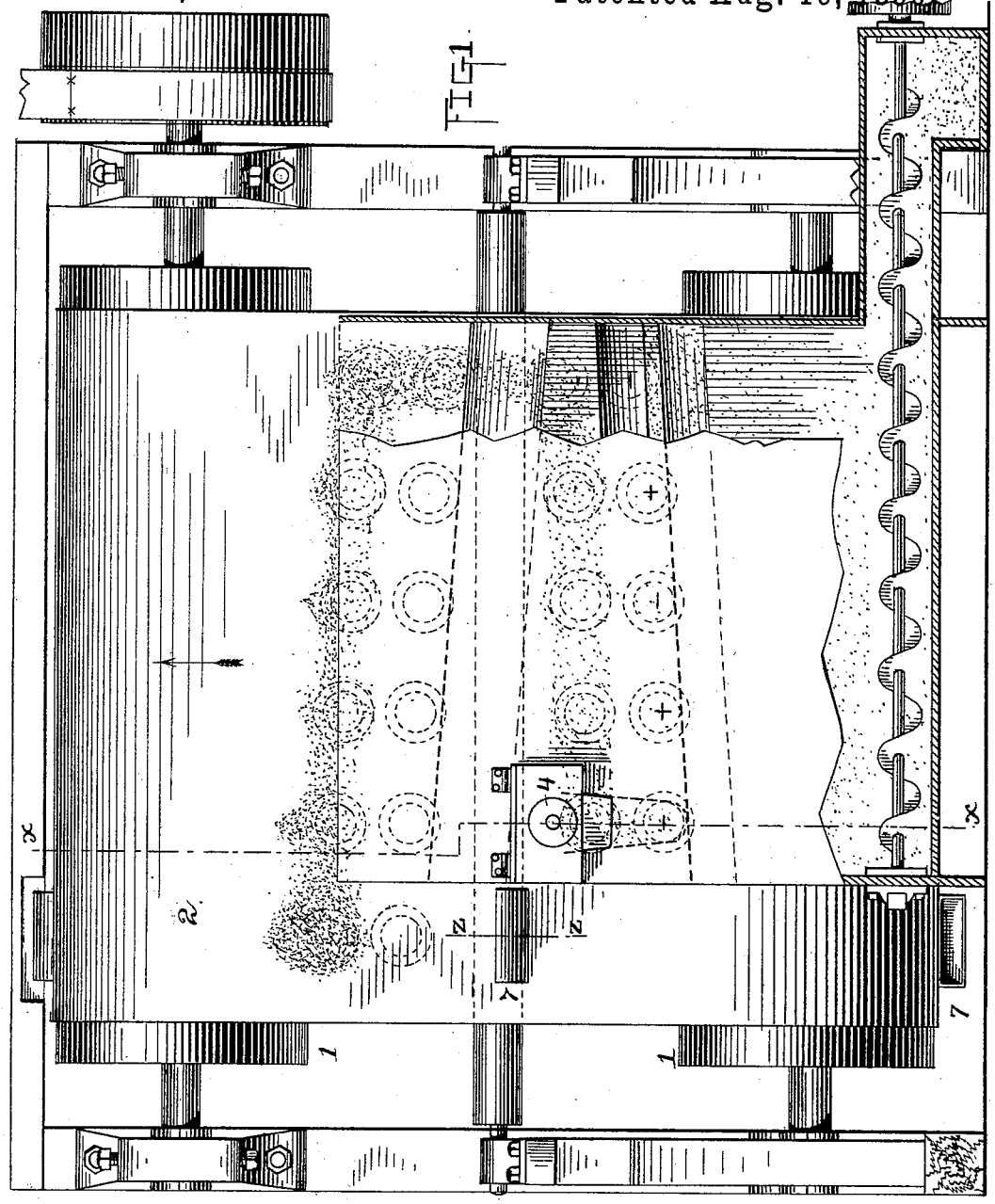
(No Model.) 3 Sheets—Sheet 1.

T. A. EDISON & W. K. L. DICKSON.

MAGNETIC ORE SEPARATOR.

No. 434,588. Patented Aug. 19, 1890.

FIG 1.



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(No Model.) 3 Sheets—Sheet 2.

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MAGNETIC ORE SEPARATOR.

