No. 854,768. PATENTED MAY 28, 1907.

F. T. SNYDER.

SHAKING TABLE SEPARATOR.

APPLICATION FILED OCT. 31, 1904.

2 SHEETS—SHEET 1.

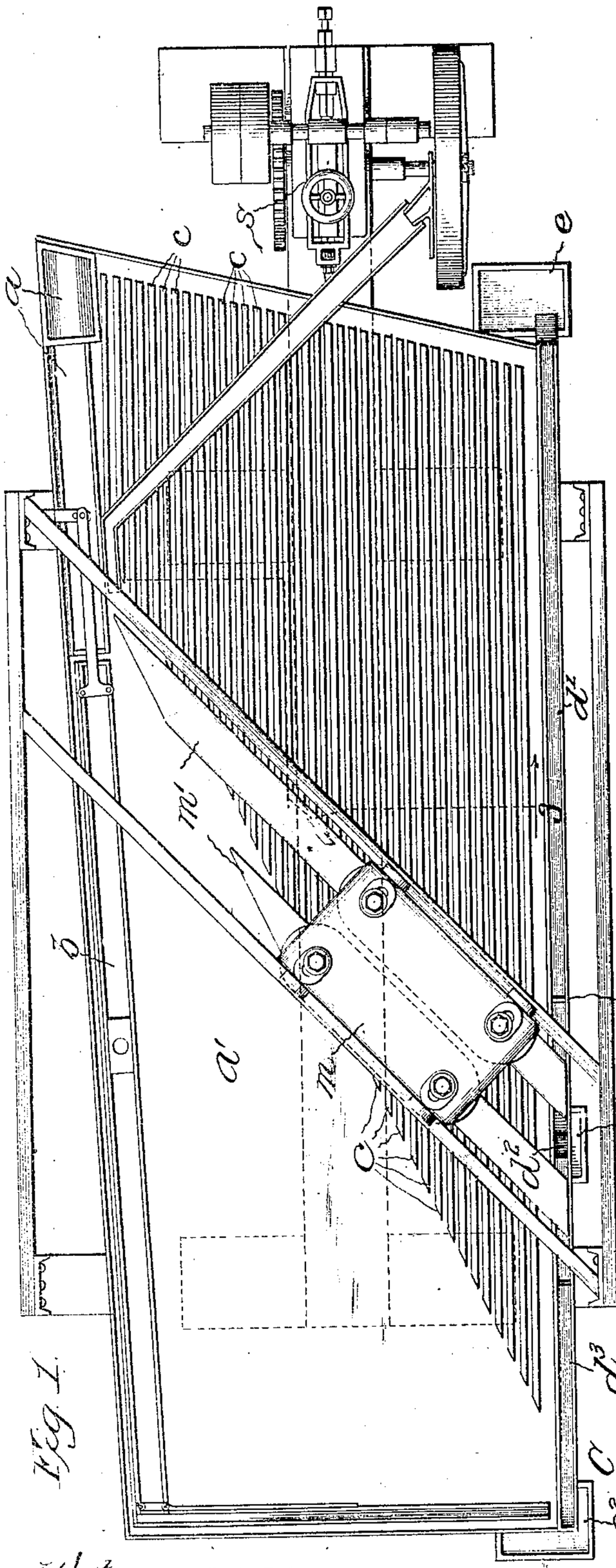

Fig. 1.

