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J. M. McMAHAN.

METHOD OF AND APPARATUS FOR MAGNETIC SEPARATION OF ORE.

No. 438,357. Patented Oct. 14, 1890.

FIG. 1.

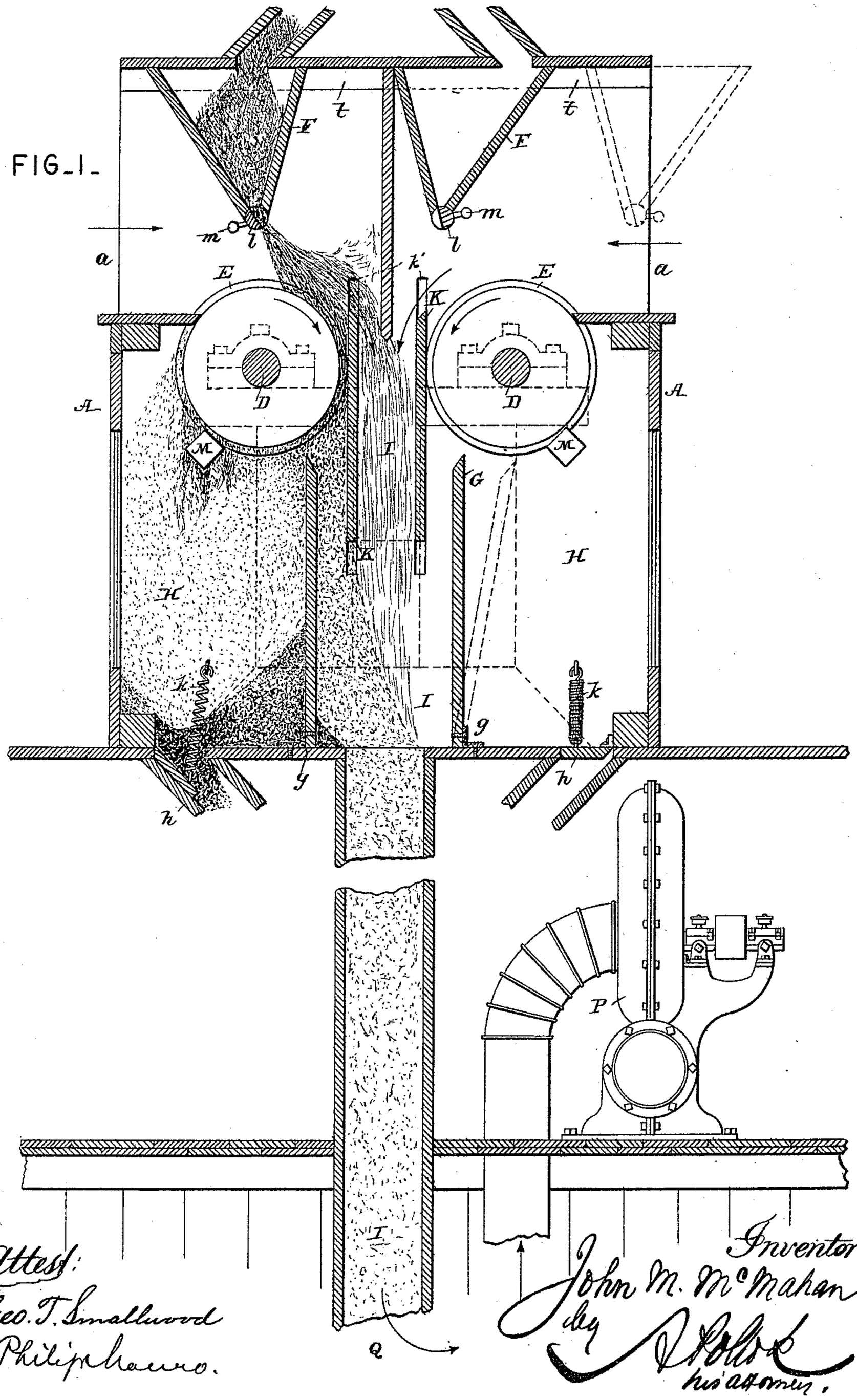

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FIG. II.

