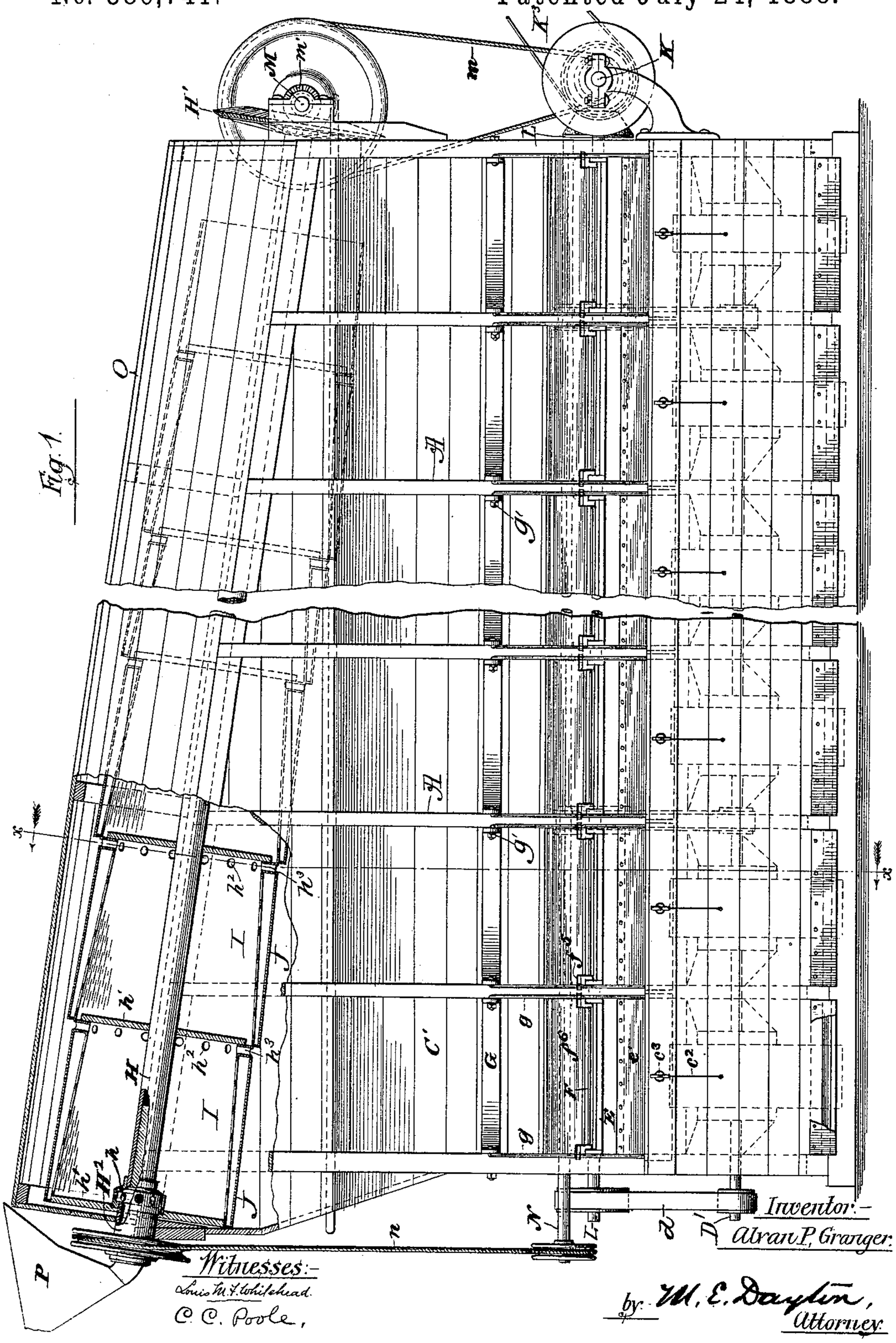
(No Model.) 3 Sheets—Sheet 1.

A. P. GRANGER.

ORE SEPARATOR.

No. 386,741. Patented July 24, 1888.

Fig. 1.



Witnesses:-
Louis M. T. Whitehead.
C. C. Poole,

Inventor:-
Alvan P. Granger:
by: W. E. Dayton,
Attorney.

(No Model.) 3 Sheets—Sheet 2.

A. P. GRANGER.

ORE SEPARATOR.

No. 386,741. Patented July 24, 1888.

Fig. 4.

