No. 871,365. PATENTED NOV. 19, 1907.

A. SCHWARZ.

MAGNETIC SEPARATOR.

APPLICATION FILED FEB. 1, 1906.

2 SHEETS—SHEET 1.

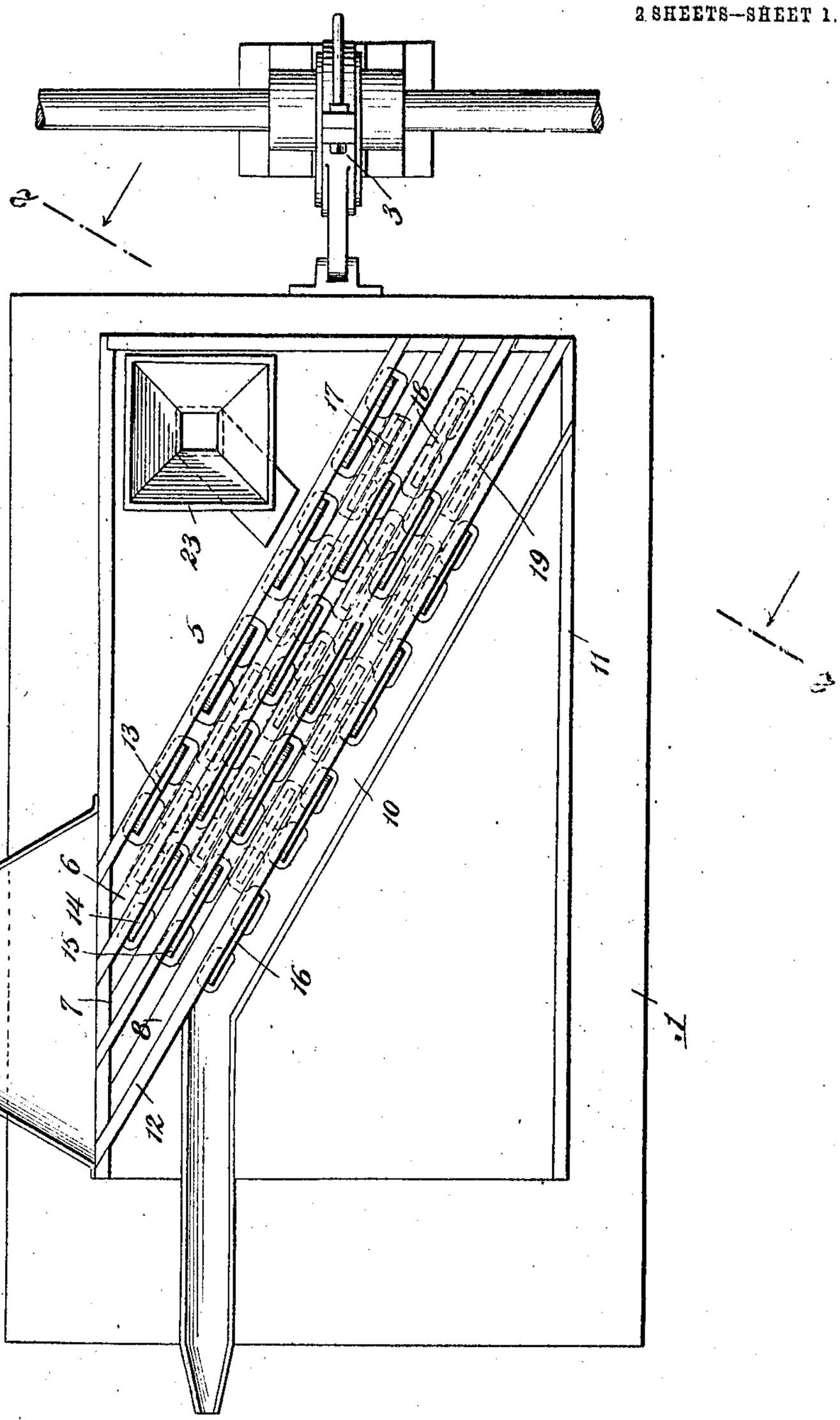

Fig. 1.

