No. 653,342. Patented July 10, 1900.

E. GATES.

DIAMAGNETIC SEPARATION.

(Application filed Sept. 26, 1899.)

(No Model.) 2 Sheets—Sheet 1.

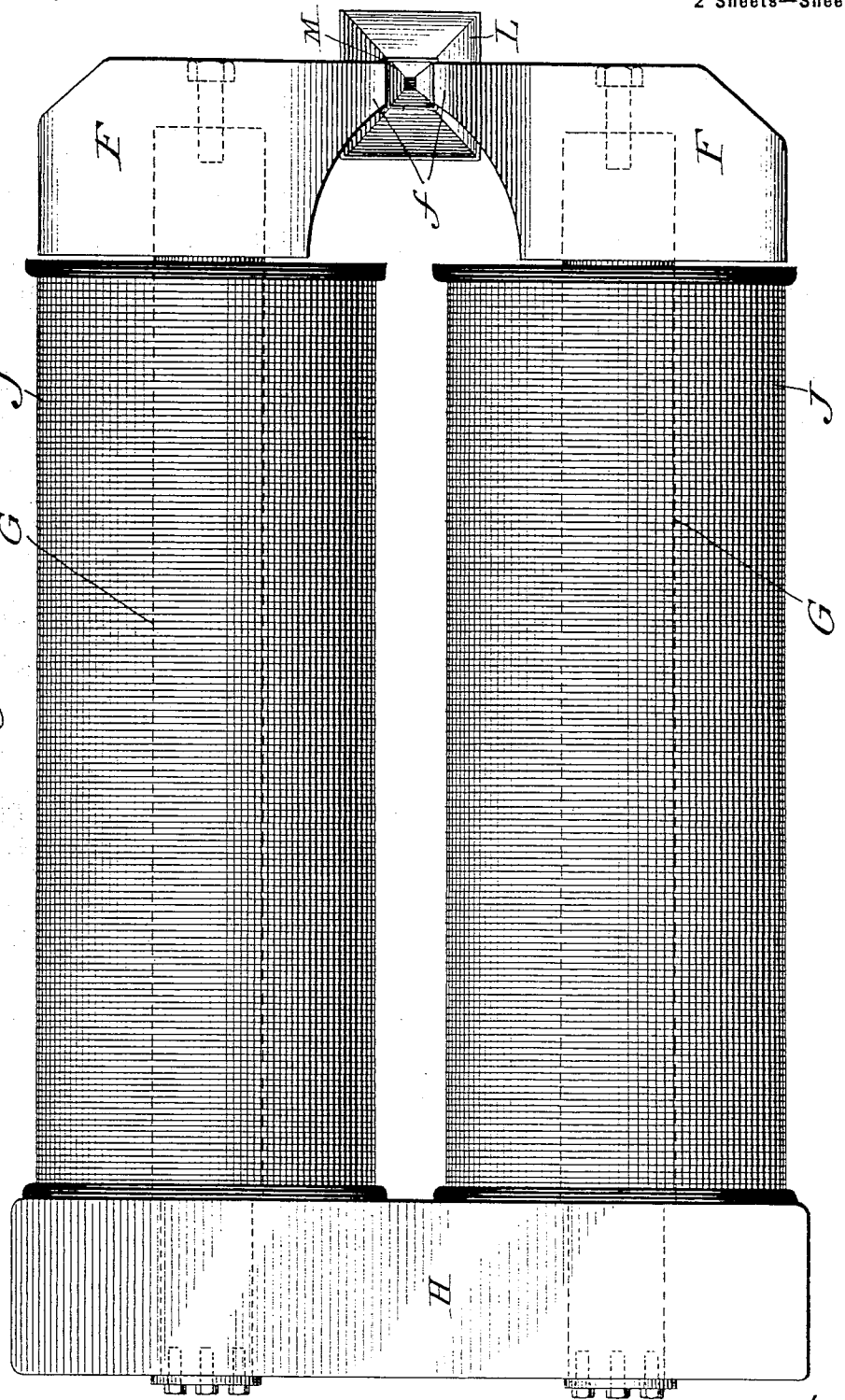

Fig. 1.

