No. 871,301. PATENTED NOV. 19, 1907.

A. SCHWARZ.

MAGNETIC SEPARATOR.

APPLICATION FILED APR. 7, 1906.

3 SHEETS—SHEET 1.

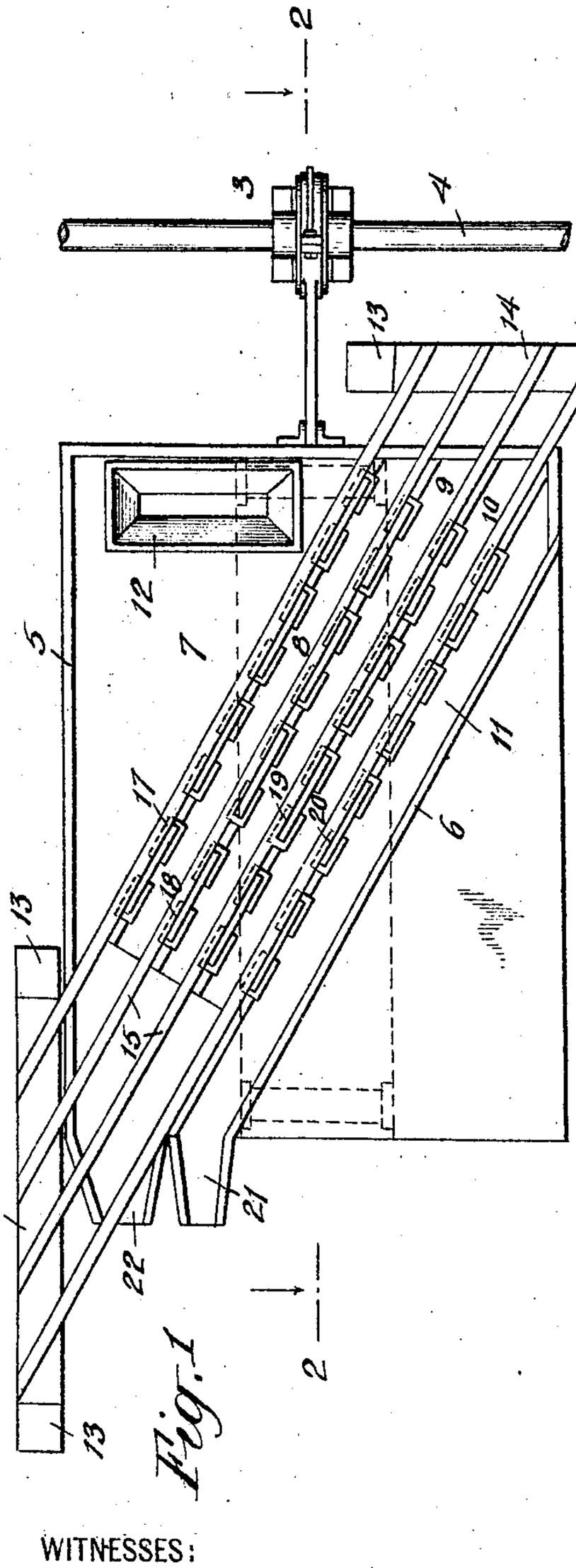