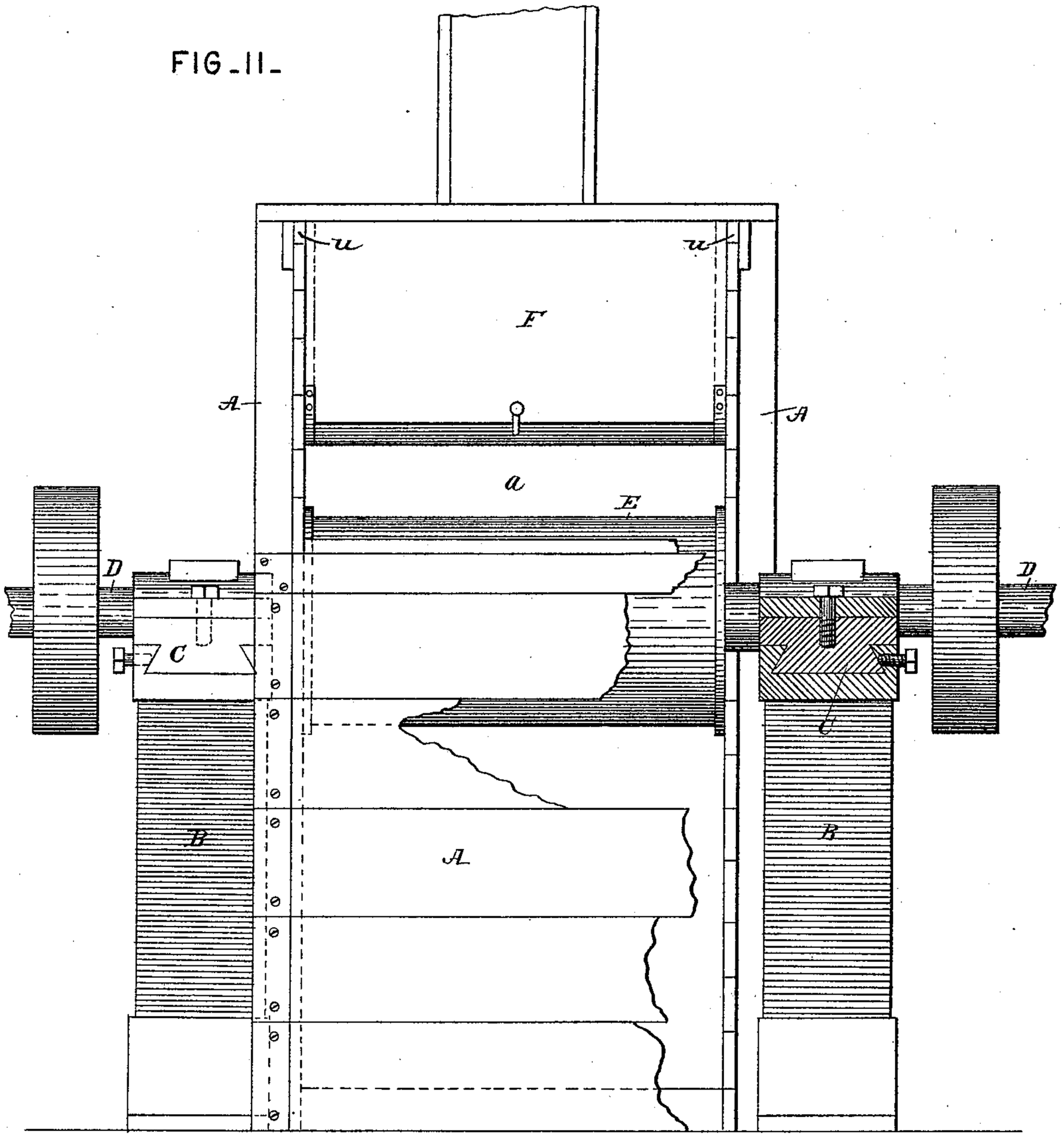

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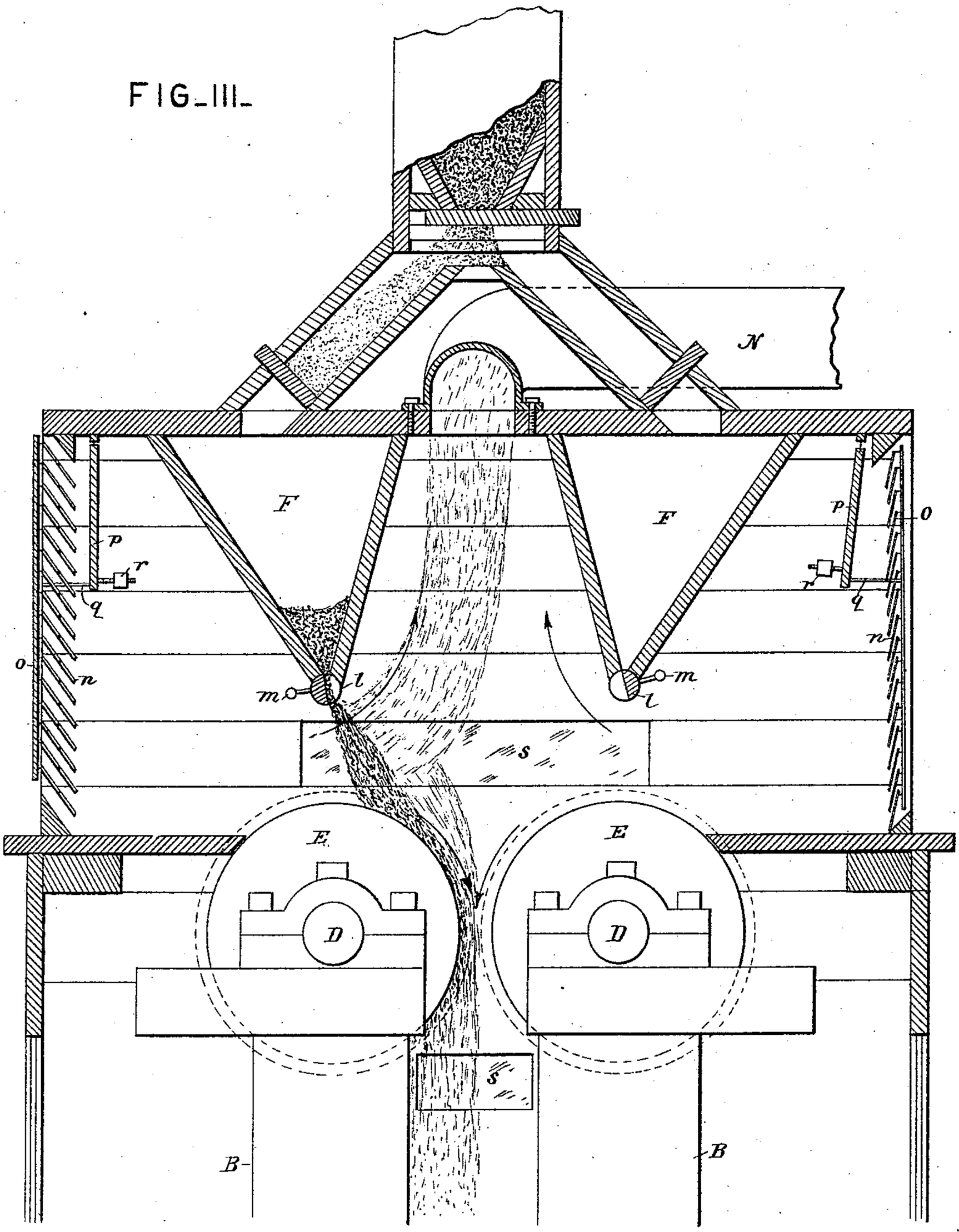
FIG. III.



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METHOD OF AND APPARATUS FOR MAGNETIC SEPARATION OF ORE.

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FIG. IV.