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2 SHEETS—SHEET 2.

Fig. 2.

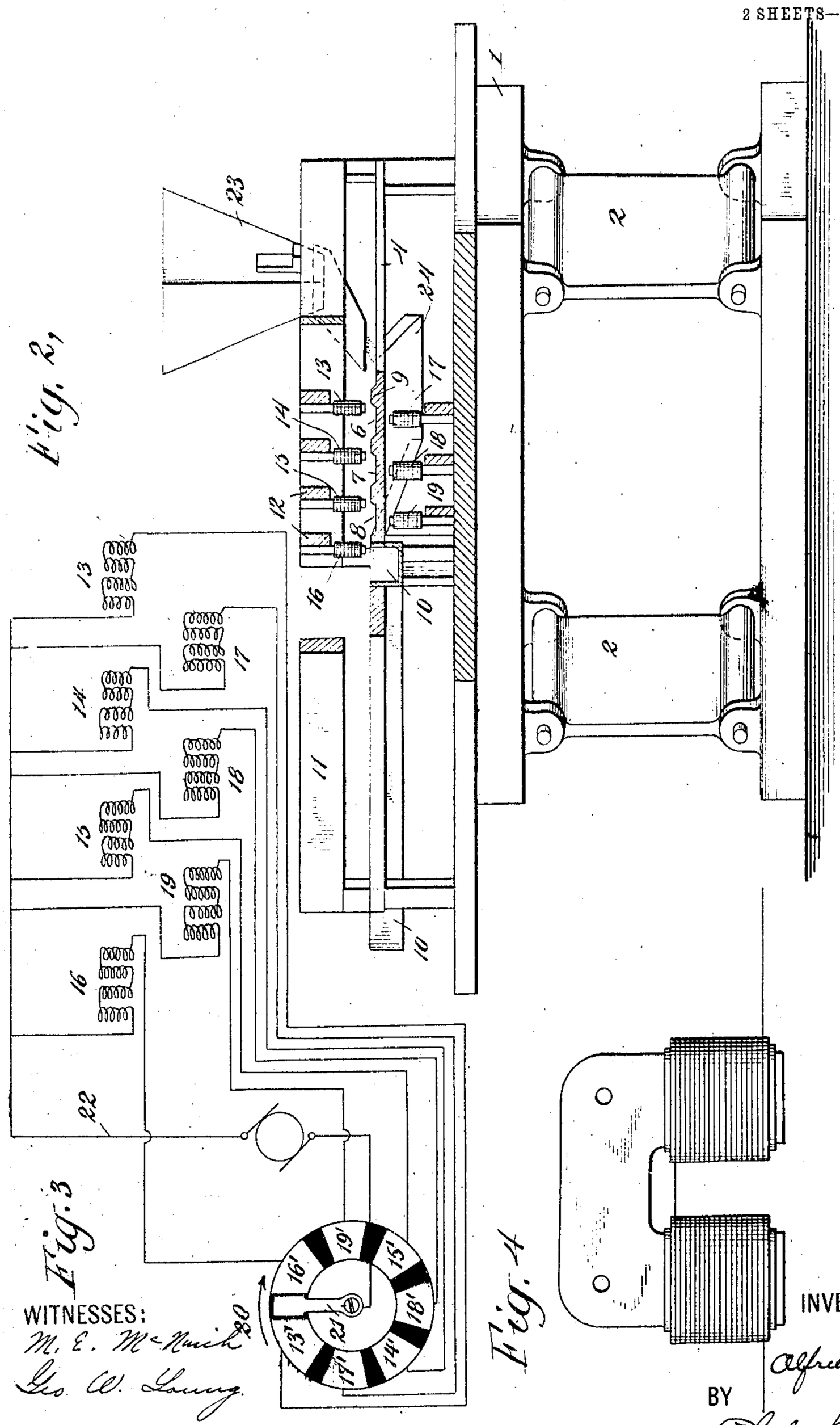

Fig. 3.

Fig. 4.

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MAGNETIC SEPARATOR.

No. 871,365. Specification of Letters Patent. Patented Nov. 19, 1907.