Fig. 1

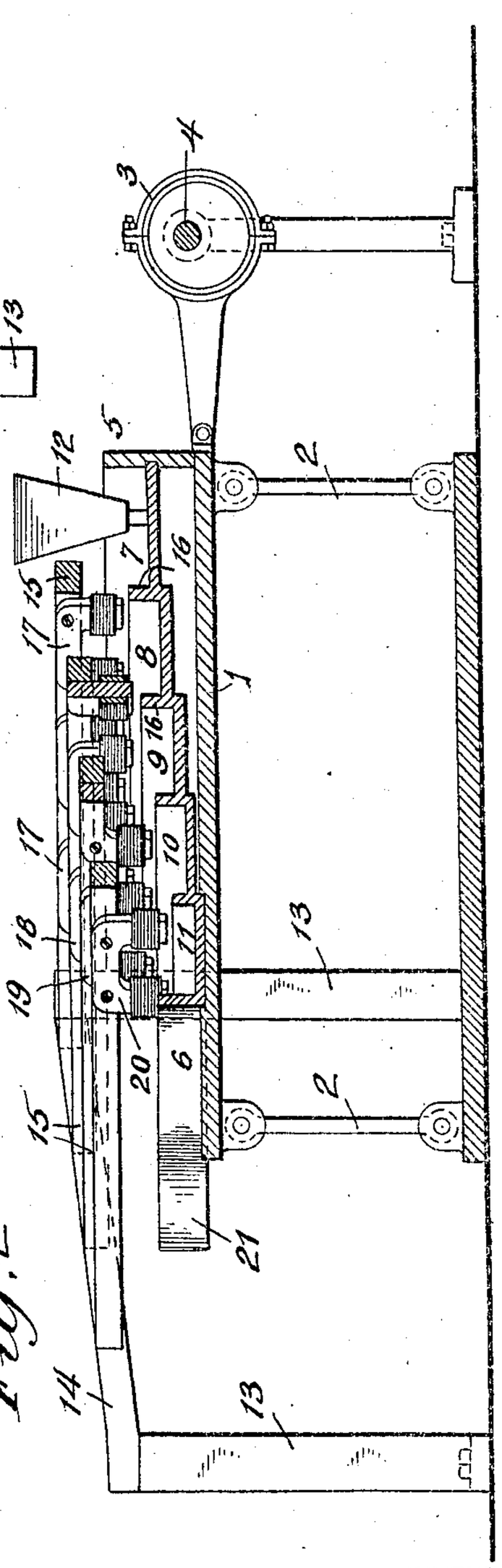

Fig. 2

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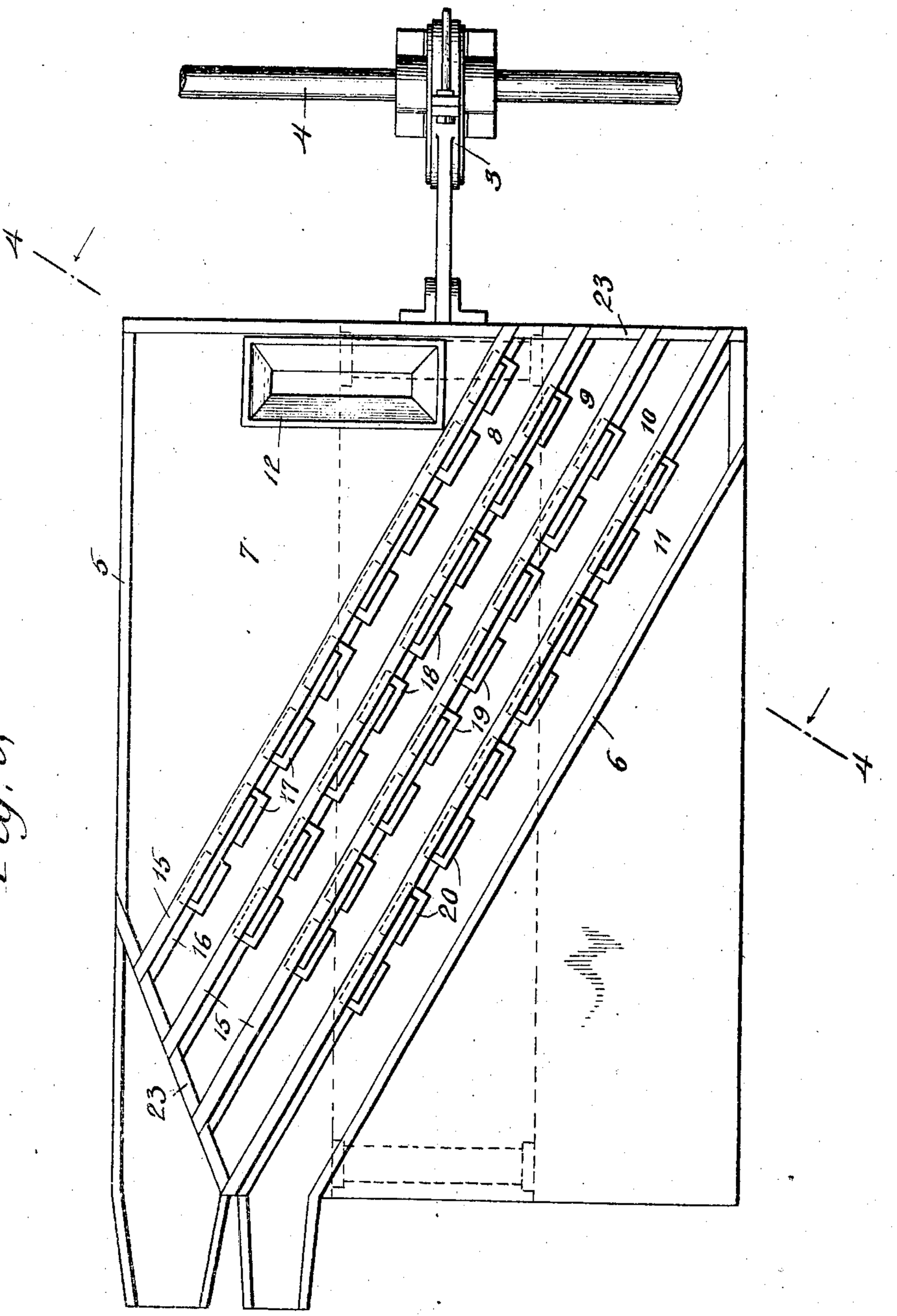

