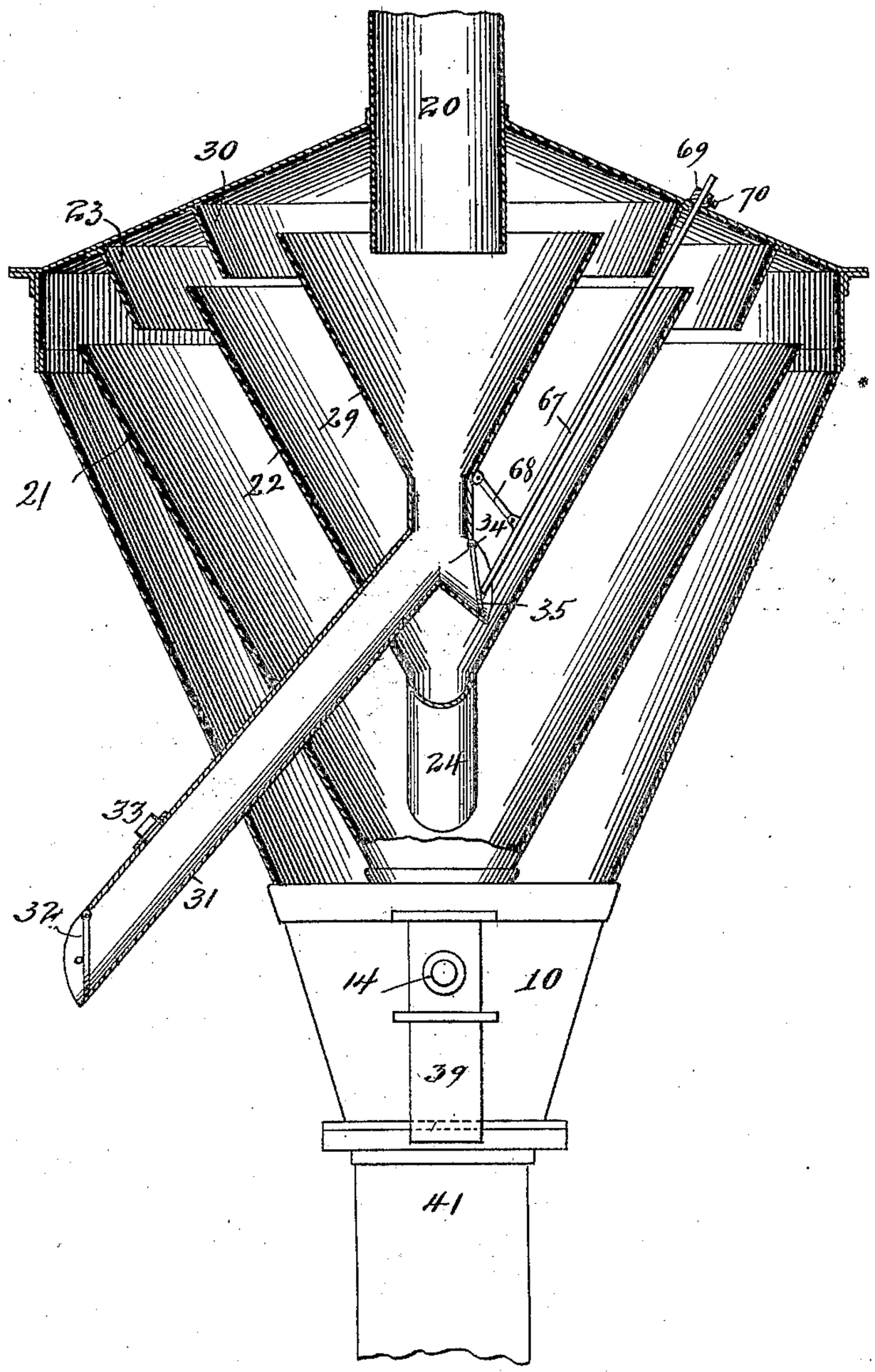
(No Model.) 6 Sheets—Sheet 5.