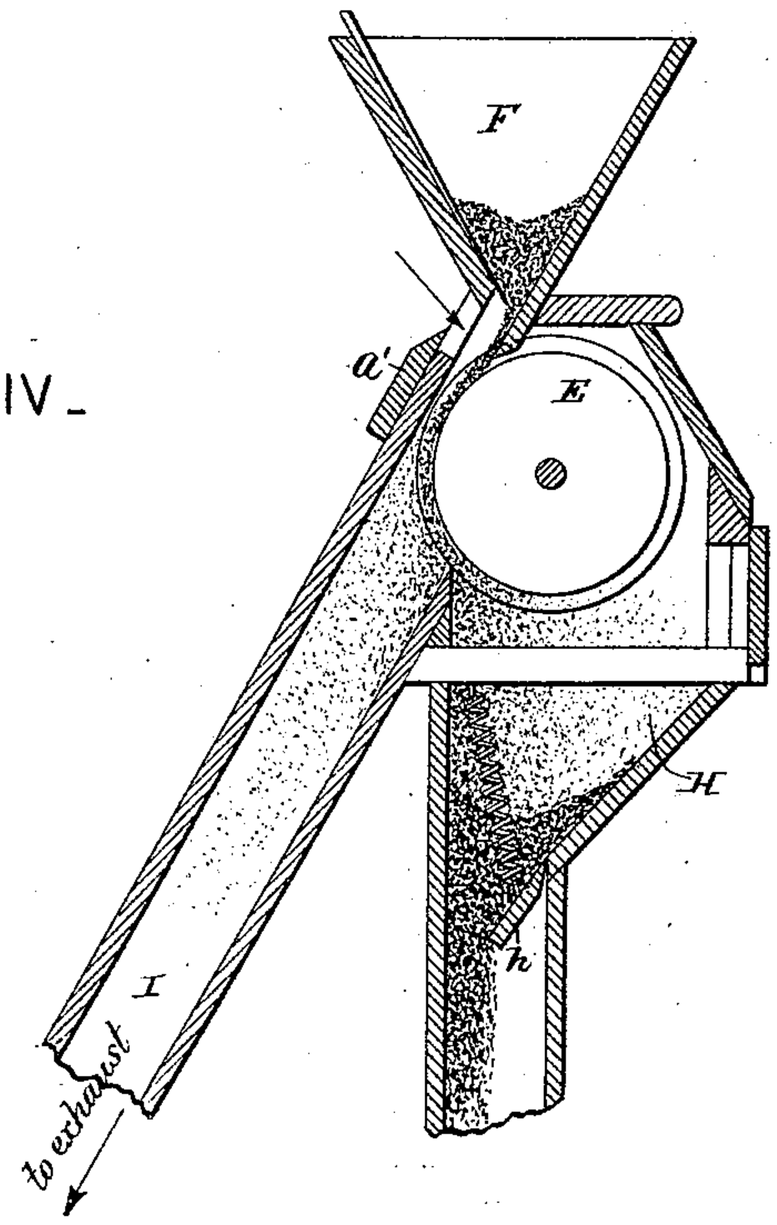
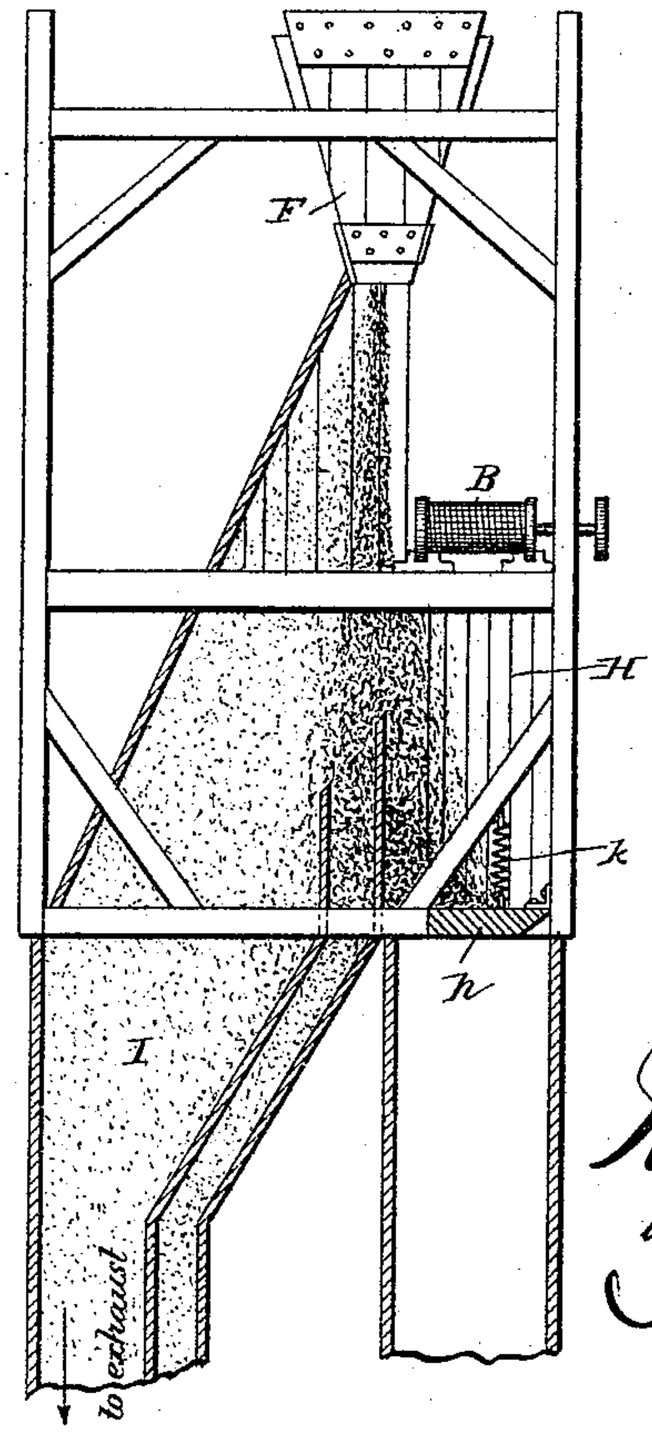