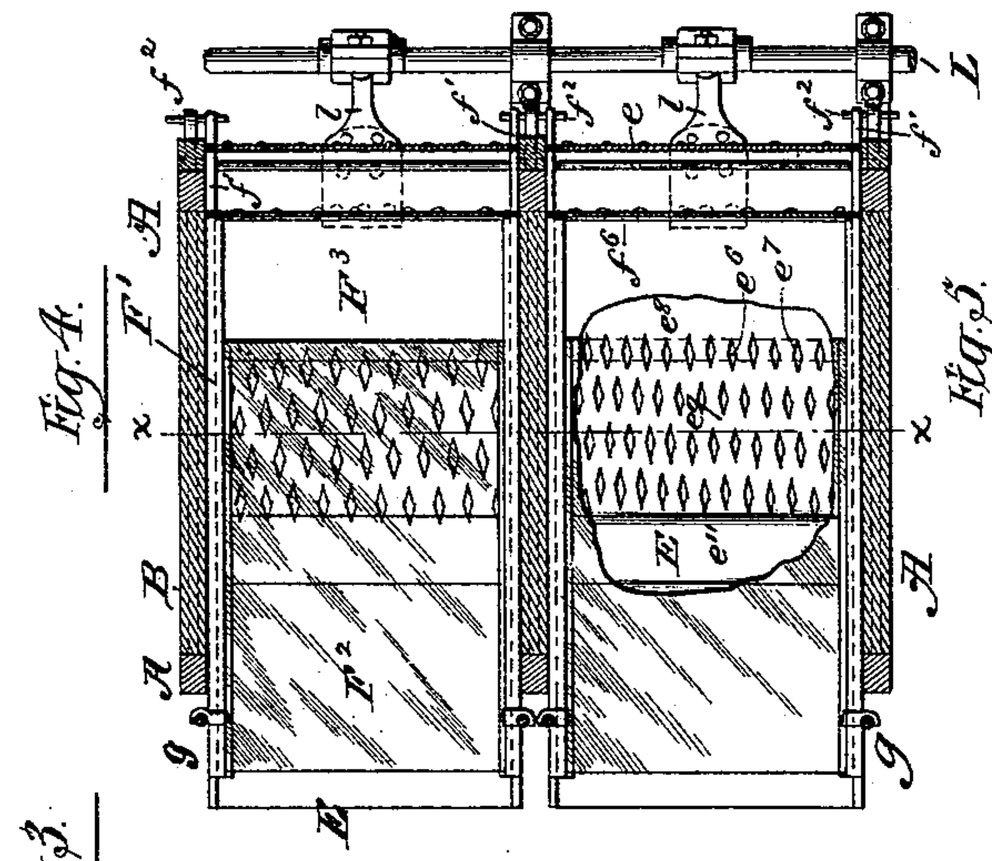


Fig. 5.

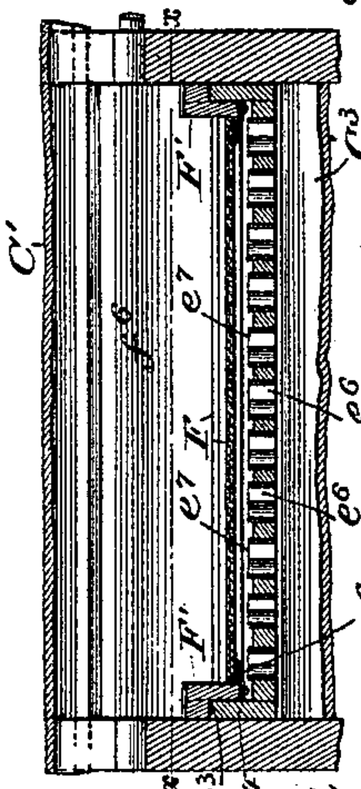


Fig. 6.

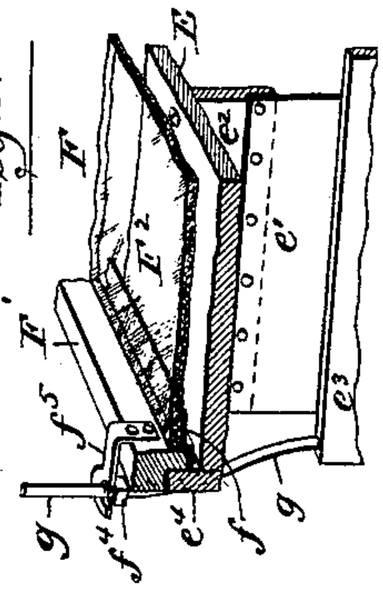


Fig. 3.