Fig. 9.



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(Application filed Feb. 5, 1898.)

(No Model.) 6 Sheets—Sheet 6.

Fig. 10.

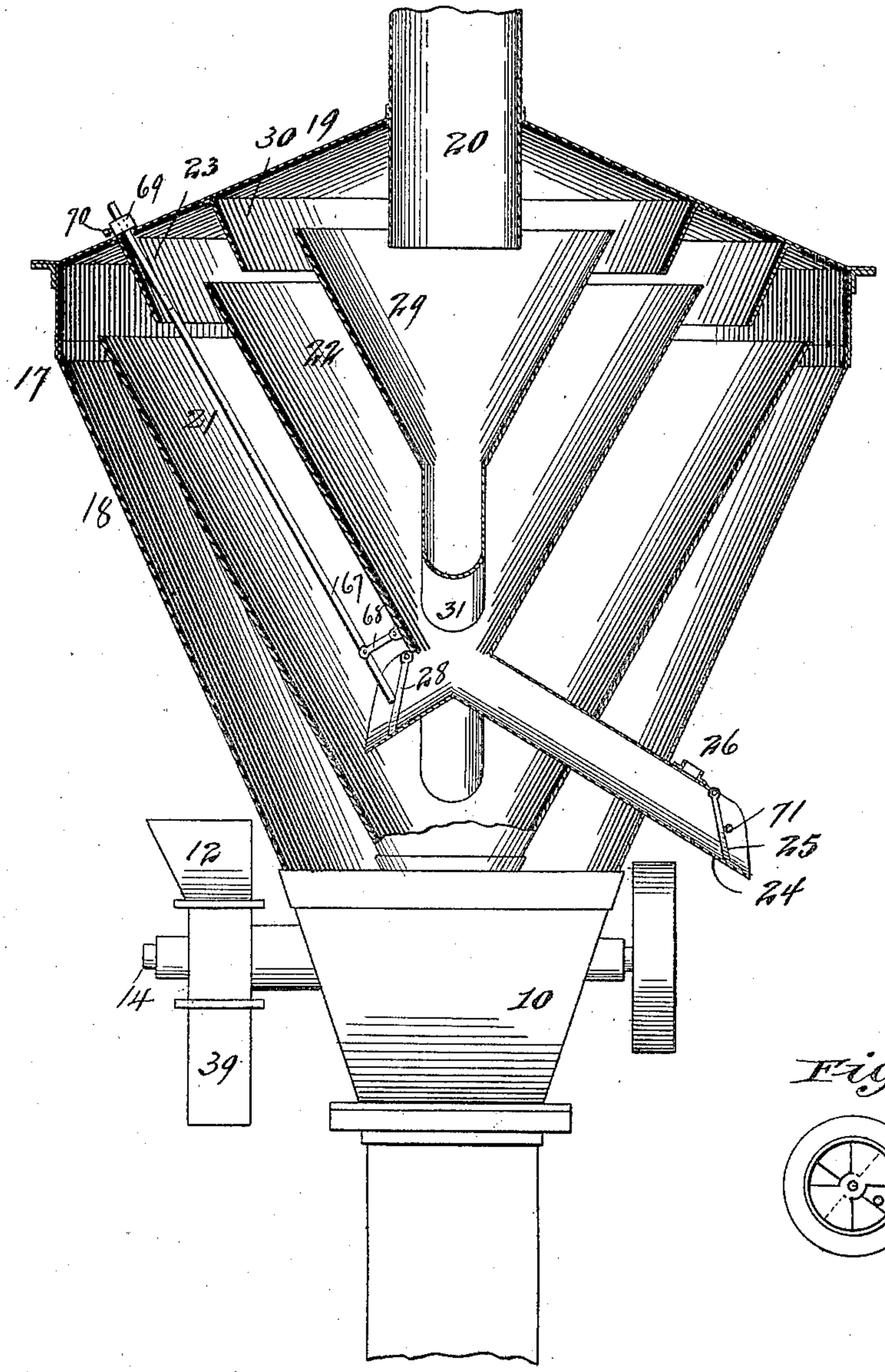

Fig. 11.