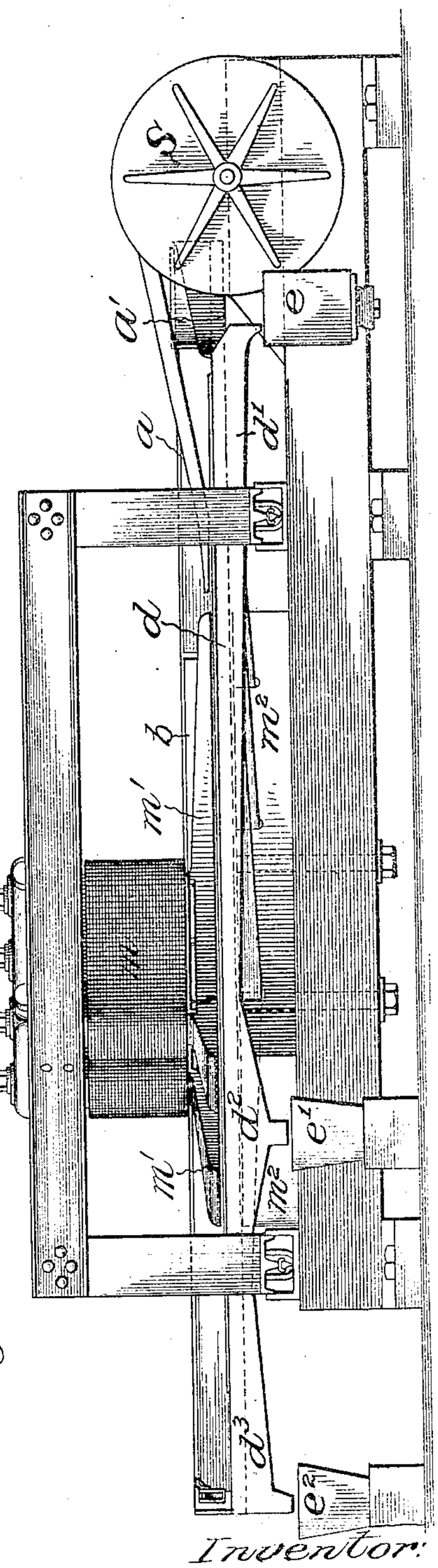

Fig. 2.

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2 SHEETS—SHEET 2.

Fig. 3.