FIG. V.



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UNITED STATES PATENT OFFICE.

JOHN MABRY McMAHAN, OF NEW YORK, N. Y., ASSIGNOR TO JOHN D. CHEEVER, OF SAME PLACE.

METHOD OF AND APPARATUS FOR MAGNETIC SEPARATION OF ORES.

SPECIFICATION forming part of Letters Patent No. 438,357, dated October 14, 1890.

Application filed February 20, 1889. Serial No. 300,609. (No model.)

To all whom it may concern:

Be it known that I, JOHN MABRY MCMAHAN, of New York city, in the county and State of New York, have invented a new and useful Improvement in the Method of and Apparatus for Separating Magnetic from Non-Magnetic Substances, which improvement is fully set forth in the following specification.

This invention has reference to the separation of magnetic from non-magnetic substances, and has particular reference to the treatment of magnetic iron ore.

Heretofore it has been proposed to utilize in a magnetic separator a current of air by passing the same through the stream of falling particles before they reach the magnetic field for the purpose of partially removing the fine dust or light particles contained in the mass.

My invention includes the use of air-currents to assist the force of gravity in effecting the separation of the non-magnetic particles from the magnetic particles at the time both are passing through the magnetic field. I have found that by the use of this improvement a much greater percentage of magnetic particles in the concentrate may be obtained, and that thereby a very low grade of ore may be profitably worked.

I have further found it to be essential in carrying out this invention to produce the air-currents by an exhaust-fan or similar apparatus, and that the use of a direct air-blast for the purpose is impracticable. This portion of my invention, therefore, consists in drawing by suction a current of air through the mass of particles while passing across or through a magnetic field, whereby a much larger proportion of non-magnetic particles is caused to follow the force of gravity and of the air-currents, while the magnetic particles are deflected from said course by the influence of the magnets.

In carrying out this invention it is of importance to arrange the apparatus in such manner that the trailings will not be drawn into the exhaust-fan. After thorough experiment I have found it impracticable to carry out my method with an exhaust-fan connected directly with the passage or chute by which the trailings are carried off, and that the trailings if caused to pass through the fan act as a sand-blast and destroy it in a very short time. I have therefore found it necessary for this and other reasons to arrange a large chamber or dust-trap at the end of the chute or passage aforesaid to receive the trailings and to keep an exhaust on said chamber or dust-trap.

This improvement is applicable to magnetic separators of any suitable kind, such as the Buchanan, the Wenstrom, or the Edison.

In machines such as the two first-named, in which the magnetic particles are attracted to a revolving or moving magnetic surface, such particles are designed to be dropped as soon as such surface passes beyond the magnetic field. It is found, however, that, owing to the residual magnetism or the imperfect demagnetization of the revolving surface, the particles continue to adhere thereto to a considerable extent.

To effect the detachment of all the particles, I employ what may be termed a "picker-magnet," placed in the compartment where the concentrate is to fall, and which effectually prevents any of the particles being carried around again into the magnetic field. This magnet may be a permanent magnet, but preferably is simply a bar of soft iron arranged close to the moving surface, and which becomes more or less magnetized by induction from the revolving rolls.

My invention includes certain other features of construction, as hereinafter set forth.