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UNITED STATES PATENT OFFICE.

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PNEUMATIC SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 688,810, dated December 10, 1901.

Application filed February 5, 1898. Serial No. 669,192. (No model.)

To all whom it may concern:

Be it known that I, ALBERT RAYMOND, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Pneumatic Separators, of which the following is a specification.

This invention relates to pneumatic separators of that class in which the material to be separated is carried by an air-current and the separation is effected by gravity.

The present invention has for its object, among other things, to provide a separator of this class wherein a multiple separation or grading of the material may be effectually obtained, although the construction is such that the machine may be readily adapted for use in the treatment of materials when it is desired to separate therefrom one grade only thereof and that the lightest.

To this end the present invention consists in certain novel features, which I will now proceed to describe and will then particularly point out in the claims.

In the accompanying drawings, Figure 1 is a front elevation, partly in section, of an apparatus embodying my invention in one form, the same being shown in connection with an elevator for supplying the material thereto. Fig. 2 is a side elevation of the same, the elevator being omitted. Fig. 3 is a transverse vertical sectional detail view, on an enlarged scale, through the hopper shown in Figs. 1 and 2, taken on the line 3 3 of Fig. 2. Fig. 4 is a similar view taken in a plane at right angles to Fig. 3 on the line 4 4 of Fig. 1, the casing of the hopper being shown in section and parts of the inclosed structure being removed. Fig. 5 is a detail view, partly in front elevation and partly in section, illustrating a modified form of construction. Fig. 6 is a similar view illustrating a further modification. Fig. 7 is a view similar to Fig. 3, illustrating a modification of the portion of the structure therein shown. Fig. 8 is a view similar to Fig. 4 of the construction shown in Fig. 7. Fig. 9 is an enlarged transverse sectional view of the separator proper, taken on the line 4 4 of Fig. 1. Fig. 10 is a similar view taken in a plane at right angles to the plane of section of Fig. 9 or on the line 3 3 of Fig. 2, and Fig. 11 is a detail view of one of the air-valves.

Referring first to the form of construction shown in Figs. 1 to 4 of said drawings, 10 indicates the main hopper of the apparatus, into which the material to be operated upon is fed through a cylindrical feeding-spout 11 from a receiving-hopper 12, which latter may be supplied by means of a suitable elevator 13 in case the location of the machine is such as to require the employment of an elevator. 14 indicates a shaft extending transversely through the hopper provided externally thereof with a driving-pulley 15, by means of which power may be supplied to the shaft 14 from any suitable source, and being also provided within the feeding spout or conduit 11 with a spiral feeding-screw or conveyer 16. This conveyer is comparatively short, occupying only the outer end of the feeding-conduit adjacent to the inlet thereof and leaving free the discharge end of said conduit, which is extended some little distance within the hopper. Above the hopper 10, its lower end communicating with the upper end of said hopper, is the separator proper, 17, or main portion of the separator, comprising an external shell or body 18, conical in shape and having its open lower end communicating with the upper end of the hopper 10. In the construction shown in Figs. 1 to 4 of the drawings this communication is direct or immediate. The shell 18 is provided at its top with a cover 19, also preferably conical in shape, although of very slight inclination, and receives at its central point a discharge-pipe 20, which, as shown in dotted lines in Figs. 1 and 2, extends some little distance downward into the shell or body 18.

Within the shell or body 18 are located a plurality of cones arranged concentrically to each other with their apexes downward. In the present instance I have shown three of these internal cones, although the number may obviously be varied. The outer cone 21 nearest to the shell or casing 18 extends downward into the hopper 10, wherein its discharge-mouth is located, the same being provided

with controlling mechanism hereinafter described.