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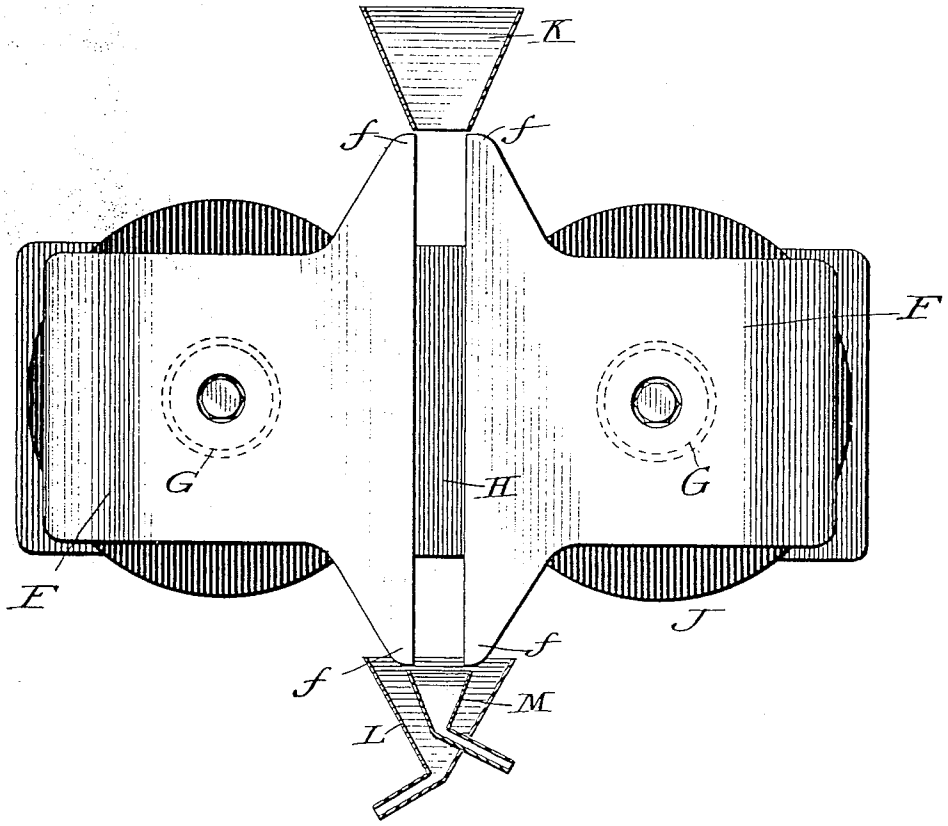
Fig. 2



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UNITED STATES PATENT OFFICE.

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DIAMAGNETIC SEPARATION.

SPECIFICATION forming part of Letters Patent No. 653,342, dated July 10, 1900.

Application filed September 26, 1899. Serial No. 731,762. (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 Diamagnetic 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.

My invention relates to certain new and useful improvements in the separation of diamagnetic substances from mixtures in which said substances appear, and more particularly to the separation from each other of diamagnetic substances of varying susceptibility—as, for instance, gold or silver from sand, quartz, and the like.

The invention is based upon the principle that whereas paramagnetic substances—such as iron, nickel, and cobalt—tend to move from weaker portions of a magnetic field toward the stronger portions diamagnetic substances tend to move from the stronger portions of the magnetic field toward weaker portions. The repellent force thus exerted is, however, extremely moderate in comparison to the force of attraction exerted upon paramagnetic substances by a magnetic field of a given intensity, and, so far as I am aware, the employment of diamagnetic action for the successful separation of substances has not heretofore been regarded as feasible.

In practicing my invention the mixture of substances to be separated, if it does not originally occur in the form of finely-subdivided particles—as, for instance, sea-sand having free gold in the form of fine particles distributed throughout its mass—is brought into that condition by means of stamps or crushers.