Fig. 3.

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3 SHEETS—SHEET 3.

Fig. 5.

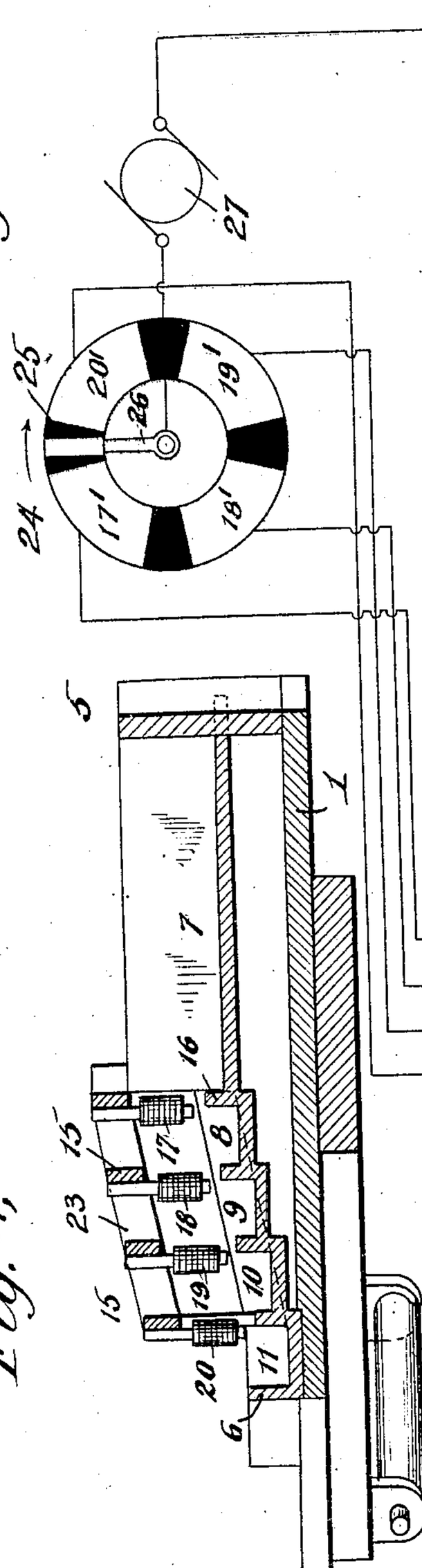
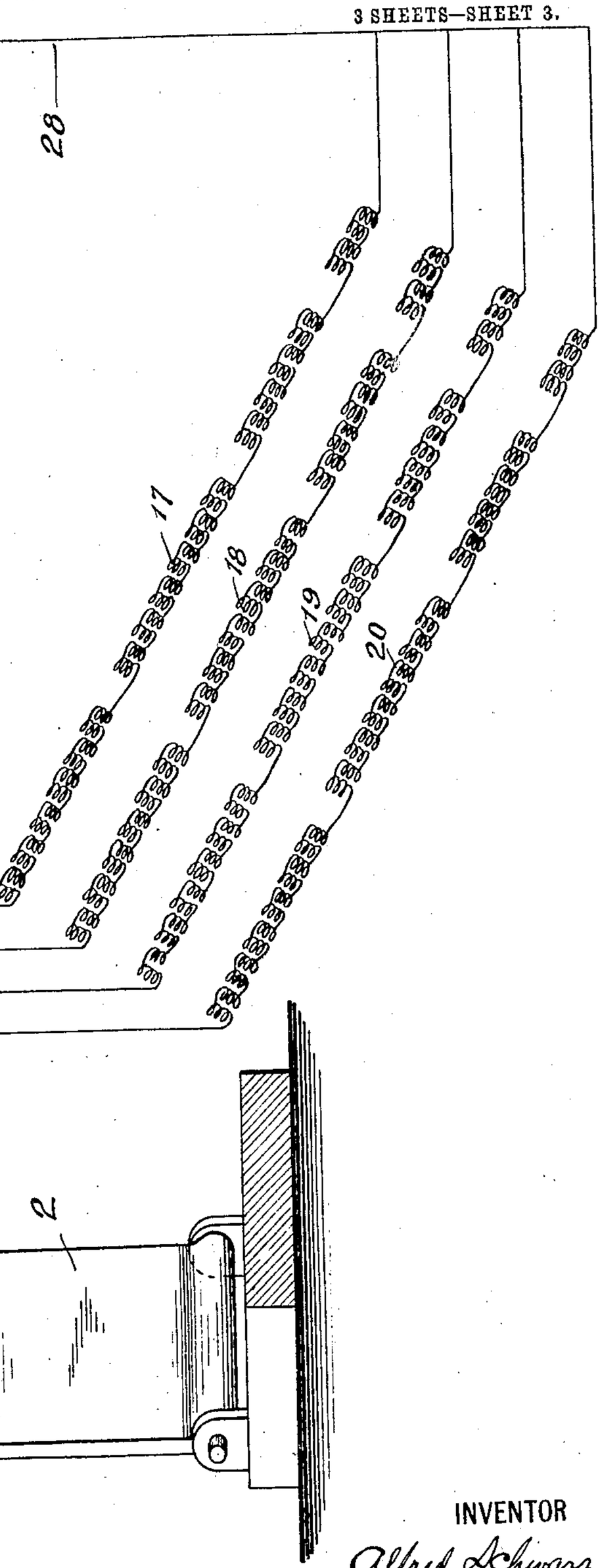