22 indicates the second internal cone, the upper edge of which is located above the upper edge of the cone 21, while the shell or casing 18 or the cover 19 thereof is provided with an annular baffle-plate 23, similar in inclination to and extending downward between the upper edges of the cones 21 and 22. The cone 22 is provided at its lower or discharge end with a discharge-spout 24, extending to the exterior of the shell or casing 18, and provided with a terminal valve 25 to control the discharge of the material, and with an air-valve 26. The cone 22 is also provided at its lower end with a second discharge-spout 27, opening into the space between said cone 22 and the cone 21, and this second discharge-spout is provided with a controlling-valve 28, which may be operated in any suitable manner from the exterior of the shell or casing 18.

29 indicates a third internal cone located within the cone 22 with its upper edge above the upper edge thereof, and the shell or casing 18 or its cover 19 is provided with an annular baffle-plate 30, extending downward between the upper edges of the cones 22 and 29 and having, preferably, an inclination similar to that of said cone. The cone 29 is provided at its lower end with a discharge-spout 31, which extends to the exterior of the shell or casing 18 and is provided with a terminal valve 32, controlling the discharge of the material, and with an air-controlling valve 33. Said cone 29 is further provided with a second discharge-valve 34, opening into the space between the cones 22 and 29, and provided with a controlling-valve 35, which may be operated from the exterior of the shell or casing 18.

The discharge-pipe 20 has its lower end extended some distance downward into the interior of the shell or body 18, such extension being sufficient to carry the lower end of said pipe within said casing below the upper edge of the cone 29, as indicated in Fig. 1 and shown in dotted lines in Fig. 2. The other end of said pipe is connected to the inlet or eye of an exhaust-fan 36, and the discharge of said fan is connected, by means of a pipe 37, with a dust-collector 38, which is preferably a centrifugal separator of any approved type. The dust-collector is provided with a valved discharge-pipe 39 for the separated material.

40 represents a return-pipe by which the air is conducted from the collector 38 to the discharge-trunk 41 of the hopper 10. This trunk extends downward from the open lower end of the hopper, its lower portion being inclined, as shown, and provided with a controlling-valve 42 and with a plurality of deflecting-plates 43 to deflect the current of air from the return-pipe 40 and prevent its affecting the lower portion of the discharge-trunk and the material therein. The pipe 40 is provided with an opening 44, which serves to relieve the system from surplus air and which may be connected with a closed separating-chamber, so as to trap any dust which is not separated or caught in the collector 38.

In Figs. 3 and 4 I have shown a construction which I have devised for preventing the currents of air from entering the cone 21 at its lower end, and thereby affecting the separation, while at the same time the material is permitted to pass freely from said cone into the hopper 10. In the construction shown this structure comprises a casting 45, which is joined to and forms a part of the mouth of the cone, it being supported within the hopper by means of rods 46, the inner ends of which may be inserted in suitable sockets 47 in the casting 45, while their outer ends rest in notched seats 48, provided on the inner face of the hopper. To the sides of the casting 45 and extending downwardly therefrom are secured parallel plates 49, and to the front and rear of said casting are hinged plates 50. The shaft 14 passes through the plates 49 and between the plates 50 and has mounted on it in the space inclosed between said four plates a grooved or fluted feed-roller 51. The outward movement of the hinged or pivoted plates 50 is limited by transverse bolts 52, and there is secured on said bolts, being clamped between sleeves 53 thereon, a deflecting-plate 54, which extends in a downwardly-inclined direction toward that side of the hopper 10 opposite to that at which the material is fed into said hopper through the conduit 11.