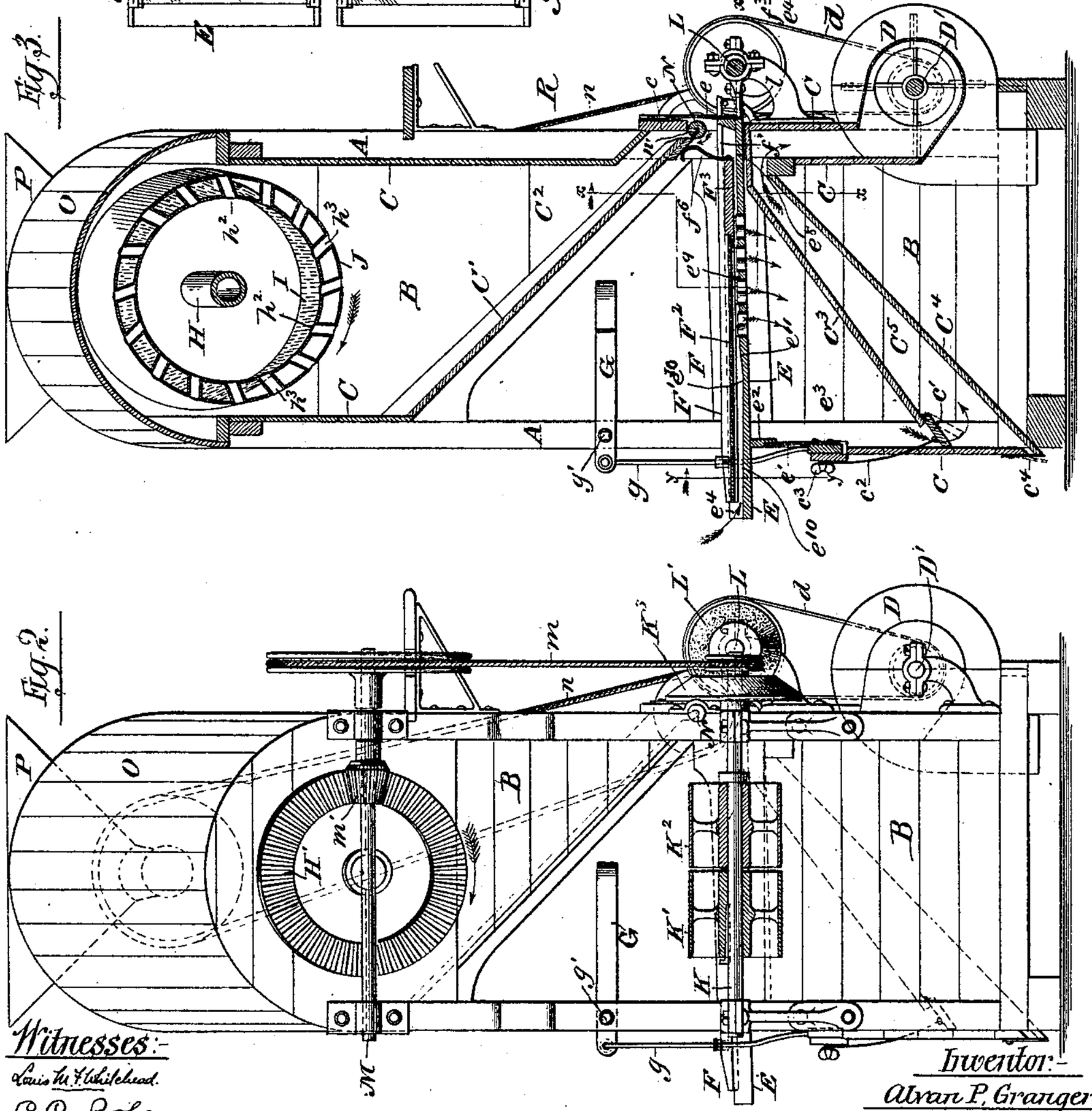


Fig. 2.

Witnesses:-
Louis M. Whitehead.
C. C. Poole

Inventor:-
Abram P. Granger.
by:- W. E. Dayton
Attorney.

(No Model.) 3 Sheets—Sheet 3.

A. P. GRANGER.

ORE SEPARATOR.

No. 386,741. Patented July 24, 1888.

Fig. 7.

