No. 662,410. Patented Nov. 27, 1900.

E. GATES.

MAGNETIC SEPARATION.

(Application filed Apr. 14, 1900.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

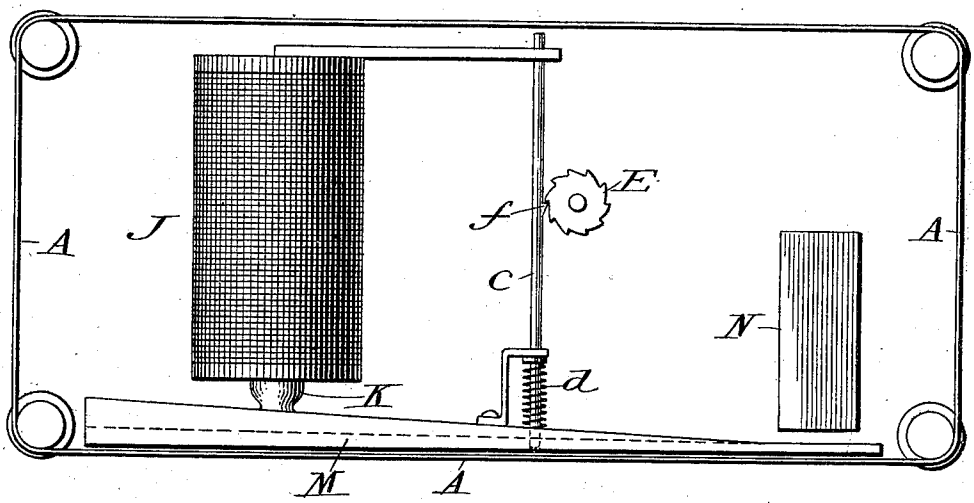
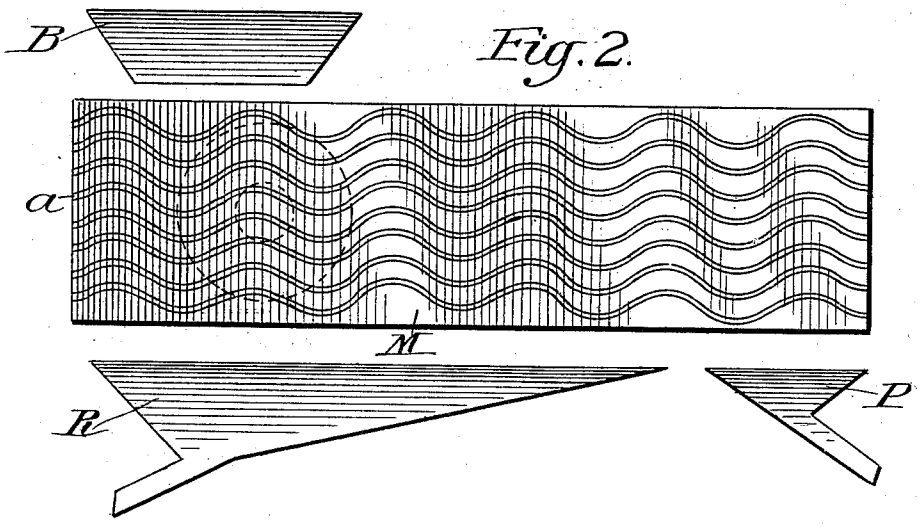


Fig. 2.



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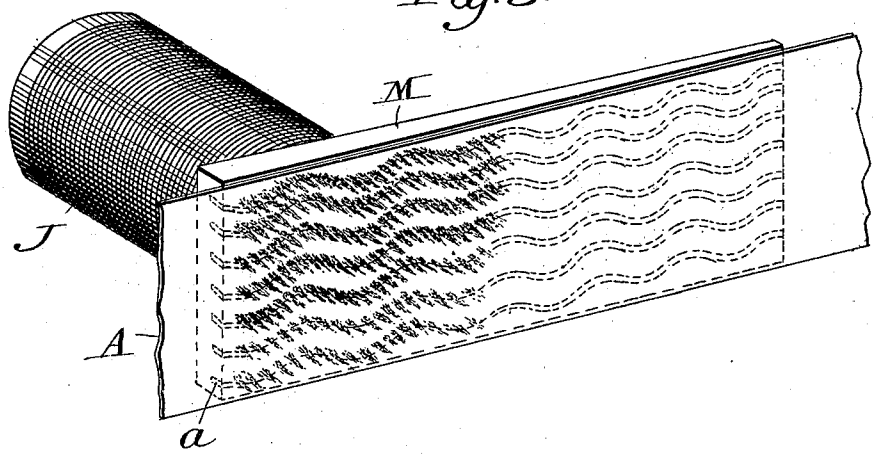
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Fig. 3.



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UNITED STATES PATENT OFFICE.

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MAGNETIC SEPARATION.

SPECIFICATION forming part of Letters Patent No. 662,410, dated November 27, 1900.

Original applications filed March 19, 1900, Serial Nos. 9,268 and 9,269. Divided and this application filed April 14, 1900. Serial No. 12,903. (No specimens.)