The operation of the machine as thus constructed is as follows when the machine is being employed as a separator and grader for the purpose of separating material into a plurality of grades of different fineness: The operation of the exhaust-fan 36 produces an upward current of air through the hopper 10 and separator proper, 17, the current passing through the pipe 37, dust-collector 38, and return-pipe 40 and thence upward through the discharge-trunk 41 to the hopper 10, thus effecting a continuous circulation of the current. The material which is fed into the receiving-hopper 12, either by the elevator 13 or in any other suitable manner, is fed forward by the screw conveyer 16 on the shaft 14, and since this conveyer terminates short of the inner end of the conduit 11 the material will fill that end of said conduit and will pack therein, and thereby cut off connection between the hopper and the external air. As the material is discharged into the hopper 10 it encounters the upward current of air, and while the heavier portions of said material may fall directly into the discharge-trunk 41 the remainder is carried upward into the space between the shell or body 18 and the cone 21. This space expands upward, owing to the increase in diameter of the cones and the consequent increase in horizontal area of the space between them, so that the carrying power of the air-current gradually diminishes

and only the finer particles are carried up over the upper end of the cone 21. The larger and heavier portions of the material are carried back into the hopper. The finer material as it passes successively under the deflecting-plates 23 and 30 and under the lower end of the pipe 20 and over the edges of the cones 21, 22, and 29 is successively deflected from its course at the mouth of each cone, the lower end of the pipe 20 serving as a deflector for the uppermost cone 29, and a portion of the material carried by the current is deposited in each one of these cones, the heaviest material being deposited in the space between the cones 21 and 22, the intermediate grade between the cones 22 and 29, and the lightest material within the cone 29. The finest material, which is too fine to be detained in the separator proper, is carried through the pipe 20, exhaust-fan 36, and pipe 37 to the dust-collector 38, where it is deposited, the purified air returning through the pipe 40 to the discharge-trunk 41 and hopper 10. The tailings or heavier particles descend through the trunk 41 and are discharged through the gates or valves 42 thereof. The material accumulating in the cones 29 and 22 may be separately withdrawn therefrom through their respective spouts 31 and 24, while the material which accumulates in the cone 21 is fed downward through the mouth of said cone by reason of the rotation of the feed-roller 51 and is again discharged into the hopper 10 in order to be again subjected to the blast for the purpose of removing the finer particles. This is done for the reason that the larger particles accumulating in the cone 21 retain along with them smaller and finer particles, which may be separated out by being again subjected to the action of the blast. I have found in practice that the suction of the current suffices to draw the hinged plates 50 inward, so as to keep them in contact with the blades of the feed-wheel 51, and by reason of this construction the blast is prevented from entering the cone 21 from below, and thereby affecting the separation by disturbing the action of the air-current in the separator proper, while the hinging of the plates permits them to swing outward to allow the passage between them and the feed-wheel of the material being fed downward by this latter. The deflecting-plate 54 serves to distribute the material more equally at the mouth of the hopper 10, where it first encounters the blast, and since a portion of the material returning from the cone 21 is in this way deflected to that side of the hopper farthest from the feed-conduit 11 the distribution of material is thus equalized.

In case it is desired to make but a single separation, or, in other words, to separate out only the fine dust without grading the remaining material, the valves 35 and 28 are opened and the valves 32 and 25 closed, whereupon the material which gathers in the upper and intermediate cones 29 and 22 is discharged into the cone 21 and thence returned to the hopper.

The air-valves 26 and 33 may be of any approved construction—as, for instance, the ordinary damper form shown in detail in Fig. 11 of the drawings. By means of these valves I am enabled to insure superior uniformity in the product delivered from each of the cones and delivery-chutes. As heretofore pointed out, the heavier particles sometimes retain among themselves finer and lighter particles, and when, for instance, the lower portion of the cone 22 and its chute 24 have become filled or partially filled with material by opening the air-valve 26 to a greater or less extent a current of air is admitted into the lower end of the chute, and passing up through the material therein and in the cone serves to withdraw the finer or lighter particles, leaving only the heavier ones, and thus insuring uniformity. The current of air is of course produced by the suction of the blast-fan.