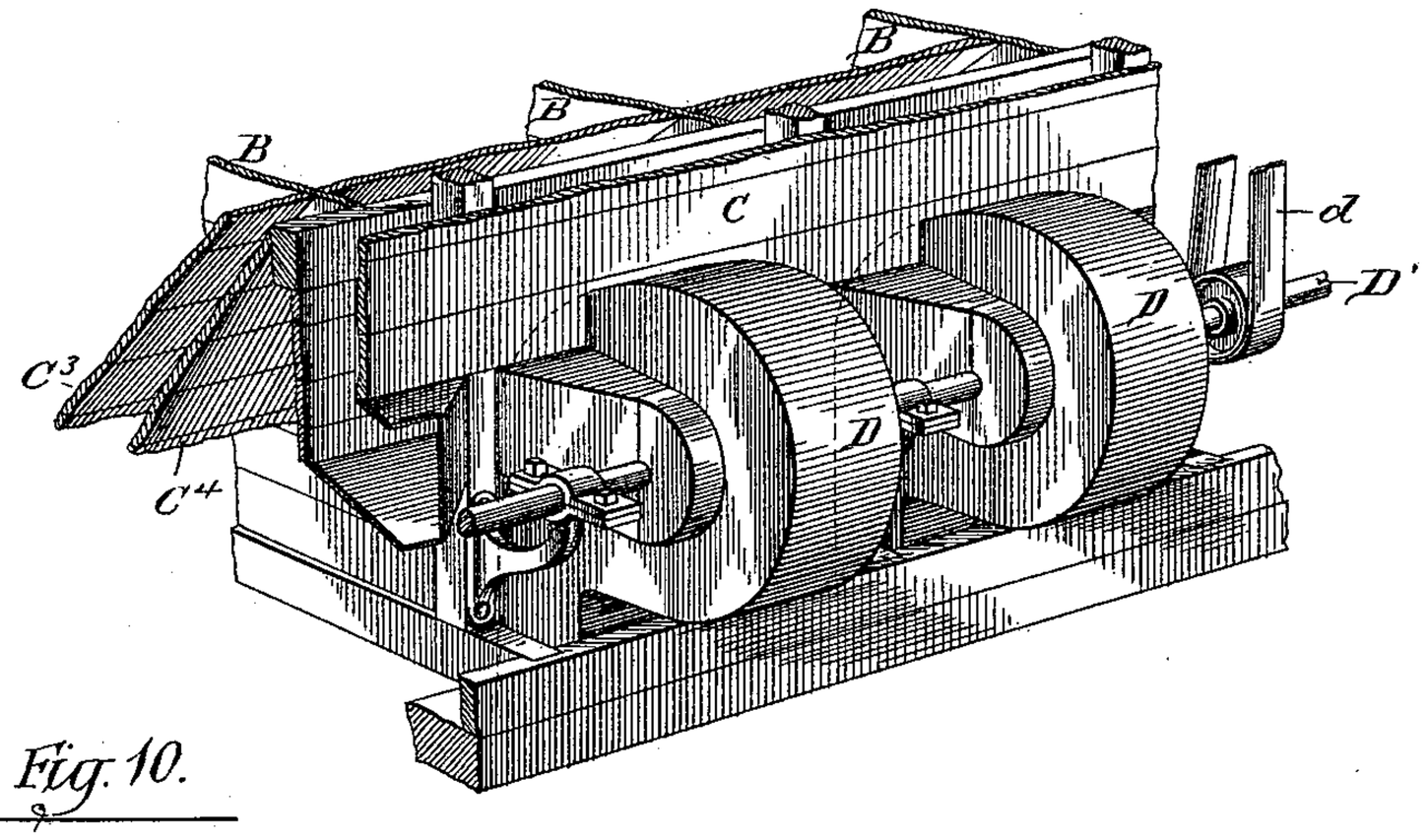


Fig. 10.

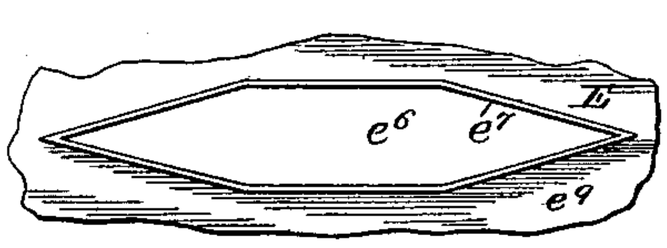


Fig. 8.

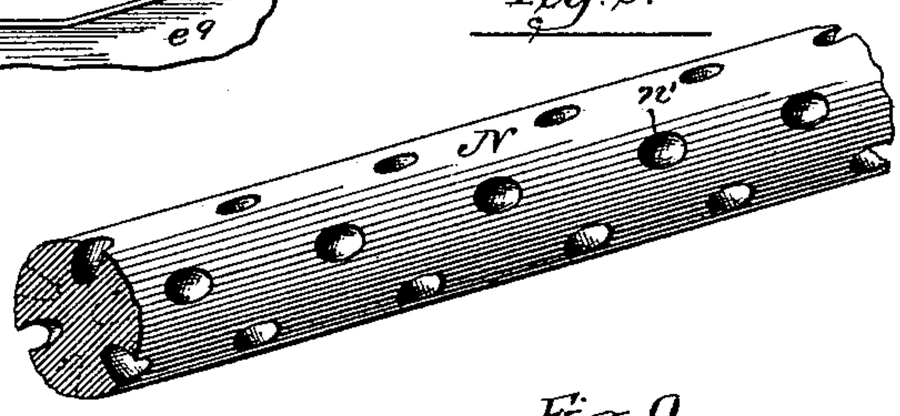
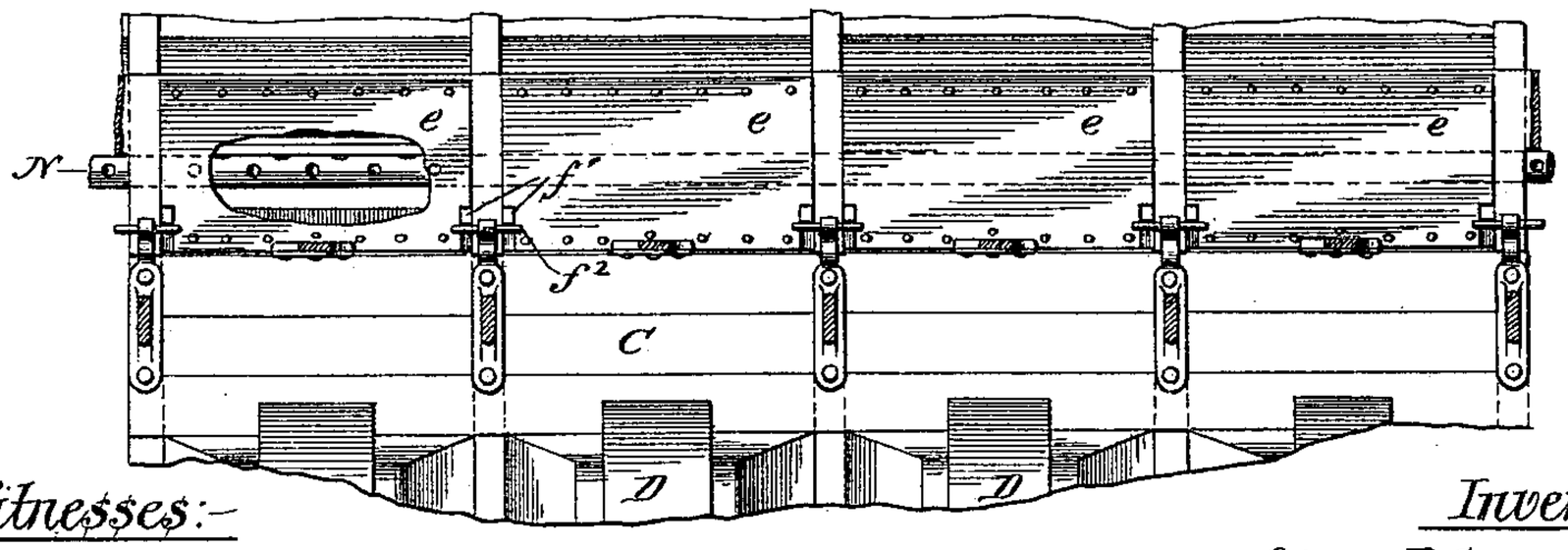


