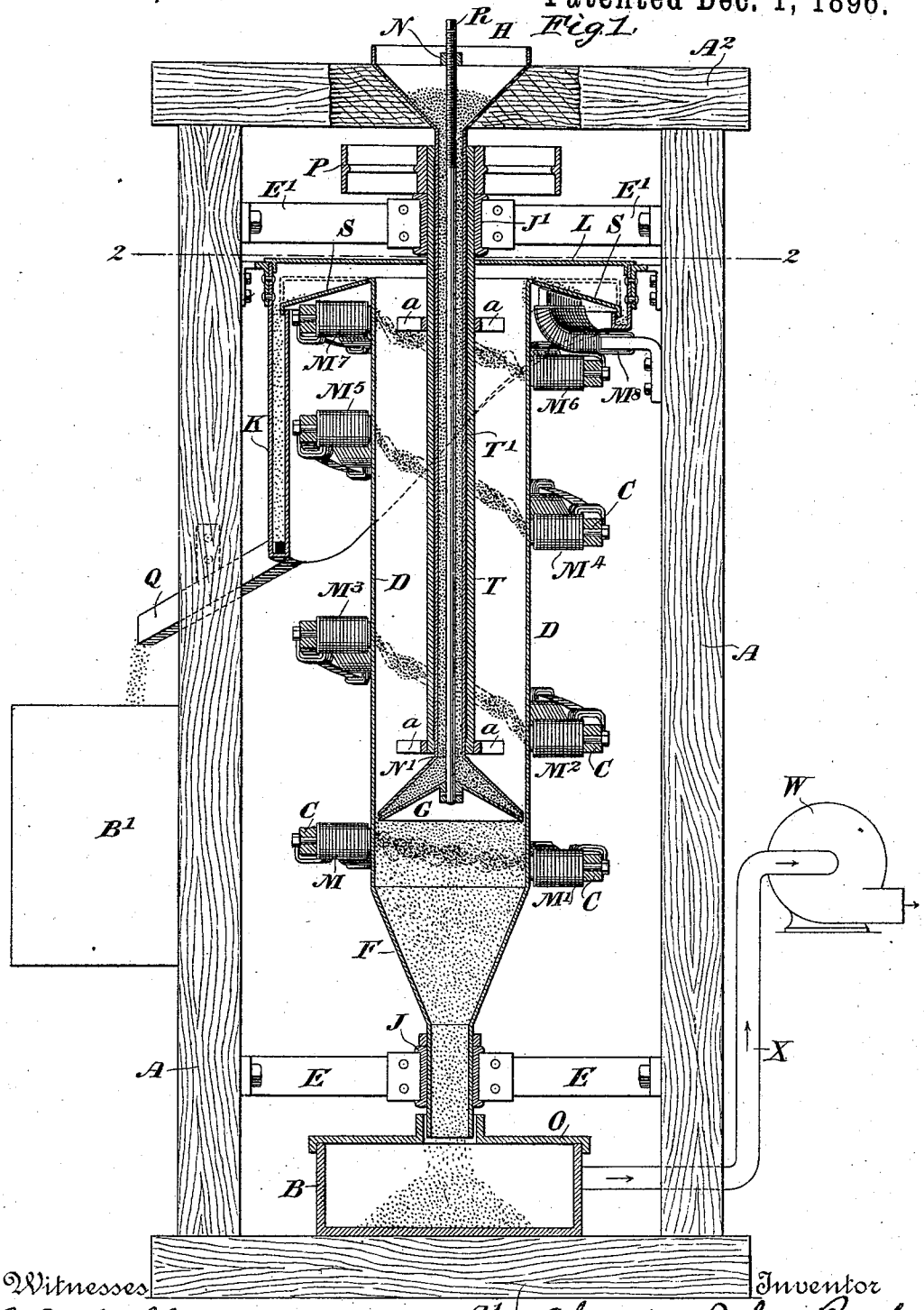
(No Model.) 3 Sheets—Sheet 1.

C. J. REED.

MECHANISM FOR SEPARATING MAGNETIC FROM NON-MAGNETIC SUBSTANCES.

No. 572,370. Patented Dec. 1, 1896.

Fig. 1.



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(No Model.) 3 Sheets—Sheet 2.