Application filed February 1, 1906. Serial No. 298,077.

To all whom it may concern:

Be it known that I, ALFRED SCHWARZ, a subject of the Emperor of Germany, and a resident of the borough of Manhattan, city, county, and State of New York, have invented certain new and useful Improvements in Magnetic Separators, of which the following is a specification.

The present invention relates to magnetic separators and is designed to effect a more thorough separation of the magnetic from the non-magnetic particles of the material treated than has heretofore been possible.

The invention comprises a table upon which is secured what I have termed a riffle-board. The separation of the magnetic particles is effected by a bank of electromagnets arranged above and having their polar faces in close proximity to the upper side of said board. These magnets are disposed in rows preferably running obliquely of the riffle-board and parallel with the riffles thereon. By means of a suitable commutator the rows of magnets are successively energized and deënergized so as to develop magnetic fields of force along successive sections of said board. By this arrangement the non-magnetic particles will be caused to travel along the riffles and the magnetic particles will be carried in a direction substantially transverse thereto. To assist the action of the separating magnets I provide a bank of electromagnets arranged in rows with their polar faces in close proximity to the under side of the riffle-board and extending below substantially the center of the riffles. The rows of magnets of the upper and lower banks are staggered relatively to each other and are so connected to the commutator that a row of magnets of the lower bank will be energized between the periods of magnetization of contiguous rows of the upper bank.

The relative arrangement of the several parts and the functions performed by each will be understood by reference to the accompanying drawings in which

Figure 1 is a top view of my improved separator; Fig. 2 a vertical section on the plane of the line 2—2 of Fig. 1; Fig. 3 a diagrammatic view of the commutator and the circuit connections; and Fig. 4 a side view of one of the electromagnets.

Similar reference numerals indicate similar parts in the several views.

Referring to the drawings the numeral 1 designates a table which is mounted on rocking supports 2 and reciprocated by any suitable means, preferably in a horizontal direction by an eccentric or crank 3. Secured to the table 1 at a suitable distance above the bed thereof is a board 4 the upper side of which is divided into any convenient number of riffles, four such being shown for the purpose of illustration designated respectively 5, 6, 7, and 8. These riffles preferably run parallel with each other and may be easily formed by attaching slats 9 to the bed of the board or by grooving the upper side thereof. It will be noted that the riffles run diagonally of the board and of the table 1, it being the function of the upper bank of magnets to transport the magnetic particles across the board at an angle to the longitudinal direction of the riffles, and of the latter to provide a means of escape for the non-magnetic particles, as will be more fully explained hereafter.

The magnetic separation is effected by a bank of electromagnets mounted upon a frame 11 secured to the reciprocating table 1. The said frame comprises a series of parallel slats 12 to which the magnets are attached. It may be here stated that any suitable form of electromagnet may be employed but I prefer one of U shape in order to utilize the entire magnetic field. This bank of separating magnets is divided into rows running parallel with the riffles, their polar faces extending to within a short distance above the board. For the purpose of illustration I have shown four rows designated respectively 13, 14, 15, and 16, each row comprising four magnets. The rows of the upper bank are so disposed that the magnets are above and a little to one side of the center line of the slats or ribs 9 of the riffle-board 4, the magnets 16, constituting the last row, being so placed that when they are deënergized the magnetic particles previously raised thereby will be deposited in a trough 10 secured below an opening in the riffle-board and along which they will be carried gradually by the jogging motion of the table to a suitable bin. Secured to the bed of table 1 is a second bank of electromagnets also divided into rows, three being shown designated respectively 17, 18 and 19, each comprising four magnets. These are so disposed that their polar faces are in close proximity to the under side of the riffle-board substantially under the center line of the riffles 6, 7 and 8 respectively. The function of the lower bank of magnets is to draw

the magnetic particles which are released upon the de-magnetization of the magnets 13, 14 and 15, into the riffles and to momentarily hold them against mechanical disturbance between the periods of their movements from one riffle to another by the magnets of the upper bank. The magnets of the lower bank are preferably weaker than those of the upper bank.