The characteristic feature of the invention consists in feeding the mixture of finely-divided particles into an intense part of a magnetic field and causing the particles of greater diamagnetic susceptibility to travel toward a weaker part of the field by continual progression, detaining or continuing them within and subjecting them to the action of the lines of force until the more diamagnetic particles have been so far diverted from the less diamagnetic particles as to be capable of being received and collected separately. By the expedient of prolonging the period within which the mixture is subjected to the action of the magnetic field I find that a comparatively-slight initial tendency to separate is by progressive small increments finally sufficient to effect the complete separation of particles of one degree of diamagnetic susceptibility, such as gold, from particles of another degree of diamagnetic susceptibility—as, for instance, sand or crushed quartz. In fact, I have found, for instance, that the tendency of fine particles of gold to move from the strongest to the weakest part of a magnetic field is so much greater than the more-feeble tendency of very weakly diamagnetic substances, such as sand, to move in the same direction that when a mixture of the particles free to move with respect to each other is, as above described, detained or continued in and subjected to the action of the magnetic field for a sufficient period the separation is readily effected and with a moderate expenditure of electric energy. The desired freedom of motion of the particles within the magnetic field, as also their sufficient period of detention therein, may be readily obtained in various ways—as, for instance, by causing them to drop by gravity through a magnetic field or succession of magnetic fields of considerable height, or by causing them to pass more slowly through a magnetic field of less height, which may be effected by immersing the magnetic pole-pieces within a body of water or like liquid, through which the particles will sink more slowly than through the air, or by causing the particles to roll down the surface of an inclined plane located in the field, or by placing the particles upon a thin disk or plate arranged horizontally or substantially horizontally within the field and imparting to the disk or plate such vibrations as will agitate the particles, whereupon they will arrange themselves in accordance with their varying degrees of diamagnetic susceptibility.

In the accompanying drawings I have represented the preferred type of apparatus for the practice of my invention.

Figure 1 represents a top plan view of said apparatus, omitting the feeding-hopper; and Fig. 2 represents a front elevation of the apparatus, showing said hopper.

Similar letters of reference indicate similar parts in both views.

Referring to the drawings, the apparatus herein shown is one wherein a highly-concentrated field of force is obtained by causing the magnetic lines to pass between pole-pieces F, having pointed or reduced ends *f*. These pole-pieces form the terminals of cores G, connected by a yoke H and enveloped by the coils or bobbins J. In practice it will be desirable with a current of fifty amperes and five hundred volts and with bobbins having each four hundred thousand ampere-turns of No. 6 Brown & Sharpe double cotton-covered wire to employ cylindrical cores each eighty inches in length and ten inches in diameter connected by a rectangular yoke of four times the cross-section of one of the cores. The pole-pieces F may conveniently be extended laterally, so as to increase the length of the field, or I may employ a plurality of magnets—as, for instance, two magnets of the type shown—arranged one above the other in such manner that their interpolar spaces shall constitute a continuous passage for the falling body of material to be separated. The placer-sand, crushed quartz, or other material to be separated is fed into the intense magnetic field existing between the pointed ends of the pole-pieces from a hopper or supply-receptacle K, and in their descent the particles of gold or silver move out laterally from the falling column into the less intense field existing between the slanting or inclined sides of the pole-pieces. Consequently the particles of gold or silver may be separately collected as heads of more or less complete concentration in the outer receiving-hopper L, whereas the main body portion of sand, deprived of its gold and silver, is collected, for instance, in the central receptacle M.

Having thus described my invention, what I claim is—

The method of separating diamagnetic particles from a mixture containing them, which consists in feeding the mixture into a relatively-intense part of a magnetic field, continuing it in and subjecting it to the action of the magnetic field until the diamagnetic particles to be separated have gradually moved out from the mixture into a relatively-weak part of the field, and then collecting said particles separately as heads, substantially as described.

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

ELMER GATES.

Witnesses:

EDWIN S. CLARKSON.

JOHN C. PENNIE.