The valves 28 and 35 may be operated in the manner shown in detail in Fig. 10 of the drawings, in which 67 indicates a valve-operating rod, extending downward through a suitable opening in the shell of the separator proper to a point immediately adjacent to the valve and outwardly from the same. The lower end of this rod is supported by a pivoted link 68, while its upper end passes through a fixed collar 69, provided with a set-screw 70, by means of which the rod may be secured in any position to which it may be adjusted. It will be seen that by pressing the rod downward it will bear against the valve and hold the same closed, while by withdrawing the rod upward the valve will be permitted to open by reason of the pressure of the material, and thus permit its discharge.

The outer valves 25 and 32 may be held closed in any suitable manner, as by means of a locking-pin 71 passing through suitable apertures in the walls of the chute outside of the valve, said pins being removable to permit the valves to open under pressure of the weight of the material in the chutes.

In Fig. 5 I have shown a means of obtaining a separation of the tailings or coarser portions of the material which may be employed intermediate the separator proper, 17, and the hopper 10. In this construction there is located between the lower end of the shell or body 18 and the upper end of the hopper, which is contracted, as shown at 10^a, a separating-chamber 55, consisting of two frusto-conical portions 55^a and 55^b, joined together by their larger portions and having located in the upper portion or throat of the chamber thus formed a deflector 56 having a body the shape of which is that of two cones joined by their bases. Below this deflector is located in the wider portion of the chamber 55 a receiving cone or hopper 57, provided with a valved discharge-spout 58. A portion of the tailings intermediate between the heavier

particles and those carried by the current into the separator proper will be collected in the chamber 55 and may be withdrawn from the cone or hopper 57 through the spout 58. When this intermediate separating device is employed, however, it will be understood, of course, that the cone 21 does not return its material to the hopper 10, as in the construction shown in Figs. 1 to 4, but is provided with a separate valved discharge-spout 21ª, so that an additional grading of the material may be had. Of course in this case the casting 45 and feed-roller 51, with its inclosing plates, are dispensed with.

A separating-chamber 59, similar to the chamber 55 just described, may be employed in the discharge-trunk 41 below the hopper 10, or, as shown in Fig. 6, two of these separating-chambers 59 may be located one below the other in said trunk. These separating-chambers, however, when located below the hopper do not effect a grading of the tailings, but merely serve to subdivide the tailings and present them more effectually to the action of the blast, the material drawn from the several chambers 59 being substantially the same.

In Figs. 7 and 8 I have shown a modification of the construction shown in Figs. 3 and 4, whereby the apparatus is adapted to either return the material from the cone 21 to the hopper 10 or discharge it separately, as desired. In this construction the lower mouth of the space between the plates inclosing the feed-roller 51 may be closed by a detachable plate 60, and there extends laterally outward from the space thus inclosed a discharge pipe or conduit 61, inclosing the shaft 14, on which is mounted a spiral conveyer 62. This spiral conveyer is secured on a sleeve 63, which may be rigidly connected to the shaft 14 by means of a set-screw 64 or in any other suitable manner, so as to cause said conveyer to rotate along with the said shaft. The conduit 61 is provided with a suitably-valved discharge-pipe 65. The sleeve 63 may be disconnected from the shaft 14 and may be locked to prevent rotation by any suitable means—such, for instance, as a set-screw 66, passing through a fixed portion of the machine. When the set-screw 64 is loosened and the set-screw 66 tightened, the plate 60 being removed, the material from the cone 21 will be fed back into the hopper 10 in the manner already described. When, however, the set-screw 66 is loosened, the set-screw 64 tightened, and the plate 60 secured in place, the material from the cone 21 is fed outward by the conveyer 62 and discharged through the spout 65.

It should be noted that in addition to the hinged plates 50 permanent side plates 50ª are secured to or form a part of the casting 45 in order to form a rigid casing for the feed-roller 51 when the bottom plate 60 is in use. When this plate is in position and the material is being fed laterally outward, the hinged side plates 50 are inoperative and assume the position shown in full lines in Fig. 8. When, however, the plate 60 is removed and the material is being returned to the hopper 10, the plates 50 assume the positions shown in dotted lines in Fig. 8.