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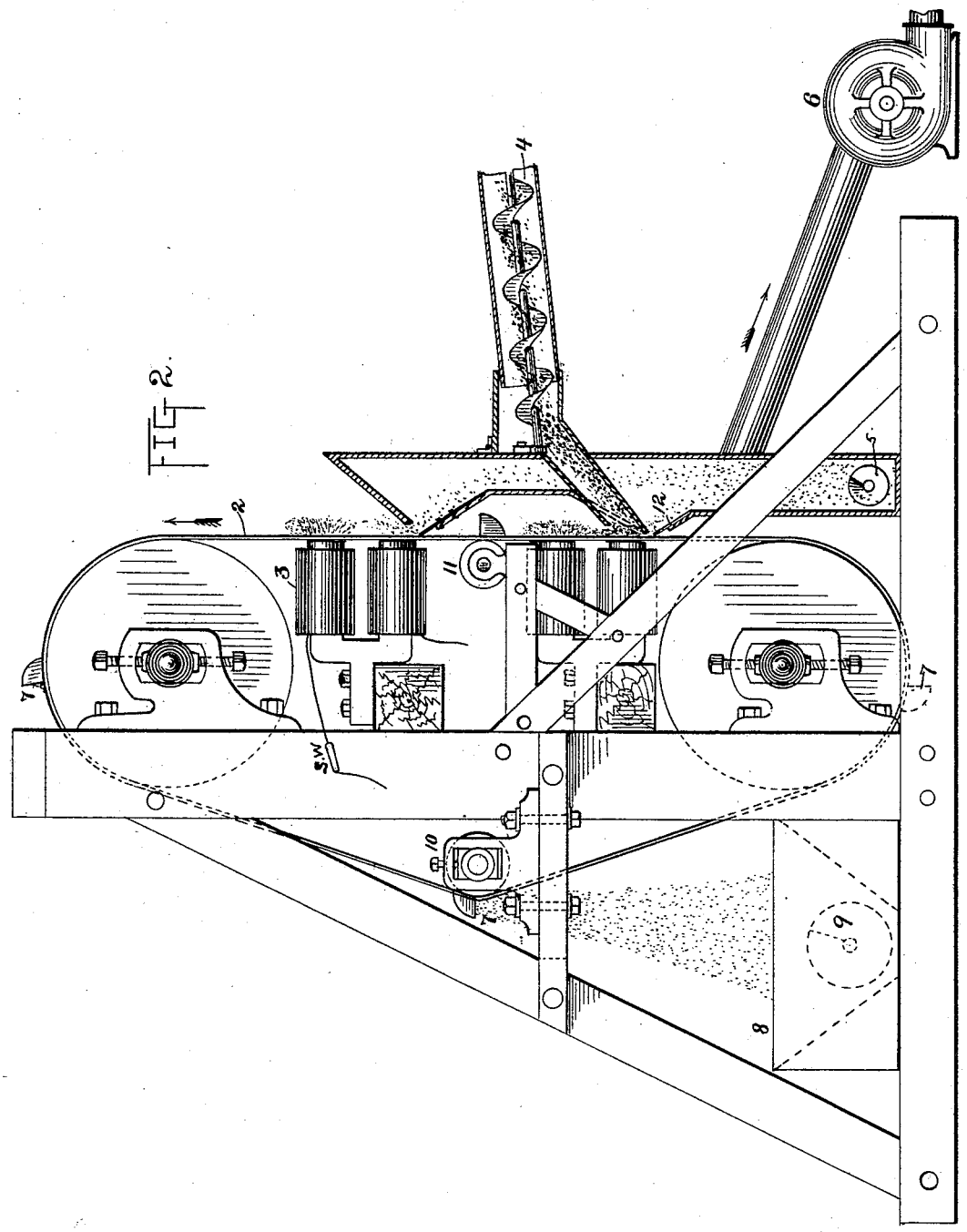
FIG. 2.



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(No Model.) 3 Sheets—Sheet 3.

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MAGNETIC ORE SEPARATOR.

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FIG. 3.