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Fig. 2,

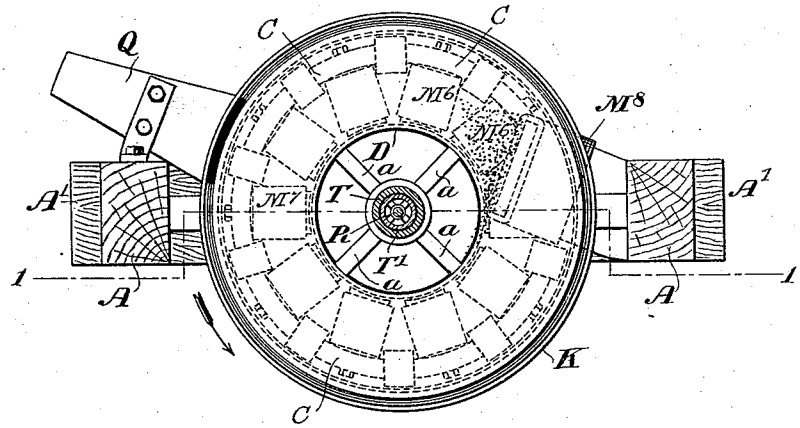

Fig. 3,

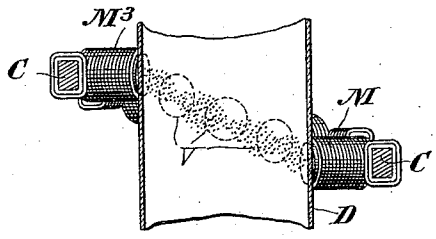

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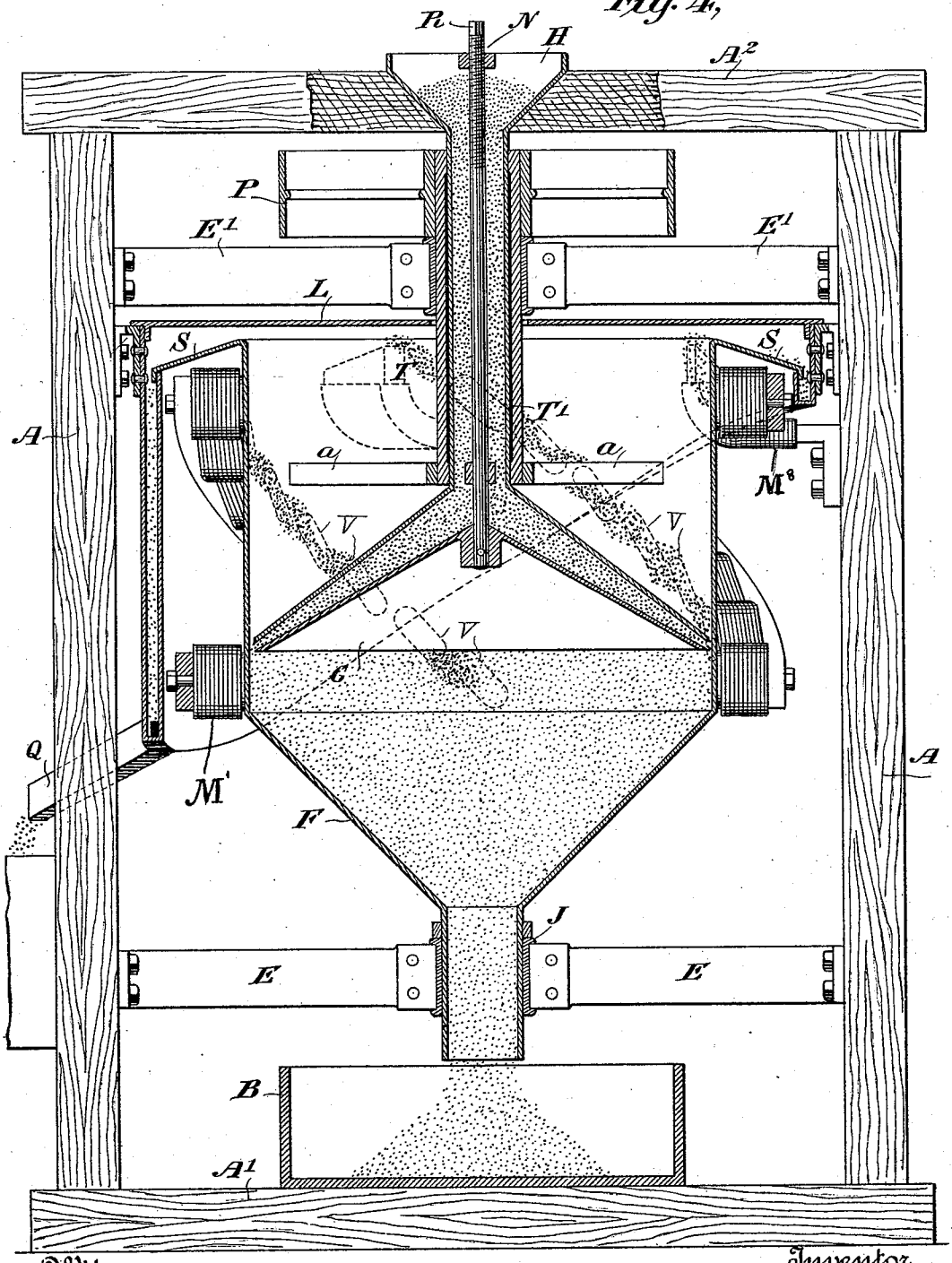
Fig. 4.