Fig. 4.



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MAGNETIC SEPARATOR.

No. 871,301. Specification of Letters Patent. Patented Nov. 19, 1907.

Application filed April 7, 1906. Serial No. 310,445.

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 in the particular embodiment thereof illustrated in the accompanying drawings comprises a table with means for imparting thereto a series of rapid reciprocations. The desired separation is effected by a bank of magnets arranged in groups or rows running diagonally across the table or at an angle to the direction of reciprocations of the table. 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 the table, the magnetic particles being transported across the table in a direction substantially transverse to that of the extension of the rows of magnets, while the non-magnetic particles are caused to travel along the table in the direction of the rows of magnets. The bank of magnets may be mounted on the reciprocating table or on a stationary frame independent of the table, the essential feature being the disposition of the magnets relatively to the table to effect the separation of the magnetic from the non-magnetic particles in the manner above stated. The magnets may be divided into as many rows as desired, and I prefer to make the magnets of each row of progressively increasing strength as will be described more fully hereafter.

In the accompanying drawings Figure 1 is a top view of one form of separator embodying my invention showing the magnets secured to a stationary frame; Fig. 2 a central longitudinal vertical section on the plane of the line 2—2 of Fig. 1; Fig. 3 a top view of a separator showing the magnets secured to the table; Fig. 4 a vertical section on the plane of the line 4—4 of Fig. 3; and Fig. 5 a diagrammatic view of the magnetic circuits and the manner of winding the magnets.

Similar reference numerals indicate similar parts in the several views.

Referring more particularly to Figs. 1 and 2 the numeral 1 designates a table mounted on pivotally supported links 2, the said table being reciprocated in a horizontal direction by a crank or eccentric 3 on the shaft 4, the latter being driven by any convenient means. Between the vertical walls 5 and 6 of the table is a series of parallel riffles 7, 8, 9, 10 and 11 preferably arranged in step-like formation and extending diagonally across the table at any desired angle. Above the riffle 7 is a hopper 12 through which the material to be separated is fed.