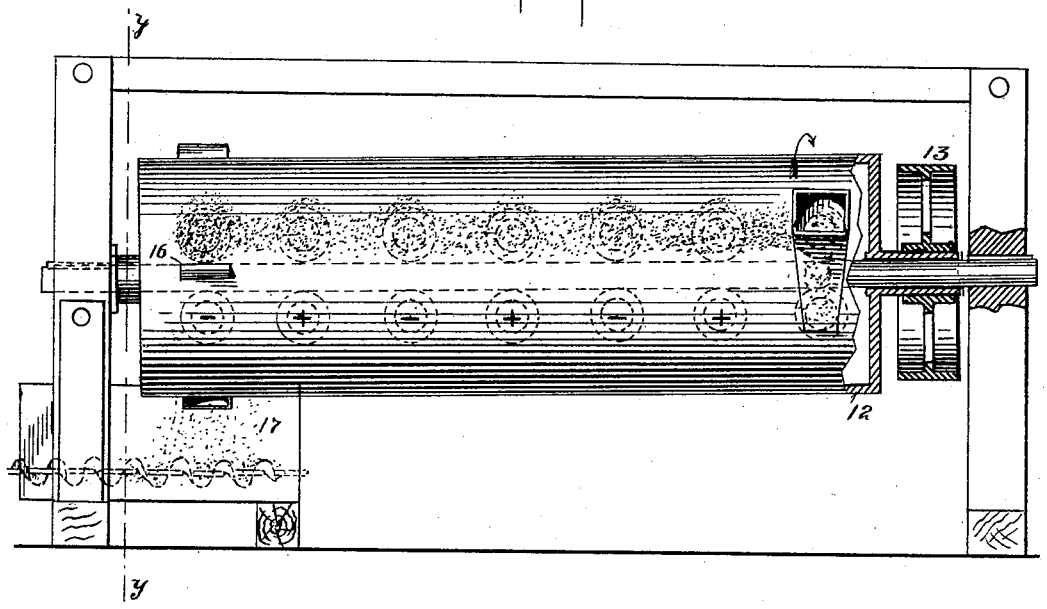
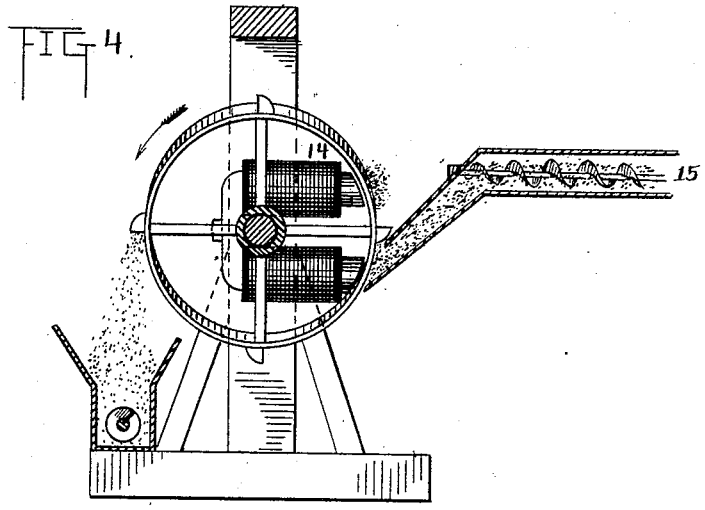


FIG. 4.



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UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, AND WILLIAM K. L. DICKSON, OF ORANGE, NEW JERSEY.

MAGNETIC ORE-SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 434,588, dated August 19, 1890.

Application filed January 20, 1890. Serial No. 337,523. (No model.)

To all whom it may concern:

Be it known that we, THOMAS A. EDISON and WILLIAM K. L. DICKSON, both citizens of the United States, and residing, respectively, at Llewellyn Park, in the county of Essex and State of New Jersey, and at Orange, in the county of Essex and State of New Jersey, have jointly invented a new and useful Method of and Apparatus for Magnetic Separation, which is fully described in the following specification.

The object of our invention is to remove magnetic particles from an inclosing mass of foreign matter—as, for example, the gangue in magnetic iron ore—and while the method is applicable to all grades of ore and to all mixed magnetic and non-magnetic materials, it is especially adapted to those ores in which the iron is in exceedingly fine particles separated or surrounded by a large proportion of gangue.

Two forms of apparatus which we have devised for carrying out our method are illustrated in the accompanying drawings, which form a part of this specification, and in which—

Figure 1 is a front elevation of a machine with parts broken away. Fig. 2 is a cross-section of the same machine on line $x\ x$ of Fig. 1. Fig. 3 is an elevation of a modified form of machine, and Fig. 4 is a cross-section through the same on line $y\ y$ of Fig. 3.