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UNITED STATES PATENT OFFICE.

CHARLES JOHN REED, OF ORANGE, NEW JERSEY.

MECHANISM FOR SEPARATING MAGNETIC FROM NON-MAGNETIC SUBSTANCES.

SPECIFICATION forming part of Letters Patent No. 572,370, dated December 1, 1896.

Application filed December 30, 1891. Serial No. 416,560. (No model.)

To all whom it may concern:

Be it known that I, CHARLES JOHN REED, a citizen of the United States, residing at Orange, in the county of Essex and State of New Jersey, have made a new and useful Improvement in Mechanism for Separating Magnetic from Non-Magnetic Substances, of which the following is a specification.

My invention is directed particularly to improvements in mechanism for separating magnetic from non-magnetic materials in which crushed or powdered material in its crude form is fed through a rotating cylinder or drum subjected to the influence of a magnetic field located in close proximity to its surface, whereby the magnetic particles are attracted toward the surface of the drum, while the non-magnetic particles are either permitted to fall by gravity or are removed under the influence of a draft of air and stream of water or the like.

In three prior patents granted to me on the 5th day of January, 1892, and bearing, respectively, Nos. 466,513, 466,514, and 466,515, I have disclosed mechanism of the character above indicated and upon which the apparatus described and claimed in the present application is an improvement. In the use of the mechanism disclosed in Patents Nos. 466,513 and 466,514 the crushed or powdered ore is separated from the non-metallic substances by the united action of gravity and stationary magnets, while the non-metallic substances or tailings are blown out of the upper end of the drum through the agency of a draft of air. In Patent No. 466,515 the drum is vertically arranged and given horizontal motion, while a movable magnetic field is caused to pass in close proximity to its surface and to carry the magnetic particles out of the upper end of the drum as the non-magnetic particles or tailings pass by gravity or under the united influence of gravity and air out of the lower end of said drum.

My invention will be fully understood by referring to the accompanying drawings, taken in connection with the following description.

In all of the drawings like letters of reference represent like parts wherever used.

Figure 1 represents a longitudinal sectional view of my improved apparatus, taken on line 1 1, Fig. 2; and Fig. 2 is a cross-sectional view thereof, taken on line 2 2, Fig. 1. Fig. 3 is a detail sectional view showing the spiral arrangement of the magnets around the drum. Fig. 4 is a longitudinal sectional view of the machine with a different arrangement of magnets based upon different proportions.

A A represent the side timbers or supports of the apparatus, attached to the bottom and top timbers A' A^2.

D represents a hollow drum or cylinder of the desired diameter, constructed, preferably, of non-magnetic material, such as brass, copper, or paper, and having at its upper end a disk or rim S and at its lower end a contracted or conical portion F, said drum or cylinder being sustained at its lower end by a journal-bearing J in a cross-bar E at its upper end by an internal tube T, which is secured to the inner face of the drum by two sets of radial arms *a a*. The upper portion of this tube T has a journal-bearing J', and is provided with a pulley P, which may be connected by a belt to any preferred source of power. The upper journal-bearing is sustained by a cross-bar E'.

T' is a tube extending downward into the tube T and attached at its upper end to a hopper H, which in turn is secured to the cross-head A^2 of the frame, the lower end of this tube T' being enlarged or of conical shape, as shown.