The separation of the magnetic particles is effected by a bank of electromagnets which may be mounted upon a stationary frame or a frame secured to the reciprocating table. The former construction is illustrated in Figs. 1 and 2 in which the numerals 13 designate the uprights of a frame secured to the floor, these uprights being connected by cross pieces 14 to which are secured slats or bars 15 running parallel with the riffles and substantially over the vertical walls 16 of the riffles. Secured to the slats 15 are electromagnets preferably of U shape in order to utilize the entire magnetic field. The magnets are so disposed that their polar faces extend to within a short distance above the vertical walls 16 so that the masses within the riffles will come within the magnetic fields, and so that when the magnetic particles are lifted from a given riffle they will be deposited in the next succeeding riffle when the corresponding row of magnets is deënergized. For the purpose of illustration I have shown the magnets divided into four groups or rows designated respectively 17, 18, 19 and 20, and each comprising four magnets. It is to be understood, however, that in practice there may be any number of rows and each row may comprise any number of magnets to effect the desired separation. The magnets 20 of the last row are so disposed as to deposit the magnetic particles, when said magnets are deënergized, in riffle 11 along which they will be gradually carried by the jogging motion of the table to a chute 21 to be deposited in a suitable bin. The riffles 7, 8, 9 and 10 along which the non-magnetic particles are caused to travel connect with a chute 22 which delivers into a bin.

As shown diagrammatically in Fig. 5 I prefer to construct the magnets so that they shall be of progressively increasing strength from the front toward the rear of the table. This may be conveniently accomplished by increasing the number of windings about the pole pieces. Thus the first magnet of each

row may have four turns, the next magnet eight turns, the next twelve turns, and so on. As the hopper 12 discharges the material to be separated in proximity to the first magnet, which is comparatively feeble, of the outer row 17 the highly magnetic particles of a given mass will be attracted thereby. As the mass now partially denuded of its magnetic particles is brought by the jogging motion of the table within the field of the second of the magnets of row 17, which is stronger than that of the first magnet, the particles of less magnetic susceptibility will be separated, and so on to the next magnet of row 17 which is of still greater strength to separate the particles of least magnetic susceptibility. The corresponding magnets of the several rows are correspondingly wound so as to be made effective in the manner above stated.

The magnets are controlled by a commutator 24 divided into sections by insulation 25, the sections corresponding to the total number of rows of magnets and designated respectively in the order of rotation 17′, 18′, 19′ and 20′. The commutator 24 is mounted on a shaft and rotated by any suitable means at a speed adapted to the effective operation of the separator, and is preferably so timed relatively to the reciprocations of the table that a given row of magnets will be deënergized at the end of each movement of the table. The advantage of this will be apparent when describing the mode of operation. A stationary brush 26 in contact with the face of the commutator is connected to one terminal of the source of current 27, and the feed line 28 connected to the other terminal has branches leading therefrom to the several rows of magnets as shown in Fig. 5. The magnets of each row are grouped in series and each row is connected to a corresponding commutator section, that is magnets 17 to section 17′, magnets 18 to section 18′ and so on, it resulting therefrom that during a single rotation of the commutator the rows of magnets will be successively energized and that but one row will be energized at a given time.

In Figs. 3 and 4 the construction and relative arrangement of the parts is the same as that heretofore described except that the slats 15 to which the magnets are secured instead of being carried upon a stationary frame are attached to cross pieces 23 mounted on the table so that the magnets will partake of the reciprocatory movements of the table.

The method of operation is as follows. The material to be treated is first crushed or ground to any desired mesh and fed to the table through the hopper 12 falling into riffle 7. The reciprocations of the table will cause the material to spread in a comparatively thin mass over said riffle in proximity to the first row of magnets 17. 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 17 are deënergized by the section 17′ of the commutator passing from under brush 20 the attracted particles will be released. When that occurs the magnetic particles will be deposited in riffle 8, the parts being so timed in the construction illustrated in Figs. 1 and 2 as to bring said riffle substantially under the magnets 17. In the construction illustrated in Figs. 3 and 4 the jogging movement will be sufficient to throw the released magnetic particles into riffle 8. From riffle 8 the magnetic particles will be attracted when magnets 18 are energized by the contact of section 18′ of the commutator with brush 26 and deposited in riffle 9 when the magnets 18 are deënergized in the course of the rotation of the commutator. The above described operations are repeated by magnets 19 and 20 as they are successively energized and deënergized. When magnets 20 are deënergized the released particles will fall into riffle 11 and the movement of the table will cause such particles to gradually move toward chute 21 and thence to be deposited in a suitable bin.

The speed of rotation of the commutator and the intensities of the magnetic fields developed in the rows of magnets successively across the table may be varied according to the character of 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 table in rapidly succeeding wave-like formations. From given masses deposited in the first riffle 7 more or less non-magnetic particles will be mechanically carried over with the magnetic particles, and as such masses are turned over and over during their progress across the table the non-magnetic particles will be set free and will fall into the riffles along which they are carried by the reciprocations of the table to chute 22.