The magnets of contiguous rows of the upper bank may be so arranged that poles of like or opposite polarity face each other. The same condition may obtain in the rows of magnets of the lower bank. Similarly the magnets of the upper and lower banks relative to each other may be so disposed that a pole of the former is above one of like or opposite polarity. Whatever the magnetic disposition may be I prefer to advance the rows of both banks of magnets in the longitudinal direction of the riffle-board in the manner shown so that the magnetic fields as they are successively developed may be effective over the mass of material as it is thrown forward by the jogging movement of the table. The magnets of both banks are controlled by a commutator 20, the circuits being shown diagrammatically in Fig. 3. This commutator is mounted on a shaft and rotated by any suitable means at a speed adapted to the effective operation of the separator. It is divided into sections by suitable insulation, the sections corresponding to the total number of rows of magnets in both banks, these sections being designated respectively in the order of rotation 13′, 17′, 14′, 18′, 15′, 19′ and 16′. A stationary brush 21 in contact with the face of the commutator is connected to one terminal of the source of current. The feed line 22, connected to the other terminal, has branches leading therefrom to the several rows of magnets as shown. The rows of magnets above described are separately grouped in series, each row being connected to a corresponding commutator section, that is magnets 13 to section 13′, magnets 17 to section 17′ and so on, it resulting therefrom that during a single rotation of the commutator the rows of magnets will be energized in the following order, 13, 17, 14, 18, 15, 19; 16. That is, the magnets are energized in rows alternately above and below the riffle-board, only one row being energized at a time.

The method of operation of the above described separator is as follows: The material to be treated is first ground to any desired mesh and fed to the riffle-board through a chute or hopper 23 so that it will fall in proximity to the polar faces of the magnets 13 of the upper bank. When said magnets are energized the magnetic particles will be attracted and remain attached to the poles thereof during their period of magnetization. As soon as magnets 13 are deënergized by the section 13′ of the commutator passing from under the brush 21 the attracted particles will be released and at the moment of de-magnetization of said magnets the magnets 17 will be energized by reason of the contact of section 17′ of the commutator with brush 21. Under the combined attractive force of magnets 17 and the jogging motion of the table the particles released from magnets 13 will be deposited in riffle 6. From the latter the magnetic particles will be lifted out when magnets 14 are energized by the contact of section 14′ of the commutator with brush 21 and deposited in riffle 7 under the attractive force of magnets 18 and the jogging motion of the table when the former magnets are deënergized and the latter energized in the course of the rotation of the commutator. The above described operations are repeated by magnets 15 and 19 as they are successively energized and deenergized. From the last riffle 8 the magnetic particles will be raised by magnets 16, and when the latter are deënergized the released particles will fall into a trough or chute 10 secured to the riffle-board below an opening therein. The movement of the table will cause the magnetic particles to gradually move toward the outlet of said chute to be deposited in a suitable bin. The speed of rotation of the commutator and the intensity of the magnetic fields developed in the rows of magnets progressively across the riffle-board may be varied according to the character of the material treated and the thoroughness of the separation desired. In practice these conditions have been so adjusted that the magnetic particles are swept across the upper side of the board in rapidly succeeding wave-like formations. The interval of time elapsing between the magnetization of successive rows of the upper bank with the intervening fields of force developed alternately therewith in the rows of the lower bank is of such short duration that a given mass of magnetic particles separated by the magnets 13 barely touches the riffles as it is swept onward by the fields successively developed in magnets 13, 14, 15 and 16.

The reciprocations of the riffle-board as the material is fed to it tend to throw the latter in the longitudinal direction of said board. This results in the non-magnetic particles being carried along the riffle-board in the direction of its length, a large percentage of such particles being set free at the first separation by the magnets 13 and they will be gradually carried by the jogging motion of the table along the riffle-board outside of but within the fields of said magnets so that when a given mass has been carried along the board it will be practically freed of all magnetic particles. More or less non-magnetic particles will be carried over me-

chanically in the masses, separated by the magnets 13 but as such masses are turned over and over during their progress across the board the non-magnetic particles are set free and will fall into the riffles along which they will be carried to a chute 24 to be deposited in a suitable bin. As many riffles may be provided as will in practice insure the complete separation of all of the magnetic particles by the time a given mass reaches the last riffle 8. A separator constructed in accordance with the present specification has been found in practice to give excellent results with four riffles, it being found that a very small percentage of non-magnetic particles is carried so far as the riffle 7. During the sweep of the magnetic particles between the magnets 13, 14, 15, and 16 the lower magnets 17, 18 and 19 tend to hold said particles from being thrown forward by the jogging movement of the table so that such motion primarily acts to release the non-magnetic particles and to facilitate their travel toward the outlets of the riffles.