To all whom it may concern:

Be it known that I, ELMER GATES, a citizen of the United States, residing at Chevy Chase, county of Montgomery, State of Maryland, have invented certain new and useful Improvements in Magnetic Separation; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

In an application for Letters Patent of the United States filed by me March 19, 1900, Serial No. 9,269, I have described and claimed an apparatus for the separation of diamagnetic and paramagnetic material by the expedient of causing the separator-magnet to be energized to a degree sufficient to cause the paramagnetic particles to assume a frond-like or moss-like structure, thereby partially disentangling the diamagnetic particles and completing the disentangling and separation of the latter by causing the frond-like or moss-like structures to continuously rearrange themselves, either by the agency of vibrations imparted to them or by causing them to travel across wavy or zigzag fields of magnetic force or by a combination of these instrumentalities. In another application for Letters Patent of the United States filed March 19, 1900, Serial No. 9,268, I have described another form of apparatus embodying generically the fundamental feature of causing the paramagnetic material to assume the moss-like or frond-like structure referred to and then causing the structure to rearrange itself, and thereby liberate the entangled diamagnetic particles.

The subject-matter of the present application relates to the method involved in the practice of the invention by means of the apparatus described in the said applications and in like apparatus having the characteristic mode of operation described therein, and to this extent constitutes a division of the said applications.

In the accompanying drawings, Figure 1 represents a top plan view of a typical form of apparatus for the practice of my invention. Fig. 2 represents a front elevation of the magnet-pole and feed-hopper. Fig. 3 represents the arrangement of the moss-like or frond-like structures along one of the wavy or zigzag magnetic fields of force.

Similar letters of reference indicate similar parts throughout the several views.

Referring to the drawings, J indicates the energizing-coil of an electromagnet provided with a core K and a pole-piece M. In front of the pole-piece M is arranged a non-magnetic screen, preferably in the form of a traveling band A, of fabric or the like, which serves as the surface upon which the material to be separated is fed by means of a hopper B. The electromagnet is energized to a degree sufficient to cause the paramagnetic particles to arrange themselves in moss-like or frond-like structures of characteristic appearance, which I have endeavored to illustrate in Fig. 3, although it will be understood that an absolute representation of these structures corresponding with every change or alteration which they experience is practically impossible. I rely, therefore, upon the general representation attempted as a sufficient index to the operator to enable him to graduate the strength of the magnet to produce the structures intended. It will be noted that in said Fig. 3 the structures are indicated as assuming in addition to their moss-like or frond-like arrangement a wavy or zigzag appearance. This latter arrangement is due to the fact that, as illustrated in Fig. 1, the magnet-pole is provided with a corresponding series of zigzag or wavy recesses *a*, preferably filled with non-magnetic material—as, for instance, lead or the like—so as to make a smooth surface for the traveling belt. In the rear of the magnet-pole M or at any other convenient place may be located means for jostling or jarring the traveling band. In the construction illustrated these means consist of a rod of brass *c*, normally held away from contact with the traveling band by means of a spiral spring *d*, but adapted to be intermittently actuated toward the band by means of a constantly-rotating toothed wheel E, engaging with a corresponding projection *f* on the rod *c*.

The magnet-pole M preferably extends to a considerable distance beyond the magnet-core, and in the illustration chosen this ex-

tension is in a lateral direction corresponding to the travel of the belt A. Near the end of the magnet-pole M there may be located a large mass of wrought-iron N for the purpose of absorbing or diverting the magnetic lines of force, and thereby releasing the paramagnetic particles to better advantage when they arrive at a point opposite said mass of iron. At this point also is located a receiving-hopper P for the reception of the magnetic sands, and a second hopper R serves to receive the diamagnetic material that has been disentangled from the mass during the operation.

The mode of operation of the invention is as follows: The material to be separated containing diamagnetic and paramagnetic particles in a finely-divided condition—as, for instance, magnetic iron ore containing sand or containing free diamagnetic metallic particles, such as gold, copper, or the like—is fed by the hopper B upon the face of the traveling belt A. The electromagnet J being energized to a degree sufficient to produce the moss-like or frond-like structures illustrated in Fig. 3 thereupon attracts the paramagnetic material and holds it to the traveling belt, together with such of the diamagnetic material as remains entangled with it. Such of the diamagnetic material as becomes at once disentangled drops immediately into the hopper R. The travel of the belt A, assisted by the constant jostling produced by the reciprocating rod *c*, causes a continuous rearrangement and re-formation of the moss-like or frond-like structures, and as a consequence more and more of the diamagnetic material becomes disentangled from the paramagnetic material, until finally a practically complete separation takes place—that is, by the time the paramagnetic material has reached the end of the pole-piece M it has lost practically all of its burden of diamagnetic material and then falls off by continued accretions into the hopper P.

It will be understood that the means for jostling the traveling band and the means for producing the wavy or zigzag fields of magnetic lines of force are supplemental to each other and may be employed to advantage separately.

Having thus described my invention, what I claim is—

1. The method of separating diamagnetic material from paramagnetic material, which consists in feeding the composite material upon a receiving-apron located in a magnetic field of a strength so graduated that the magnetic sand will arrange itself in moss-like or frond-like structures and in zigzag or wavy lines, and thereupon bodily moving the said structures along the zigzag or wavy lines of force established, so as to occasion a corresponding zigzag or sinuous travel of said structures and their concurrent progressive re-formation; substantially as described.

2. The method of separating diamagnetic material from paramagnetic material, which consists in feeding the composite material upon a receiving-apron located in a magnetic field of a strength so graduated that the magnetic sand will arrange itself in moss-like or frond-like structures and in unbroken zigzag or wavy lines, and thereupon bodily moving the said structures along the zigzag or wavy lines of force established, so as to occasion a corresponding zigzag or sinuous travel of said structures and their concurrent progressive re-formation; substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

ELMER GATES.

Witnesses:
J. E. HUTCHINSON, Jr.,
A. E. GRANT.