The apparatus is more particularly devised for use in the separation of pulverized ores, especially those of the precious metals; but it is obviously capable of being applied to the separation of pulverized materials generally and is adapted for wide application.

I do not wish to be understood as limiting myself to the precise details of construction hereinbefore set forth, as it is obvious that various modifications in the construction shown and described may be made without departing from the principle of my invention.

I claim—

1. A pneumatic separator, comprising an outer conical shell having a closed head, an opening in its lower contracted portion into which the material to be separated is delivered, and an air-supply opening below said delivery-point, a plurality of internal cones concentrically arranged within each other in an ascending series, open at their tops and having separate discharge-spouts at their lower contracted ends, deflectors extending downward from the head between said cones, a central discharge-pipe extending downward through the head below the upper edge of the uppermost cone, and a fan adapted to cause a current of air to pass through said separator, substantially as described.

2. A pneumatic separator, comprising an outer conical shell having a closed head, an opening in its lower contracted portion into which the material to be separated is delivered, and an air-supply opening below said delivery-point, a plurality of internal cones concentrically arranged within each other in an ascending series, open at their tops and having separate discharge-spouts at their lower contracted ends, deflectors extending downward from the head between said cones, a central discharge-pipe extending downward through the head below the upper edge of the uppermost cone, an exhaust-fan connected to said discharge-pipe, and a dust-collector into which the exhaust-fan discharges, substantially as described.

3. A pneumatic separator, comprising an outer conical shell having a closed head, an opening in its lower contracted portion into which the material to be separated is delivered, and an air-supply opening below said delivery-point, a plurality of internal cones concentrically arranged within each other in an ascending series, open at their tops and having separate discharge-spouts at their lower contracted ends, deflectors extending downward from the head between said cones, a central discharge-pipe extending downward through the head below the upper edge of the uppermost cone, an exhaust-fan connected to said discharge-pipe, a dust-collector into

which the exhaust-fan discharges, and a return-pipe for returning the air-current from the dust-collector back to the separator at its air-supply opening, substantially as described.

4. In a pneumatic separator, a separator proper, comprising an outer conical shell having a closed head, an inlet-opening at its lower contracted end and an outlet-opening at its upper end, a plurality of concentric cones arranged in an ascending series within said shell, and deflectors extending downward from the head between said cones, said cones being provided with valved delivery-spouts whereby each cone may be separately discharged externally of the casing, or the several cones may be discharged through the series to the inlet-point, and means for causing a current of air to pass upward through said separator, substantially as described.

5. In a pneumatic separator, the combination, with an external conical shell or casing having a closed head, an inlet-opening at its contracted lower end and a discharge-opening, of an internal cone concentric with said shell, open at its upper end and having a discharge-opening at its lower end, a grooved or fluted revoluble feed-roller located in the throat of said discharge-opening, hinged plates located laterally of said feed-roller, and an exhaust-fan connected to the discharge of the separator, whereby said hinged plates are held in contact with said feed-roller to prevent the air-current from entering the discharge end of the internal cone, substantially as described.

6. In a pneumatic separator of the character described, the combination, with the external conical body or casing of the separator proper, and an internal cone concentric therewith and adjacent thereto, and having a discharge-opening at its lower end, of a grooved or fluted feed-roller within the throat of said discharge-opening, lateral hinged plates adjacent to said feed-roller, means for closing the mouth of said discharge-opening, and a lateral conduit provided with a conveyer and external discharge, substantially as described.

7. In a pneumatic separator, the combination, with a separator proper, substantially such as described, of a downwardly-extending tailings-discharge trunk below said separator, having its lower extremity inclining to the vertical and provided with similarly-inclined deflecting plates, an exhaust-fan connected to said separator at its top, a dust-collector connected to the exhaust-fan, and an air-return conduit opening into the discharge-trunk in an upwardly-inclined direction corresponding with that of the lower inclined end thereof, substantially as described.

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