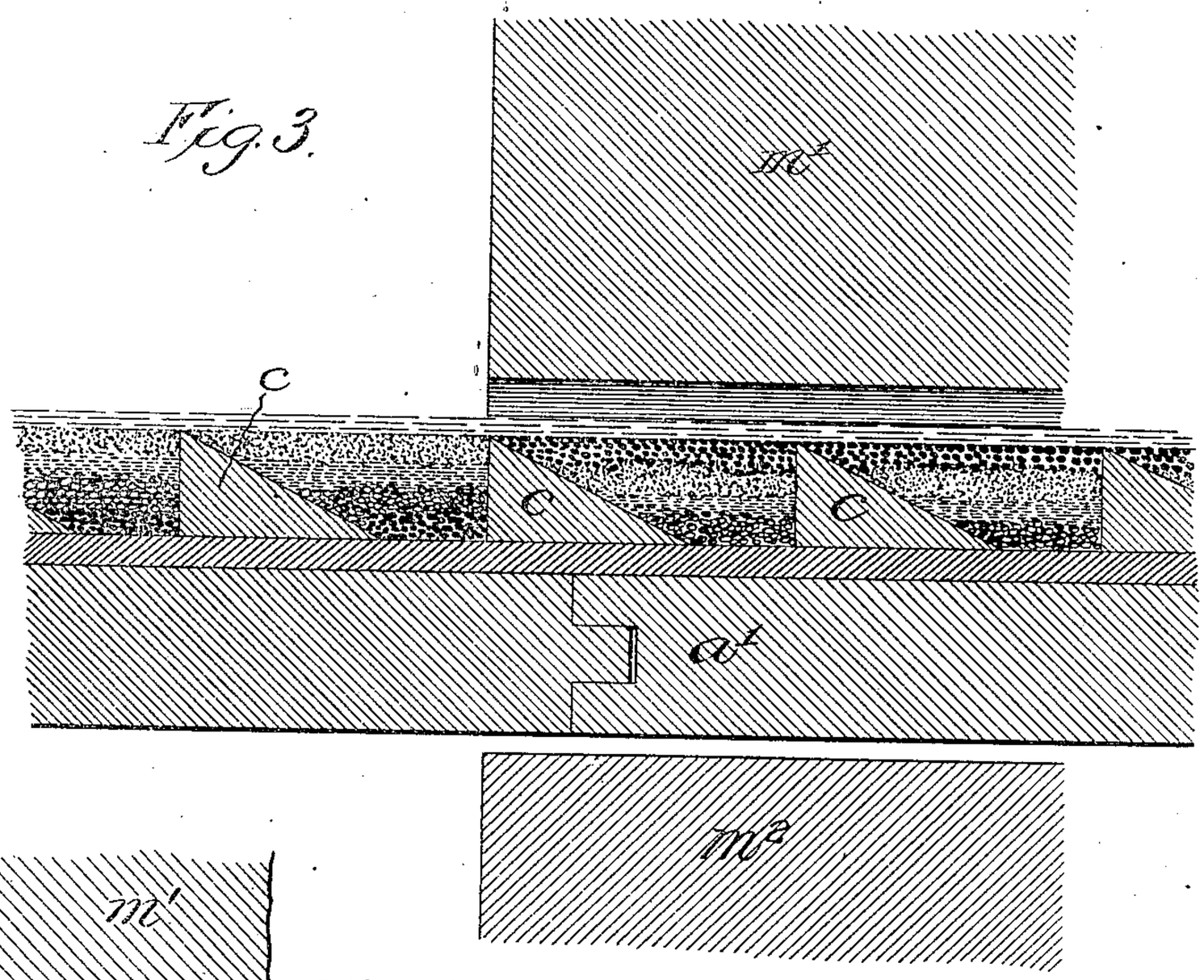
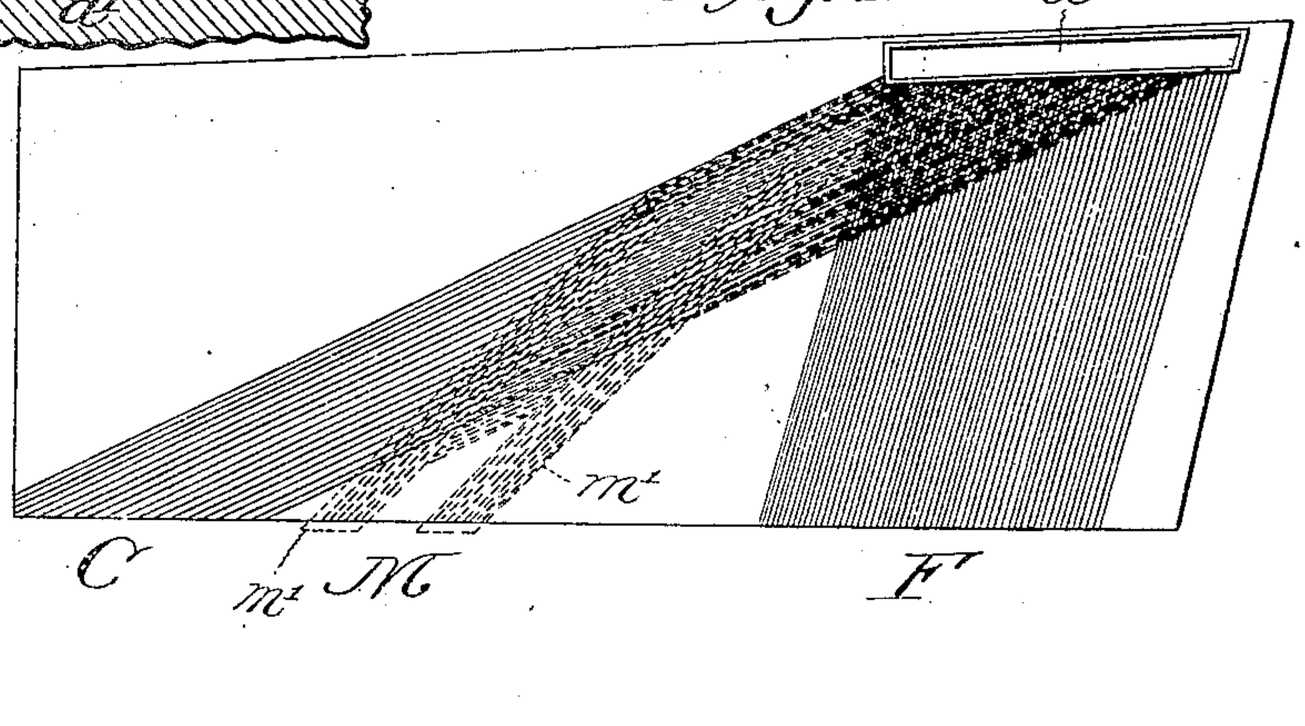


Fig. 5.

Fig. 4.



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UNITED STATES PATENT OFFICE.

FREDERICK T. SNYDER, OF CHICAGO, ILLINOIS, ASSIGNOR TO INTERNATIONAL SEPARATOR COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF NEW JERSEY.

SHAKING-TABLE SEPARATOR.

No. 854,768. Specification of Letters Patent. Patented May 28, 1907.

Application filed October 31, 1904. Serial No. 230,640.

To all whom it may concern:

Be it known that I, FREDERICK T. SNYDER, a citizen of the United States, residing at Chicago, Oak Park, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Shaking-Table Separators, of which the following is a full, clear, concise, and exact description.