In the accompanying drawings, which form part of this specification, Figure I is a cross-section, partly in side elevation, of a machine of the Buchanan type, adapted to carry out my invention. Fig. II is an end elevation of the same. Fig. III is a partial view in vertical cross-section illustrating a somewhat different arrangement. Fig. IV is a vertical section of a machine of the Wenstrom type, adapted to carry out my invention; and Fig. V is a similar view of an Edison machine.

Referring more particularly to Figs. I and II, A represents the casing inclosing the apparatus, which is made as near air-tight as possible, except at the part marked *a*, where

it is left open for free admission of the air. The field-magnets B are arranged on opposite sides of the casing, and they support in bearings C the shafts D of the magnetic rolls E. The bearings are mortised into a dovetail groove, as shown in Fig. II, so that the rolls can be adjusted toward and away from each other.

The material to be worked is fed from hoppers F onto the sides of the rolls, as the latter rotate toward each other, thus passing in its descent through the strongest portion of the magnetic field. Beneath each roll is a partition G, which separates the compartments H, which are to receive the concentrate from the chute or passage I, leading to the dust-trap and exhaust-fan P, or other suction apparatus. Partitions G are hinged at *g*, so as to be adjustable to different positions.

In Fig. I are also shown two other partitions K, which are set close to the sides of the rolls E and are adjustable vertically in grooves *k'* in casing of apparatus, as shown in Fig. I.

When the machine is set into operation, the exhaust-fan P produces a steady and uniform draft of air down the chute I in the direction of the falling mass. The air enters at *a* in the direction of the arrow, part passing through the falling mass before it comes under the influence of the magnets. Consequently a portion of the dust and light particles will be carried over the partition K directly into the chute I, whence they fall into the dust-trap Q. The bulk of the mass containing the magnetic particles will be drawn down with the air between partition K and the roll E, passing through the densest portion of the magnetic field. The particles attracted by the magnet will be carried by the roll E past the partition G into compartment H, while the force of the air-draft, acting in the line of gravitation, will carry the non-magnetic particles down the chute I. A very perfect separation thus ensues. The exact dividing-line or line of separation between the magnetic and non-magnetic particles will vary somewhat with the richness of the ore and other conditions. Experience will show the proper position in which to set the adjustable partition G. The same may be said of the vertically-adjustable partitions K. The dust-trap for receiving the trailings is located between the chute I and exhaust-fan P. This arrangement, or something equivalent, is essential in practicing the method of separation herein described, inasmuch as it is impracticable to draw the trailings through the exhaust or suction apparatus.

The chambers H are practically air-tight, so that there will be no disturbance of the air-draft and no eddies or back currents between the end of partitions G and the rolls. The bottoms of chambers H are closed by trap-doors *h* upheld by springs *k*, so that their doors only open when there is a sufficient weight of ore above to overcome the springs *k*. When thus open or partially open, the mass of ore above door *h* prevents a draft of air being established through the same.

When rolls E pass partitions G and approach the weaker portion of the magnetic field, a large part of the magnetic particles will be detached therefrom by the force of gravity; but still a considerable portion would adhere to the rolls, to prevent which the picker-magnets M, which may be simply bars of soft iron, are placed close to the rolls. These detach the particles from the rolls as they pass, and the particles adhering to magnets M detach themselves and fall into chambers H as soon as their aggregate weight becomes too great to be sustained by the magnet M.

The hoppers F, from which the ore is fed, are adjustable in their supports, so that the orifice can be set over or more or less to one side of the axis of the rolls and the length of contact between the ore and the surface of said rolls increased or diminished as desired, according to the richness of the ore and the strength of the air-currents used.

The adjustability of the hoppers may be secured in any suitable way. As shown in Figs. I and II, they have at each end a side bar *u*, forming a tongue, which rests and is supported in a groove *t* in the sides A of the apparatus, and in these grooves the hoppers can be moved horizontally to the desired position.

At the mouth of each hopper is arranged a rod *l*, supported in bearings, which acts as a regulating-valve and has a lever or handle *m* for turning the same. About half of the rod *l* is cut away, and by adjusting its position the size of the stream of ore may be regulated or the mouth of the hopper closed entirely, as shown for the right-hand hopper, Fig. I. These several provisions for regulating and adjusting different parts of the apparatus are found in practice to be very important and advantageous to enable the machine to be adapted to the ever-varying conditions of working.