Fig. 9.



Witnesses:-

Louis W. Whitehead.

C. C. Poole

Inventor.

Alvan P. Granger.

by:- M. E. Dayton

Attorney:-

UNITED STATES PATENT OFFICE.

ALVAN P. GRANGER, OF DENVER, COLORADO, ASSIGNOR OF ONE-HALF TO CHARLES L. AMES AND ABEL H. FROST, OF CHICAGO, ILLINOIS.

ORE-SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 386,741, dated July 24, 1888.

Application filed March 2, 1886. Serial No. 193,715. (No model.)

To all whom it may concern:

Be it known that I, ALVAN P. GRANGER, of Denver, in the county of Arapahoe and State of Colorado, have invented certain new and useful Improvements in Ore-Separators; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to pneumatic ore-separators; and it has among its objects to provide means in such a machine for feeding the ore upon the precipitator or into the separating-chamber, which will not permit the air to pass with the ore at the point of its entrance to said separating-chamber.

Still another object is to provide an improved construction and action on the part of the precipitator upon which the ore is spread and agitated and through holes in which the gangue is drawn by an air-current.

Another object has reference to the better and more convenient inspection and control of the action of the air-current upon the ore on the precipitator.

To these and other ends, which will hereinafter more fully appear, the invention consists in the matters hereinafter set forth, and pointed out in the appended claims.

In the accompanying drawings, illustrating one practical and desirable form of my invention, Figure 1 is a front side elevation of a serial dry-ore separator adapted for grading the ore and concentrating the several grades separately, parts being broken away for better illustration of the construction. Fig. 2 is an end view, partly in section, of the machine looking toward the left of Fig. 1. Fig. 3 is a transverse vertical section on the line *x x* of Fig. 1. Fig. 4 is a fragmentary horizontal section taken above the dressing-plate and eccentric-shaft or on the line *x x* of Fig. 5. Fig. 5 is a vertical section of a single division of the machine taken in the indirect line *x x* of Fig. 3. Fig. 6 is a fragmentary detail, of which the front section is in the line *y y* of Fig. 3. Fig. 7 is a fragmentary perspective rear view, showing the connection of the suction-fans with the housing. Fig. 8 is a broken part of the feed-roller, showing a practicable arrangement of recesses therein. Fig. 9 is a fragmentary rear elevation, broken away to reveal the recessed feed-roll in place and showing other details of construction. Fig. 10 is a plan view of one form of the curbed opening of the precipitator, enlarged.

A A are frame uprights.

B B are transverse partitions.

C C are vertical walls or housings attached to the frame.

C′ is an inclined board, forming the bottom of a hopper, C^2, from which the ore is delivered to the concentrating devices.

C^3 is an inclined board upon which falls the gangue from the concentrating devices.

C^4 is another inclined board beneath the board C^3, and forming with the latter an inclined air-passage, C^5, which is downwardly prolonged from its upper end into communication with the suction-fan D.

E is a nearly horizontal precipitator placed between the hopper C^2 and the cant-board C^3.

F is a "dressing" plate placed over the precipitator.

G is a yoke-formed lever pivoted to the frame uprights for regulating the vertical position of the foot of the precipitator.

H is an inclined rotating shaft, on which are secured a succession of ore-grading tubular screens.

I I are the several screens.

J J are imperforate shells surrounding the screens.

K is the drive-shaft, located across the foot of the machine, and provided with fast and loose pulleys K′ K^2 and beveled friction-wheel K^3, which engages with the similar wheel, L′, on the longitudinal eccentric shaft L.