My invention relates to an ore concentrator, and has for its object to provide improved apparatus for separating magnetically permeable ores from mixtures of materials containing such ores; my invention being more particularly intended to be used in connection with mixtures of ores or materials which have so nearly the same specific gravity that they could not ordinarily be separated by the usual type of shaking table separator which is dependent for its operation upon the different specific gravities of the materials worked upon.

For example, where the mixture is composed of materials whose specific gravities do not differ more than one unit such as a mixture of feldspar, hornblende, magnetite and corundum, the ordinary type of shaking table concentrator is ineffective to separate any one of these materials from the rest.

My invention, broadly speaking, contemplates the application of a magnet to a shaking table concentrator, the magnet being adjusted so as to act upon the materials upon the table to the extent of changing the effective weight of the more permeable particles, so that the relative effective weights of the different materials in the mixture will be readjusted with a view of permitting the separation of the effectively lighter particles from the others.

I will describe my invention particularly by reference to the accompanying drawings, which illustrate the preferred embodiment thereof.

Figure 1 is a plan view of the ore concentrator constructed and equipped in accordance with my invention; Fig. 2 is an elevation thereof; Fig. 3 is a sectional enlarged diagram on line 3—3 of Fig. 1, showing a portion of the table in cross section, together with the materials thereon to illustrate the readjustment in the relative positions of the materials which takes place under the influence of the magnet; and Fig. 4 is a diagrammatic plan view of the table showing the distribution and separation of the materials. Fig. 5 is a detail cross sectional view illustrating teeth or ridges upon the pole face of the magnet.

The same letters of reference indicate the same parts wherever they are shown.

The concentrating table shown in the drawings, except for the magnet and its supporting parts, is a type well known in the art. The material is fed onto the table a' through the feed box a shown in the upper right hand corner of Fig. 1, from which it is gradually caused to move along the table toward the other end. Such movement is caused by the differential reciprocating or shaking movement of the table produced by the mechanism S of the usual type. The return movement of the table at the end of its movement toward the left in Fig. 1 is much quicker than its return from the movement toward the right. This differential reciprocating motion, as is well known, will cause a step-by-step progression of the materials on the table toward the left hand end. This movement may be assisted somewhat by a slight inclination of the table in the same direction. The table is also slightly inclined about its longitudinal axis, so that wash water fed to the table through the clear water box b in the upper right hand portion will flow down the surface of the table in the usual manner. Riffles $c\ c$ are provided upon the surface of the table, said riffles extending parallel to the direction in which it is reciprocated. As shown, the riffles are successively longer toward the lower part of the table, so that their left hand ends are located in a diagonal line from the upper right hand corner to the lower left hand corner thereof.

The normal operation of such a table is that the materials fed onto the table through the feed box a are gradually moved along the table parallel to the riffles $c\ c$, by the differential reciprocating or shaking motion which is imparted to the table by the mechanism S. At the same time dressing water flowing across the table transversely to the riffles carries the lighter material over the tops of the riffles and downward to the lower edge of the table. The heavier material, however, sinks to the bottom of the channels between the riffles and continues its passage down the

table parallel to said riffles. The result is that the lighter materials are separated from those which are heavier, the lighter materials coming off near the forward end of the table, while the heavier materials stay on the table until they reach the lower end.

As before stated, however, unless there is a difference of over one unit in the relative specific gravities of the materials in the mixture to be separated, such a separation cannot be properly made in the manner above described; and in accordance with my invention I mount a magnet adjacent to the table and adjust the same to act upon the magnetic particles in the mixture of materials, in such a way as to vary their effective weight, producing in this way a difference in the effective weight of the magnetic and non-magnetic materials sufficient to admit of their separation by the shaking table. This result may be obtained by disposing the magnet *m* immediately above the table with its pole pieces *m' m'* extending in lines diagonal to the riffles, with the faces of said pole pieces as close to the surface of the table as practical. The faces of the pole pieces should be roughened or provided with permeable projections to establish convergences of the lines of force toward said poles, since the magnetic particles tend to follow the converging lines of force.

To decrease the reluctance of the magnetic circuit, an iron plate m^2 may be provided underneath the table directly below the magnet poles.

By the means above described, a series of narrow areas of magnetic concentration is established, in lines diagonal to the general direction of passage of the materials upon the table. The effect of the magnetic field thus established is that when the materials upon the table come within the influence of said field, the more permeable particles are so influenced that their effective weight is changed with relation to the non-magnetic materials, the permeable particles in this instance rising to the top of the mixture, where they may be washed off by the dressing water, while the less permeable particles remain at the bottom and are gradually carried along parallel to the riffles by the differential shaking motion of the table.