In Fig. III the rolls are shown set very close together, thereby concentrating the magnetic field. This condition of the parts would not admit of the use of the partitions K of Fig. I; but the same result is effected by arranging a branch pipe N at the top of the casing, which connects it at any suitable point with the dust-trap and suction apparatus, and through which the light particles will be drawn, thus effecting a preliminary separation before the mass reaches the magnetic field.

Each air-inlet is shown as provided with a series of slats *n*, similar to a Venetian blind, and provided with the rod *o* for opening and closing the same. Inside the casing is hung an oscillatory flap or board *p*, connected with rod *o* by a link *q* and provided with an adjustable weight *r*. This contrivance acts as an automatic regulator of the air-current. The weight *r* being set at the desired point, should the force of the air-current increase beyond the normal the flap *p* would be blown

farther inward, drawing with it rod *o* and partially closing the blinds. Any other suitable automatic regulator or damper may be used.

As shown in Fig. III, glass windows are inserted in the casing in convenient places for observing the action of the apparatus.

Fig. IV shows how my process may be carried out with a Wenstrom separator. Similar parts are designated by the same reference-letters as in the other figures. The chute I carries off the tailings and leads to the exhaust-fan. Air is admitted at the adjustable door *a'* and acts as before in the direction of the falling gangue as it passes through the magnetic field. The door may, of course, be replaced by an automatic damper, as above described.

Fig. V illustrates a machine of the Edison type, in which the metallic particles are not caused to adhere to a magnetized surface, but the magnet B is arranged to alter the trajectory of the magnetic particles as the mass falls past said magnet. The direction and action of the air-current will be understood from the drawings. In machines of this type it may be advantageous to admit the air through an automatic damper, as above described.

From the foregoing description it will be evident that my improvements may be applied to and carried out by machines of different type, and that some of the improvements described may, if desired, be used without the others.

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

1. The method of separating magnetic from non-magnetic substances in a finely-divided state by feeding the mass across or through a magnetic field and drawing by suction a current of air through the mass while passing through said magnetic field, substantially as described.

2. In the method of separating magnetic from non-magnetic particles in a pulverized condition, the improvement which consists in feeding the same by gravity through a magnetic field of force and drawing by suction a current of air through the mass as it passes through the field of force in the direction in which the mass falls, substantially as described.

3. In the method of separating the magnetic from the non-magnetic particles of a mass of pulverized ore or other material, the improvement which consists in causing said mass to fall through a magnetic field, drawing by suction a current of air through said falling mass before it reaches said field, and simultaneously drawing a current of air with said mass through the magnetic field in the direction taken by the non-magnetic particles, substantially as described.

4. The combination, with a casing, of the field-magnets, the ore-hopper above the same, a partition below the same for keeping apart the streams of magnetic and non-magnetic substances separated by said magnet, and the exhaust apparatus drawing air through the magnetic field traversed by the ore and into the chute down which the non-magnetic particles pass, substantially as described.

5. The combination of the field-magnet, the chute or passage for the material to be separated passing through the magnetic field, the exhaust apparatus connected with said chute or passage, and the adjustable partition arranged below the magnetic field for dividing the magnetic and non-magnetic particles, substantially as described.

6. In a magnetic separator, the combination, with a movable magnetized surface for attracting the magnetic particles as they pass through the magnetic field, of a picker-magnet arranged near the weaker portion of the magnetic field for detaching any particles adhering to said surface, substantially as described.

7. In a magnetic separator, the combination of the field-magnets, the main passage or chute leading through the magnetic field thereof, the exhaust apparatus, and the damper arranged at the air-inlet for controlling the force of the air-current, substantially as described.

8. In a magnetic separator, the combination, with a magnet, of a hopper for allowing the substance to be worked to fall through the magnetic field, said hopper being adjustable, so as to cause the mass to fall closer to or farther from the pole of said magnet, substantially as described.

9. The combination of the field-magnet, the main chute or passage leading through the magnetic field, the exhaust apparatus connected with said passage, the air-inlet above the field-magnet, and a branch passage to one side of the main passage, but connected therewith below the magnetic field for effecting a preliminary separation of the dust and light particles, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

JOHN MABRY McMAHAN.

Witnesses:
VICTOR E. BURKE,
ROBERT J. CUMMINGS.