The angle at which the riffles may be disposed may be varied, an angle of 30° to the center line of the riffle-board having been found in practice to give good results. The longitudinal disposition of the magnets will be at the same angle, but, as will be noted, the successive fields of force draw the magnetic particles in a direction substantially transversely to that of the riffles, so that the described separation is effected by causing the non-magnetic particles to travel in a direction obliquiely to the riffle-board and the magnetic particles to be carried in an opposite oblique direction across said board.

The table 1 may be of sufficient size to accommodate several separators each comprising the parts above described. In the present construction another set of magnets could be arranged above and below the riffle-board but I have not deemed it necessary to illustrate the same as their operation would be similar to that above described. By providing a table with several independent separators different materials could be operated upon at the same time. This, however, will depend upon the size of the table and certain commercial considerations including cost among other things.

It will be noted that the separation of the magnetic from the non-magnetic particles is effected by the upper bank of magnets. The lower bank of magnets is not absolutely essential to the successful operation of the separator and may be omitted.

What I claim and desire to secure by Letters Patent is:

1. In a magnetic separator the combination of a table having a riffle board supported thereon, electromagnets above and having their polar faces in proximity to said board, said magnets being disposed in independent rows, means to feed the material to be separated in proximity to the first row of magnets, means to energize and deënergize said rows of magnets successively to separate a given mass of magnetic particles from the non-magnetic and to transport the former across the table by alternately attracting and releasing the same so as to fall within the fields of successive rows of magnets, rows of electromagnets below and having their polar faces in proximity to the under side of said board, and means to energize and deënergize said magnets alternately above and below the riffle board.

2. In a magnetic separator the combination of a table having a riffle board supported thereon, electromagnets above and having their polar faces in proximity to the upper side of said board, electromagnets below and having their polar faces in proximity to the under side of said board, said magnets being disposed in rows so that a lower row is in a vertical plane between the vertical planes of contiguous rows of upper magnets, and means to energize and deënergize said magnets alternately above and below said board.

3. In a magnetic separator the combination of a board on which the described separation is effected, electromagnets above and having their polar faces in proximity to the upper side of said board, electromagnets below and having their polar faces in proximity to the under side of said board, said magnets being disposed in rows and those of the lower bank being weaker than those of the upper bank.

4. In a magntiee separator the combination of a table having a riffle board supported thereon, electromagnets above and having their polar faces in proximity to the upper side of said board, electromagnets below and having their polar faces in proximity to the under side of said board, said magnets being disposed in rows, and a commutator controlling said magnets in such manner as to develop magnetic fields of force in successive rows of the upper magnets alternately with those of the lower magnets.

5. In a magnetic separator the combination of a table having a riffle board supported thereon, electromagnets above and having their polar faces in proximity to the upper side of said board, electromagnets below and having their polar faces in proximity to the under side of said board, said magnets being disposed in rows, a commutator divided into sections corresponding to the number of rows of magnets in both banks, a controlling circuit for each row of magnets connected to a corresponding commutator section, said circuits being so arranged as to alternately and successively energize the magnets in the rows of the upper and lower banks.

6. In a magnetic separator the combina-

tion of a table, a riffle board supported on said table, magnets also supported on said table, said magnets being disposed in rows in staggered relation above and below the board, means for energizing and deënergizing said rows of magnets alternately above and below said board, and means for reciprocating said table.

In witness whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ALFRED SCHWARZ.

Witnesses:
OLIN A. FOSTER,
M. E. MCNINCH.