M is a horizontal shaft, mounted across the foot of the machine for rotating the screen, for which purpose it is driven by a belt, *m*, from the shaft K, and is provided with a pinion, *m′*, which meshes with the wheel H′ on the shaft H.

N is a feed shaft or roll, driven by a belt, *n*, from the screen-shaft H at the head of the machine. The fans D—one for each compartment or division of the machine—are mounted on a longitudinal shaft, D′, and are driven by

a belt or belts, *d*, from the eccentric-shaft L. Over the inclined series of screens I I is a housing, O, and at the head of the series of screens is a feed-hopper, P, which delivers into the first screen of the series through a hollow trunnion, H^2, on the end of the screen-shaft, which trunnion has lateral openings *h* within the said first screen of the series.

The illustrated rotary serial-screen mechanism for sizing the ore is constructed to deliver the coarser size of ore at the head of the machine and the smaller sizes successively toward the foot of the machine. This arrangement is desirable, as favorably affecting the durability of the sizing mechanism and also as affecting advantageously the power required to run the machine. This sizing mechanism consists of a series of conical screens, I I, mounted on the same inclined shaft H, and having their larger ends toward the head of the machine. They are made of slotted metal, held concentric with the shaft H by circular end boards, *h'*. These boards *h'* close the lower ends of the several screens I, preventing the passage of material over their tails. External to each screen I, and concentric therewith, is secured, in any suitable way, an imperforate tubular metal shell, J, which is arranged at its foot to discharge directly into the next screen I of the series past the margin of the adjacent board *h'*. At the foot of each screen I the latter is provided with a series of lateral openings, h^2, from which lead tubes h^3, through the shell J, in position to discharge the contents of the screen, from which they lead, into the subjacent hopper C^2. The material, which passes through the slots (or other form of screening-passages) in the screen, falls upon the surrounding shells J, and passes on from said shell, between the tubes h^3, into the next screen I, the foot of each shell J being, as shown in Fig. 1, arranged in line with the head of the next screen. Properly speaking, therefore, the material which rides over the screen, instead of that which passes through it, is that part of the ore which each screen delivers into the hopper below. Several advantages result from this construction, among which may be mentioned that the screens which are nearest the head of the machine, and have, therefore, the heavier load to carry, and are exposed to the more severe wear, may be of heavier metal, which, however, cannot be so finely perforated as lighter metal, but which can be properly perforated coarsely for the operation above described.

No screen is present in the last compartment of the machine; but the shell J about the next preceding screen is prolonged to deliver into said last compartment or hopper. This feature is sufficiently indicated by dotted lines in Fig. 1.

Any other form of sizing mechanism, or mechanism for delivering to the several compartments of the machine, may be employed in place of the sizing-screens above described.

The hopper-bottom board C' declines from the front to the back of the machine, and the frame is open beneath said bottom board, as shown in Figs. 2 and 3. The converging walls of the hopper C^2, in each division of the serial machine, are only proximate, as shown in Fig. 3, and along the delivery-opening thus formed is arranged a suitable means for permitting a regular passage of ore downwardly without allowing a current of air to be created through the same passage by the action of the fans. (To be hereinafter described.) In the present instance such means is shown to consist of a continuous rotating feed-roll, N, which makes a close joint with both the edge of the board C' and the terminal bar or cleat *c* of the outer housing, C. To effect the feeding from the hopper by this roller, the latter is made, say, one and one-half inches, more or less, in diameter, and is peripherally recessed—as by holes *n'* bored radially therein, into which the ore drops from the hopper and which discharge successively as the roll is rotated on its axis.

Beneath the feed-roller N is located the head of a precipitator, E. To facilitate the rapid reciprocation or vibration of this precipitator, in a direction from front to rear of the machine, and at the same time to practically cut off the admission of air at this point, the head of the precipitator is shown suspended from the cleat *c* by a sheet of metal, *e*, external to the feed-roll N, so that the material delivered by the latter falls on the head of said precipitator. At its foot the precipitator is supported by a similar sheet of metal, *e'*, fastened at its upper edge to a transverse cleat, e^2, on the under side of the precipitator, and at its lower edge to a cleat or bar, e^3. Said bar e^3 is in length only equal to the width of one division of the machine and is vertically movable to afford vertical adjustment of the foot of the precipitator. This adjustment is effected at will by means of two connected levers, G—one for each side of the precipitator—pivoted to the proximate faces of the adjacent frame-uprights A, the levers being connected in order that both of them shall move in harmony and hold the movable end of the precipitator level transversely.

As an additional improvement, the levers G are made of a single piece of flat bar-iron bent to horseshoe form, and having their curved connection directed inwardly beneath the hopper C^2, so as to be out of the way of disturbance when once set, as well as in favorable position for manipulation when required to be moved. Incidentally the levers in this position may balance the precipitator; but they are held sufficiently by the threaded bolts *g'*, which form their pivots. The free ends of the levers G connect by vertical rods *g* with opposite ends of the bar e^3 and rise past the edges of the precipitator, as seen in Figs. 2, 4, and 6, so that the latter can be freely vibrated between them.