In Fig. 1 is shown a frame supporting, in suitable adjustable bearings, two rollers 1 1, and upon the shaft of the upper roller is shown a driving-pulley, with belt-connection to the source of power. Over these rollers runs a wide belt 2, of rubber, leather, or other non-magnetic material. Behind the front side of this belt is placed a series of powerful magnets 3, which are preferably bolted to cross-beams. These beams may be given an inclination from the horizontal, for a purpose hereinafter described. In front of the belt and before the first magnet of the lower series is a suitable guide for directing the material to be treated against the lower pole of said first magnet, and below the magnet and extending across and in front of the entire series is a plate 12, which receives falling gangue or the other non-magnetic material and directs it into the receptacle provided therefor. A like plate is provided under the upper series of magnets. A screw conveyer 4 or other device is provided for continuously feeding forward the ore. A like conveyer 5 is provided for removing the coarse non-magnetic materials which fall away from the magnet, and a blower 6 removes the finer dust. Near one side of the belt are placed one or more pockets 7 for removing the iron which accumulates over the last magnet of the series and depositing the same in a suitable receptacle 8, from which it may be removed by a continuously-operating conveyer 9, if desired. These pockets are shown of such length as to sweep over the entire pole of the last magnet; but in practice we find it advisable to make the pockets smaller, as by dividing them on the line $z\ z$, Fig. 1, and removing that portion to the right of the line. The pockets would then remove only one-half of the iron collected on the magnet. A tension-roller is provided for the belt, as shown at 10, and there is a roller the surface of which is slightly in advance of the magnet-poles for the front of the belt to bear against, as shown at 11; but this may be omitted.

In the modified form illustrated on Sheet 3 a cylinder 12, of brass or other non-magnetic material, is employed in place of the belt heretofore described. This cylinder is suitably journaled in a frame, and is provided with a pulley 13 for driving the same. Within the cylinder is supported a series of magnets 14, one or more, the poles of which are adjacent to one side of the cylinder. These magnets are supported upon the central shaft and are stationary. In the drawings the shaft is shown keyed so that it cannot turn, and the cylinder is sleeved upon the shaft and turns thereon. A conveyer 15 feeds the pulverized ore or material against the lower pole of the first magnet in the series, and one or more pockets 16 are arranged on the cylinder at the opposite end of the series of magnets for removing the concentrated iron which collects at this point and conveying the same to the receptacle provided therefor at 17. In this form of machine the magnets

must necessarily be arranged along the axis of the cylinder, and for the purpose of placing the magnets at an inclination, as before described, the axis itself and the cylinder are or may be inclined.

The operation will now be described in connection with the form of apparatus shown in Figs. 1 and 2. The ore, finely pulverized and either wet or dry, is fed in a continuous stream by the conveyer 4 to the magnetic field adjacent to the lower pole of the first magnet. The iron particles are strongly attracted by said pole and tend to remain in the magnetic field. The heavy and loose non-magnetic material falls by gravity on the plate 12, and thence into the receptacle provided therefor. The continuous movement of the belt 2 tends to carry the iron particles away from the lower pole to the upper pole, and when the field of said first-mentioned pole becomes overloaded the iron particles will gradually work over to said upper pole, and in a short time the field adjacent to the upper pole will also become loaded. The moving belt tends in the same way to raise the material away from this upper pole. At the same time the attraction of the magnet and the attraction of gravity force it back into the field. In this way the iron particles associated with and adhering to the gangue are beaten about and turned over and over and rubbed together in the magnetic field. This action allows the free foreign matter to drop, and at the same time loosens material which may adhere with considerable force to the iron particles. In a short time, in the operation of the machine, the field of the first magnet becomes loaded, and the magnetic material is slowly drawn by the adjacent pole of the next magnet to itself, thereby partially unloading the first magnet. The materials receive over this second magnet the same shaking and agitation as described in connection with the first magnet, and when the second magnet or magnetic field becomes overloaded it yields its load to the third magnet, where the operation is repeated, and so on through the series. It should be here stated that the magnets are preferably arranged with opposite poles adjacent, as indicated on the drawings.

The movement of the belt tending to carry the material forward would, if the magnets were arranged horizontally, move the material somewhat out of the field of attraction of the succeeding magnet. This may be obviated by placing the magnets on an incline, each succeeding magnet of the series being a little in advance of its predecessor. It will be evident that the exact inclination of the series will depend on the speed with which the belt is driven, and that the machine will operate successfully with the magnets arranged horizontally.