R is an adjusting-rod adjustably secured within the tube T' in a nut N, carried by a cross-bar at the upper end of the hopper H, and a corresponding nut N', having radial arms, is secured inside and near the bottom of the inner tube. To the lower end of this adjusting-rod R is secured a regulating-cone G of substantially the same diameter at its lower edge as the enlarged end of the tube T', the arrangement being such that as the rod R is raised or lowered the opening between the enlarged end of the tube T' and the conical part G will be varied, as will be described more particularly in connection with the mode of operation.

M M' M^2, &c., to M^8 represent a series of magnets, either permanent or electromagnets, but preferably the latter. When electromagnets are used, they are secured to a helical iron or other magnetic support C, so

that their successive poles next to the drum are alternately of opposite polarity. This helical support C is secured at various intermediate points to the framework of the machine, and the magnets may be, if preferred, independently adjustable, so as to bring their inner poles V (see Figs. 2, 3, and 4) into the desired proximity of the outer surface of the revolving drum D. The enlarged rim or shelf S at the upper end of the drum extends laterally over the upper edge of the inner wall of a collecting-chute K, which is secured by its outer wall to the inner faces of the framework A, and is provided at its top with a removable cover L, which may be of glass or any suitable material. At the extreme lower portion of this collecting-chute K is an outlet-spout Q, adapted to deposit the magnetic particles into a receptacle B′ on the left of the machine.

B is a receptacle for the tailings or non-magnetic particles, and is provided with a removable dust-tight cover O.

W is an exhaust-fan connected by a pipe X with the upper portion of the receptacle B, and is designed to produce a downward draft of air through the drum. In the construction illustrated in Fig. 4 I have shown the drum or cylinder as of different proportion from that illustrated in Fig. 1, and have also shown the magnets M M′, &c., arranged in two or more oblique or helical rows around the outside of the drum D, and I have also shown in this figure of the drawings the inner poles V as being of elliptical or oblong form and arranged so that the upper edge of any one pole lies slightly above the lower edge of the next succeeding higher pole, thereby facilitating the transfer of the magnetic particles in an upward direction from pole to pole in sequence throughout the entire series as the drum is rotated.

The mode of operation of the above-described apparatus is as follows: The magnets M M′ to M^8, if electromagnets are used, are magnetized to the desired saturation by a source of electrical energy, (not shown,) and the drum D is set in motion by the agency of a belt acting upon pulley P, and is rotated in such direction as to cause the magnetic particles to be carried from the lower magnets in the series toward the next succeeding higher magnets in sequence. The material to be operated upon having first been crushed to the desired comminution is fed into the hopper H, and passes down, as shown in Figs. 1 and 4, through the tube T′ to the conical distributer or spreader G, which by virtue of its conical shape causes the powdered material to be thrown out in the form of a thin layer against the inner surface of the revolving drum or cylinder at points above the lower row of magnets, which completely surrounds the lower end of the drum, the amount of the material thus fed forward being limited by the adjustment of the conical feed-regulating device G through the agency of the adjusting-rod R and nut N. The non-magnetic particles, therefore, descend by the action of gravity through the conical or contracted portion F at the lower end of the drum, and pass finally to the covered receptacle B, while the magnetic particles, which have fallen into the magnetic field, are attracted by the magnets and held firmly against the inner surface of the rotating drum. This rotating action tends constantly to carry the particles forward in the direction of the drum's rotation out of the field of the magnets acting upon them and into the field of the next magnets of the series located slightly above, so that there are constantly two forces acting upon the magnetic particles, the resultant action of which causes them to ascend step by step in a spiral or helical direction around the inner surface of the drum or cylinder until finally they appear upon the upper surface of the rim or disk S under the influence of the last magnet M^8 of the series, which is arranged to carry the magnetic particles out of the cylinder and hold them on the inclined upper face of said disk or ring. As the cylinder or drum continues to rotate, therefore, and the magnetic particles continue to accummulate over the pole of this last magnet M^8 or two or more of such magnets, if it be found desirable to use more, they will finally be thrown off by virtue of the rotary action of the rim or disk and gravity and fall into the collecting-chute K, which completely surrounds the entire drum D at its upper end and is so constructed that all of the magnetic particles descend by gravity to the lowest portion of this chute and ultimately pass out through the spout Q and to the receptacle B′.