The construction of the precipitator, as here shown, and as particularly claimed as a dis-

tinct improvement, will be hereinafter described. For the purposes of these claims herein made, which do not specify the distinctly novel form of the precipitator, it is to be understood that said claims are not restricted to that form.

Over each precipitator is placed a plate, F, here called a "dressing" plate, because it is concerned in controlling the air-current by which the dressing of the ore is performed on the subjacent precipitator. This plate may be of any suitable material; but, as a separate improvement, it may consist, in part, at least, of glass, in order to afford a view of the material upon the precipitator. As here shown, it is partly of glass and partly of wood.

F' F' are opposite side bars supporting a glass portion, F^2, of the dressing-plate by means of sheet-metal strips *f*, Figs. 5 and 6, and F^3 is a wooden part of the plate at its rear margin, which connects the opposite side bars, F'. At their rear ends the side bars, F', are prolonged in their upper portions, as seen at *f'*, Figs. 3 and 4, and these prolonged ends rest on pins or other suitable supports, f^2, near the point of suspension of the precipitator beneath the plate F, in order that in the adjustment of these parts at their opposite ends their movements may be made from practically coincident centers of motion. Both the precipitator and the superposed dressing-plate are retained laterally in place by the frame-uprights and partitions B, the lateral space between which they loosely fill.

The precipitator is, however, provided with side cleats, e^4, which form marginal walls therefor and which rise into rabbets f^3 in the outer and under faces of the bars F', as more clearly seen in Figs. 5 and 6. The front ends of each plate F are severally adjustable vertically, either with the subjacent precipitators or independently of the latter, by means of screw-threaded nuts f^4, Fig. 6, on the rods *g* and brackets f^5, attached to the side bars, F', and resting on the nuts f^4. These brackets are preferably slotted or otherwise arranged to bear on the rear faces of the rods *g*, in order to prevent forward movement of the plates F. At their rear ends said plates F have attached to them vertical spring-plates f^6, of sheet metal, the upper edges of which bear against the bottom board, C', of the hopper C^2 in front of the feed-roller N, so as to close off the ingress of air at this point.

From a point closely adjacent to the under surface of the head of each precipitator E the board C^3 declines forwardly, reaching from one partition-wall, B, to the opposite one, and at its lower edge said board is provided with a hinged flap-valve, *c'*, extending, preferably, entirely across the compartment. This valve *c'* is raised and lowered, to regulate the extent of its opening, by suitable means—as a cord, c^2, which passes out through a hole in the housing, and is wound up on a screw or pin, c^3, to hold the valve in a required position. Each compartment is provided with a separate suction-fan, D, and the fans are shown to be of different capacities or powers, the stronger being located at or near the head of the machine and the weaker toward its foot. The different capacities of the fans are indicated by their differing widths, in dotted lines of Fig. 1. The air-passages C^5, leading to the fans D, accumulate the gangue which falls from the cant-board C^3, until the amount overcomes the suction and forces the flap-valve c^4, in the usual manner of such devices.

Returning to the precipitator E, I remark, first, that said precipitator may, in its details and for the general purposes of my invention, be of different construction from that herein described—as, for example, it may be like that or those shown and described in Letters Patent No. 269,848, granted to me January 2, 1883.

The improved form and construction here shown are substantially as follows: In general the precipitator is a board, E, having a number of holes, e^6, through it, downwardly through which holes the particles of gangue are drawn from the surface of the mass of material on the said board. These particles of gangue are brought to the surface of the ore mass on the board by a rapid reciprocation of the latter, by short strokes, in its own plane. This reciprocation is effected by means of a short-throw eccentric on the shaft L, preferably opposite the middle of each board, and a suitable eccentric-strap or its equivalent, *l*, which communicates the throw of the eccentric to the board E. The holes e^6 are more numerous in the board at the head than in that at the foot of the machine, and their number is graduated in these and the intermediate boards proportionately to the relative force or quantity of air required to accomplish the work of dressing. Each hole e^6 is surrounded by a curb, e^7, which projects a short distance above the surface of the board, and as a further improvement said curbs are oblong and diamond shaped in plan view, as seen in Figs. 4 and 10, to facilitate the passage of the ore about them. The construction adopted as most convenient is to make the holes themselves diamond-shaped and to force two bent plates, e^7, into the holes to form the said curbs and side walls thereof. These apertures e^6 are also desirably arranged in alternation with each other to afford the largest possible room for the passage of the ore between the curbs thereof, as seen in Fig. 4.