In the diagram Fig. 3 I have illustrated the rearrangement of the materials in the mixture which is brought about when said materials come within the range of influence of the magnet. The left hand portion of the figure illustrates the relative positions which the different materials in the mixture will assume under normal conditions, while the right hand portion of the figure illustrates the relative positions of the materials when the magnetic particles have been rendered effectively lighter under the influence of the magnet.

The magnet should not be of sufficient strength to actually lift the magnetic particles off the table or draw them out of the mixture, but simply to overcome the force of gravity to such an extent that in the shaking of the table they will be brought to the top where they can readily be washed off by the dressing water.

To give a specific illustration, the ordinary relative weights of feldspar, hornblende, magnetite and corundum under water are indicated by the following figures: feldspar, 1.50; hornblende, 2; magnetite, 4; corundum, 3.

It will be seen that there is not sufficient difference in the specific gravities of these several materials to permit of a ready separation thereof by the ordinary type of shaking table concentrator. With the concentrator of my invention, however, equipped with the magnet, when the materials come within the influence of the magnet, their apparent or effective weights under water become as follows: feldspar, 1.50; hornblende, 1.50; magnetite, 1.50; corundum, 3. That is to say, the corundum is now the heaviest material in the mixture, and there is a difference of one and a half units between its specific gravity and the apparent or effective specific gravity of either of the other materials; whereas without the magnet the magnetite would be heavier than the corundum, but not enough heavier to permit of satisfactory separation by the shaking table. Such a mixture of feldspar, hornblende, magnetite and corundum may therefore be separated by means of my concentrator as above described, the feldspar, hornblende and magnetite under the influence of the magnet being raised to the top of the riffle by the shaking of the table, and washed from the riffles by the dressing water, coming off at the lower edge of the table in the zone marked M, while the corundum will be carried along to the lower end of the table where it will finally come off in the zone marked C.

Under present methods of operation, the different minerals to be separated are also found associated with large quantities of silica or other barren rock, usually equaling from three to ten times the weight of the mineral. The present practice consists in putting the ore over a wet shaking table which separates the gangue from the mineral. The mineral is then dried and put through a magnetic separator for the separation of the different minerals. In my present form of appáratus these second and third steps are avoided, as the material is separated magnetically at the same time that the mineral is concentrated out of gangue. It will be seen that the operation of the magnet interferes in no way with the concentration of the minerals from the gangue. The paths taken by the different materials are illustrated in Fig. 4, the zone marked F being that occu-

pied by the feldspar, which in the illustration selected is the gangue material. The path of the magnetite is indicated at M, and the path of the corundum is indicated at C. A trough is provided along the lower side of the table, and is divided into three compartments d' d^2 d^3. The compartment d' is adapted to receive the feldspar or other light silicates and convey the same to a suitable receptacle e; similarly the compartment d^2 receives the magnetite or other magnetic particles, and conveys the same to a box e', while the heaviest non-magnetic material, such as corundum, is conveyed by the compartment d^3 to a box e^2.

Having thus described my invention, I claim:

1. In a concentrator, the combination with a transversely-inclined shaking table having longitudinal channels thereon, of means for feeding a mixture of magnetic and non-magnetic minerals and gangue to the head of the table, means for imparting a differential reciprocating motion to the table parallel to said channels in a direction to cause a travel of the mixture toward the foot of the table, means for flowing water across the table transversely to said channels to remove the gangue from the mixture, and a magnet suspended above the table near the foot thereof and adapted to exert a lifting force upon the magnetic constituents of the mineral concentrate, sufficient to cause said constituents to be washed by the water across said channels into a path divergent from the remainder of said concentrate.

2. In a concentrator, the combination with a table, of means for feeding materials to be separated to said table, means for agitating said table to pass said materials gradually along the table longitudinally thereof, a magnet having pole pieces above the table close to the surface thereof, said pole pieces extending across the table to the lower lateral edge thereof in a direction diagonal to the direction of passage of materials along the table, and means for flowing water across the table, substantially as set forth.

3. In a separator for mixtures of materials of different magnetic permeability, but of nearly the same specific gravity, the combination with a transversely-inclined table and means for feeding the mixtures of materials in a thin layer upon the table, a series of low obstructions extending longitudinally upon the table, means for imparting a differential reciprocating motion to said table in a direction to cause a gradual movement of the materials along the table substantially parallel to said obstructions, means for establishing a flow of water across the table at an angle to said obstructions, and a magnet adapted to act upon the materials upon said table to the extent of changing the effective weight of the more permeable particles relative to the weight of the other materials, whereby the materials having the highest effective weight rise above the level of the other materials and are washed over said obstructions by the water, and so separated.