An examination of Fig. 3, which illustrates in dotted lines the arrangement of the successive poles of the magnets, will convey a clear idea as to how the rotary action of the drum will cause the magnetic particles to pass under the influence of the succeeding magnets in sequence throughout the series until finally the material is deposited on top of the inclined disk or rim S, which may also be a flat surface, if preferred, as shown in Fig. 1 in dotted lines, dependent in that case solely upon the action of centrifugal force to throw the magnetic particles into the chute K. In the form shown in Fig. 4 the elliptical or elongated shape of the magnet-poles V and their arrangement with relation to each other is such that there is no possibility of the magnetic particles being released by the magnetic field until they pass entirely out at the top of the machine. In other words, the upper edge of each magnet-pole is above the lower edge of the next succeeding higher magnet-pole, so that it is not possible for gravity or any other force which is utilized for removing the non-magnetic particles to overcome at any time this magnetic force. By the double spiral arrangement of magnets, illustrated also

in this figure, I am enabled to further insure the carrying forward of the magnetic particles.

As thus far described the operation of my improved apparatus is made dependent solely upon the action of three forces—viz., that of the rotation of the cylinder and the magnetic effect of the magnets, which joint action causes the magnetic particles to move in one direction, while gravity, the other force, causes the tailings of non-magnetic particles to move in a reverse direction. I may aid gravity in effecting this last step by utilizing the exhaust-fan W, connected to the receptacle for the tailings, by causing a draft of air to pass downward through the drum to the exhaust-pipe, as shown. The exhaust or blast is not an essential feature, and is only suggested as an additional expedient for aiding gravity in separation in certain cases.

The powdered material may be fed into the field of the lowest magnets in the series or of any of the higher ones. I prefer, however, to feed it into the fields of some of the intermediate magnets, leaving the lower magnetic fields to utilize their full power in catching any stray magnetic particles that might otherwise escape with the non-magnetic material.

I do not limit myself to the specific mechanism herein described and shown for carrying into effect the methods of operation hereinbefore described. I believe it is broadly new with me in the art of magnetic separation to cause the magnetic particles to move in one direction through or parallel with a rotating drum or cylinder and the non-magnetic particles to move in a reverse direction under the influence of the stationary magnetic field, and I desire it understood that my claims in this particular shall be construed to cover, broadly, the application of this generic principle for the purpose specified. Nor do I limit myself to the shape or conformation or proportions of the rotating drum, nor to the number or disposition or arrangement of the magnets, as these features may be varied at will, as may suggest themselves to those skilled in the art, and still come within the scope of my invention.

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

1. In a machine for separating magnetic from non-magnetic particles, a hollow revolving drum in combination with fixed or stationary external magnets and means consisting of a tube and a feed-regulating device for regulating the flow of the material into the interior of the drum, substantially as herein set forth.

2. In a machine for separating magnetic from non-magnetic particles, a hollow revolving drum, into which the material is introduced in combination with fixed external magnets arranged in helical rows, substantially as herein set forth.

3. In a machine for separating magnetic from non-magnetic particles, a hollow revolving drum into which the material is introduced in combination with external magnets and a terminal cone for the discharge of tailings substantially as herein set forth.

4. In a machine for separating magnetic from non-magnetic particles, a hollow revolving drum into which the material is introduced in combination with external magnets and a terminal rim for discharging the magnetic particles, substantially as herein set forth.

5. In a machine for separating magnetic from non-magnetic particles, a hollow revolving drum in combination with external magnets, an internal distributer and a hopper, substantially as herein set forth.

6. In a machine for separating magnetic from non-magnetic particles, a hollow revolving drum in combination with external magnets, an internal distributer and a receptacle for receiving the magnetic particles, substantially as herein set forth.

7. A rotating cylinder, or drum, a series of magnets arranged spirally near the outer surface of said cylinder and means for forcing a blast of air through the cylinder, substantially as herein set forth.

8. A rotary cylinder or drum, a series of magnets arranged spirally in one or more rows around the outer surface of said cylinder with their free or magnetizing poles in close proximity to the cylinder and means for feeding the powdered ore in a layer against the inner face of the drum at points near the lower magnets of the series substantially as herein set forth.

9. An ore-separator consisting of a hollow revolving drum, a series of magnets arranged spirally around its outer surface and a feed-tube extending from the top of the drum to a point near the lower end of the drum, substantially as herein set forth.

10. In an ore-separator a series of electromagnets arranged in one or more spiral rows with their free or magnetizing poles near a moving surface, said poles being of oblong shape and located above each other in sequence, substantially as herein set forth.

11. A hollow drum, or cylinder having a series of magnets arranged with their free or magnetizing poles in close proximity to one surface of the drum, said poles being oblong or elliptical and located above each other in sequence, substantially as herein set forth.

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Witnesses:
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