In the construction here shown, the board E (say, three feet and six inches or four feet long from head to foot, and twenty to twenty-two inches wide) has a plain, flat, unapertured part, e^8, at its head end extending a distance of, say, twelve inches. The apertured part e^9 comes next, extending, say, twelve or fifteen inches. Next follows an unapertured portion, e^{10}, which has a transverse depression presenting, first, a longitudinal declivity, e^{11}, extending, say, three inches, and dropping the surface of

the board about an eighth or three-sixteenths of an inch at its lowest point. From this lowest point the surface rises longitudinally to about its original plane by an ascent extending, say, fifteen or sixteen inches. The object of the depression mentioned is to provide for the accumulation of a "mineral bed," over or upon which the air-dressing is effected. The declivity for said bed may, if desired, extend above the lower line of curbed apertures e^6 or as far back toward the rear end of the precipitator as may be thought best. The entire surface of the board E is desirably covered with a coat of corundum—secured by means of shellac or otherwise—for the purpose of giving a durable rough surface, which facilitates precipitation. The board or precipitator is slightly and adjustably inclined downwardly from head to foot, so that in the constant vibration of the board the ore slowly passes forward thereon. The ore received at the head of the precipitator is, by the shaking action, uniformly spread or distributed upon the plain or unapertured part e^8 of the board and, owing to the same fact, of shaking, the precipitation of the mineral to the bottom, and ascent of the gangue to or toward the surface of the mass at once begins and continues during the passage of the ore over the board. The air drawn inward by the suction-fan D finds ingress to the space between the precipitator and the dressing-plate F only at the foot of the precipitator, and it consequently passes up along the surface of the ore on the board E till it reaches the holes e^6, through which it passes downwardly to the fan. In this movement of the air over the precipitator it picks up the particles of gangue, which have risen to the surface of the mass of ore thereon, and removes them through the holes e^6, whence they fall upon the inclined board C^3 and move with the air-current through the adjusted valve c'. Beyond this valve the air is deflected backwardly and upwardly through the passage C^5, the lower end of which is purposely made wider, as shown, in order to lessen the suspensive force of the air-current at this point, and thereby to release the gangue which finds escape through the valve c^4.

In the operation of the mineral bed formed in the depression of the precipitator the dressing action is performed exclusively upon the surface of the mass, the gangue being withdrawn from the top, as described, and the mineral being delivered over the foot of the board into any suitable receptacle. (Not shown.) In this forward movement of the mineral the bed is being constantly changed and renewed and never becomes exhausted or impaired.

The inclination of the precipitator will be generally or invariably greater than the acclivity leading from the depression to the foot of the board, in order that the desired forward movement of the ore and mineral may take place in opposition to the force of the oppositely-moving air-current. The force of the air-draft will be of itself adjusted by the valve c'; but with a given air-draft the movement of the ore upon the precipitator will be regulated by adjustment of the inclination of the latter. The dressing-plate will commonly stand at its lower end about seven-eighths of an inch from the surface of the precipitator; but at the head of the precipitator it will usually stand about five sixteenths of an inch distant therefrom. The transparent part of the dressing-plate enables the operator to watch the action going on upon the precipitator, and thereby to avoid loss of mineral by too great tension of the air-current.

I claim as my invention—

1. The combination, in a pneumatic ore-separator, of a vibratory precipitator having curbed apertures, a plate supported at a distance above said precipitator, affording an air-space between them, a suction-fan in communication with said air-space through the apertures of the precipitator, a feed-passage for the ore leading from the hopper-opening to the space between the precipitator and the superposed plate, and a feed-regulating roller preventing free passage of air while permitting the passage of the material being fed, substantially as described.

2. A vibratory precipitator having apertures provided with curbs which project above the upper surface of the board, and having a depression or depressions in its surface for the formation of a mineral bed thereon, substantially as described.

3. The combination of an apertured, inclined, and reciprocating precipitator having its angle of inclination adjustable about an axis at its head, a dressing-plate arranged over the precipitator and also adjustable as to its inclination about an axis which is near that of the precipitator, and a suction-fan in communication with the space between the precipitator and the dressing-plate through the apertures in the precipitator, substantially as described.

4. The combination, in a pneumatic ore-separator, of an inclined reciprocating precipitator provided with curbed apertures and a depression for the formation of a mineral bed, a dressing-plate supported above the precipitator, and a suction-fan communicating with the space between the precipitator and the superposed plate through the apertures in the precipitator, substantially as described.

5. A precipitator for ore-separators provided with apertures having curbs which entirely surround said apertures and which converge at acute angles at their ends and have their greater length in the direction in which the material to be separated moves over the precipitator, substantially as described.

6. The combination, with a precipitator of an ore-separator, a superposed dressing-plate, and a transverse vertically-movable bar and flexible plate supporting the foot of the precipitator, of a lever connected with the trans-

verse bar and having adjustable engagement with the dressing-plate, substantially as described.

7. The combination, with a precipitator and the laterally-inclosed inclined board beneath the precipitator having a discharge-passage at its lower margin, of a suction-fan and an upwardly and rearwardly inclined air-passage beneath said board provided with an outwardly-opening valve at its lower end and communicating at its upper end with the suction-fan, substantially as described.

8. The combination, with a frame, a supply-hopper, and a precipitator beneath the hopper, an open space being provided within the frame between the hopper and precipitator, of a transparent dressing-plate over the precipitator, and adjusting devices for the precipitator at said open side of the machine, whereby the effects of adjustment may be conveniently observed while such adjustment is being performed, substantially as described.

In testimony that I claim the foregoing as my invention I affix my signature in presence of two witnesses.

ALVAN P. GRANGER.

Witnesses:
M. E. DAYTON,
C. CLARENCE POOLE.