Returning now to the operation of the machine, the iron by the time it reaches the last magnet is practically free from the gangue, and it is taken by means of the pockets already described, or is allowed to fall by gravity if the pockets be omitted, as they may be, into suitable receptacles.

The magnets may be in series in a circuit from a single source of current, or they may be each in a separate circuit, or any other suitable arrangement may be employed. The belt may be instantly cleared by breaking the magnet-circuit, as by a switch *s w*.

In the form of machine shown in Fig. 3 the inclination of the magnets is slightly in a reversed direction relative to the moving surface from that shown in Fig. 1. This is due to the fact that the cylinder is driven at a slower speed, and it has been found by experiment that this arrangement is advisable, although not essential. The operation of this modified form is the same as that of the other machine. The material to be cleaned is delivered against the lower pole of the first magnet, where it is agitated by the combined action of the moving cylinder and the magnetic attraction, and when the field around this pole becomes loaded the material passes to the upper pole and thence along to the succeeding poles, being thoroughly shaken and rubbed at each point of its movement, as already described, and when it reaches the last magnet of the series it is removed by pockets 16 and deposited in box 17.

In the actual operation of the machine very little iron gathers over the lower pole of the magnets, (arranged as shown,) owing largely to the fact that the moving belt or cylinder tends to carry the material to the upper pole and away from the lower pole.

While we prefer to employ a series of magnets in the machines for separating ore, a machine with a single magnet would be operative, but would operate more slowly and would necessitate an intermittent instead of a continuous feed.

Having thus described our invention, what we claim is—

1. The method of separating magnetic material from non-magnetic material, which consists in agitating the mixed pulverized materials in a magnetic field, transferring the magnetic material and particles adhering thereto to a second magnetic field in a higher horizontal plane by the combined action of a moving body and magnetic attraction and further agitating the materials in the second field, substantially as described.

2. The method of separating magnetic material from non-magnetic material, which consists in continuously conveying the pulverized materials into the lower of two or more adjacent magnetic fields and agitating the materials therein, transferring the magnetic material and particles adhering thereto to a second magnetic field in a higher horizontal plane by the combined action of a moving body and magnetic attraction, and, further, agitating the material in the second field, substantially as described.

3. The method of separating magnetic ma-

terial from non-magnetic material, which consists in agitating a pulverized mass of the materials on a moving body and in a magnetic field until said field becomes overloaded with magnetic material and adhering gangue, transferring the materials by magnetic attraction to succeeding magnetic fields, and, further, agitating the same, substantially as described.

4. The combination, in a magnetic separator, of a movable body, a stationary magnet with poles adjacent to one surface of said body, and means for delivering material to be treated to the opposite surface of the movable body adjacent to the lower pole of said magnet, substantially as described.

5. The combination, in a magnetic separator, of a movable body, a series of magnets adjacent to one surface of said body and arranged transversely to the direction of movement thereof, and means for delivering pulverized ore or other material to the opposite surface adjacent to the first magnet of the series, substantially as described.

6. The combination, in a magnetic separator, of a movable body, with a transverse series of magnets mounted on one side thereof having their poles adjacent to one surface of said movable body, said magnets being in different planes successively, and means for delivering material to be treated against the opposite surface of the movable body and adjacent to the first magnet, substantially as described.

7. The combination, in a magnetic separator, of a movable body, a series of magnets arranged transversely to the direction of movement of said body on one side thereof, means for delivering the material to be treated to the opposite side of the movable body and adjacent to the first magnet of the series, and means for removing the iron or other material from the last magnet of the series, substantially as described.

8. The combination, in a magnetic separator, of a belt passing around and movable on suitable rollers, a transverse series of magnets mounted behind one side of said belt with poles adjacent thereto, and means for delivering the pulverized material to be treated against the belt and adjacent to the first magnet of the series, substantially as described.

9. The combination, in a magnetic separator, of a belt movable on suitable rollers, a transverse series of magnets mounted behind one side of said belt with poles adjacent thereto, the several magnets being in different horizontal planes, and means for delivering the material to be treated against the opposite surface of the belt and adjacent to the first magnet, substantially as described.

This specification signed and witnessed this 16th day of January, 1890.

THOMAS A. EDISON.
WILLIAM K. L. DICKSON.

Witnesses:
ALFRED O. TATE,
THOMAS MAGUIRE.