From the above description it will be noted that the movements of the table tend to throw the material in the longitudinal direction thereof and that by reason of the oblique trend of the riffles the non-magnetic particles are caused to travel in one direction, and by reason of the disposition of the magnets and the development of successive fields of force the magnetic particles are transported in a direction substantially transverse to that taken by the non-magnetic particles. The alternate lifting and falling of the masses of magnetic particles affords an opportunity for the release of any inclosed non-magnetic particles so that when a given mass reaches the last riffle 11 it will be practically free of non-magnetic particles.

The angle at which the riffles may be disposed may vary, an angle of 30 degrees to

the center line of the table having been found in practice to give good results. As the rows of magnets are in substantial alinement with the riffle walls their longitudinal disposition will be at the same angle, but as above stated, the development of the successive fields of force have the effect of transporting the magnetic particles in a direction transverse to that of the riffles.

In order to effect the travel of the non-magnetic particles toward the foot of the table it is to be understood that the table will be given a slight downward inclination; or a so-called differential shaking means may be employed.

In my application, Serial Number 298,977, filed February 1, 1906, I have described a separator having magnets disposed in rows both above and below the table, and a commutator controlling said magnets in such manner as to develop fields of force in successive rows of the upper magnets alternately with those of the lower. In my application, Serial Number 298,978, filed February 1, 1906, I have described the same relative disposition of the magnets, the riffles on the table, however, being arranged successively in different horizontal planes, or in a step-like formation. I do not in the present application desire to claim any of the specific features claimed in said prior applications.

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

1. In a magnetic separator the combination of a table subdivided by riffles adapted to prevent transverse gravital flow of the material fed thereto, electro-magnets above and having their polar faces in proximity to said table, 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 from riffle to riffle in response to magnetic attraction, and means to receive the separated masses.

2. In a magnetic separator the combination of a table subdivided by riffles adapted to prevent transverse gravital flow of the material fed thereto, electromagnets disposed in independent rows above and with their polar faces in proximity to said table, 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 from riffle to riffle in response to magnetic attraction, and means to cause the non-magnetic particles to travel along the riffles.

3. In a magnetic separator the combination of a table subdivided by riffles adapted to prevent transverse gravital flow of the material fed thereto, electromagnets arranged relatively to said table and disposed in rows running parallel with and above the riffles, means for feeding 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 from riffle to riffle in response to magnetic attraction, and means to cause the non-magnetic particles to travel along the riffles.

4. In a magnetic separator the combination of a table subdivided by riffles adapted to prevent transverse gravital flow of the material fed thereto, means to reciprocate said table, a stationary frame, magnets secured to said frame and disposed in independent rows above the table, means for feeding 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 from riffle to riffle by magnetic attraction, and means to receive the separated masses.

5. In a magnetic separator the combination of a table subdivided by riffles adapted to prevent transverse gravital flow of the material fed thereto, electromagnets above and having their polar faces in proximity to said table, said magnets being disposed in independent rows and the magnets of each row of progressively increasing strength, means for feeding 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 from riffle to riffle in response to magnetic attraction, and means to receive the separated masses.

6. In a magnetic separator the combination of a table subdivided by riffles adapted to prevent transverse gravital flow of the material fed thereto, said riffles being arranged in step-like formation, electromagnets disposed in rows above and with their polar faces in proximity to said table, means for feeding the material to be separated to the uppermost riffle and in proximity to the first row of magnets, means for energizing and deënergizing said rows of magnets successively from the uppermost to the lowermost to separate a given mass of magnetic particles from the non-magnetic and to transport the former from riffle to riffle in response to magnetic attraction, and means to receive the separated masses.

7. In a magnetic separator the combination of a table subdivided by riffles adapted

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to prevent transverse gravital flow of the material fed thereto, said riffles being arranged in step-like formation, electromagnets disposed in independent rows above and with their polar faces in proximity to the outer edges of said riffles, means for feeding the material to be treated to the uppermost riffle and in proximity to the first row of magnets, means for energizing and deënergizing said rows of magnets successively from the uppermost to the lowermost to separate a given mass of magnetic particles from the non-magnetic and to transport the former from riffle to riffle in response to magnetic attraction, and means for reciprocating the table to cause the non-magnetic particles to travel along said riffles.

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

ALFRED SCHWARZ.

Witnesses:

OLIN A. FOSTER,

CHARLES S. JONES