4. In a concentrator, the combination with a table having longitudinal riffles thereon, of means for feeding materials to be separated to said table, means for imparting a differential reciprocating motion to said table in a direction substantially parallel to said riffles to cause a net travel of the material along the channels between said riffles, means for flowing water across the table transversely to the riffles, and a magnet suspended above the table adapted to exert a lifting force upon the magnetic particles sufficient to enable said particles to be washed by the water across the riffles, whereby said magnetic particles are separated from the heavy non-magnetic materials.

5. In an ore-concentrator, in combination, for effecting selective separation of various mineral values and gangue, a table having a riffled top slightly inclined from the horizontal, means for supplying a flow of water over said table-top, means for feeding onto the higher part of the table-top the mixed materials to be separated, mechanism for differentially agitating said table-top, and a source of magnetic influence of limited intensity so arranged that such of said materials as are of like specific gravity but diverse magnetic properties will have their flotation differentiated while passing through the magnetic field and will be resultantly dispersed and isolated from each other, substantially as specified.

6. In an ore-concentrator, in combination, for effecting selective separation of various mineral values and gangue, a table having a riffled top slightly inclined from the horizontal, means for supplying a flow of water over said table-top, means for feeding onto the higher part of the table-top the mixed materials to be separated mechanism for differentially agitating said table-top, and an electromagnet of limited intensity so arranged that such of said materials as are of like specific gravity but diverse magnetic properties will have their flotation differentiated while passing through the magnetic field and will be resultantly dispersed and isolated from each other, substantially as specified.

7. In an ore-concentrator, in combination, for effecting selective separation of various mineral values and gangue, a table having a riffled top slightly inclined from the horizontal, means for supplying a flow of water over said table-top, means for feeding onto the higher part of the table-top the mixed materials to be separated, mechanism for differentially agitating said table-top, and an electromagnet of limited intensity suspended

slightly above the water-current flowing over said table-top and arranged so as to facilitate the flotation and resultant isolation of such of said materials as are of like specific gravity with others but of higher paramagnetic properties, substantially as specified.

8. In an ore-concentrator, in combination, for effecting selective separation of various mineral values and gangue, a longitudinally movable table having its top slightly inclined from the horizontal and provided with a series of longitudinal riffles successively increasing in length from the upper toward the lower edge of said table, means for supplying a flow of water over said table-top from its upper toward its lower edge, means for feeding onto the higher part of the table-top above the shortest riffle the mixed materials to be separated, mechanism for imparting differential reciprocating movement to said table, and a source of magnetic influence of limited intensity so arranged that such of said materials as are of like specific gravity but diverse magnetic properties will have their flotation differentiated while passing through the magnetic field and will be resultantly dispersed and isolated from each other, substantially as specified.

9. In an ore-concentrator, in combination, for effecting selective separation of various mineral values and gangue, a longitudinally movable table having its top slightly inclined from the horizontal and provided with a series of longitudinal riffles successively increasing in length from the upper toward the lower edge of said table, means for feeding onto the higher part of the table-top above the shortest riffle the mixed materials to be separated, mechanism for imparting differential reciprocating movement to said table, and an electro-magnet of limited intensity so arranged that such of said materials as are of like specific gravity but diverse magnetic properties will have their flotation differentiated while passing through the magnetic field and will be resultantly dispersed and isolated from each other, substantially as specified.

10. In an ore-concentrator, in combination, for effecting selective separation of various mineral values and gangue, a longitudinally movable table having its top slightly inclined from the horizontal and provided with a series of longitudinal riffles successively increasing in length from the upper toward the lower edge of said table, means for supplying a flow of water over said table-top from its upper toward its lower edge, means for feeding onto the higher part of the table-top above the shortest riffle the mixed materials to be separated, mechanism for imparting differential reciprocating movement to said table, and an electro-magnet of limited intensity suspended slightly above the water-current flowing over said table-top and arranged so as to facilitate the flotation and resultant isolation of such of said materials as are of like specific gravity with others but of higher paramagnetic properties, substantially as specified.

In witness whereof, I hereunto subscribe my name this 10th day of October A. D., 1904.

FREDERICK T. SNYDER.

Witnesses:

DE WITT C. TANNER,

WINFIELD W. LEACH.