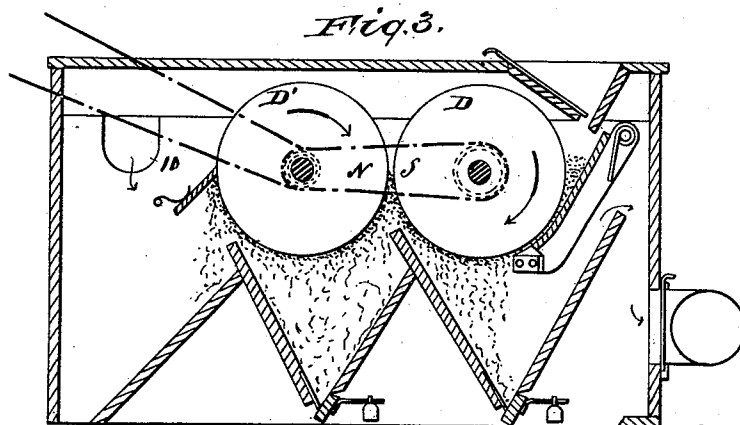
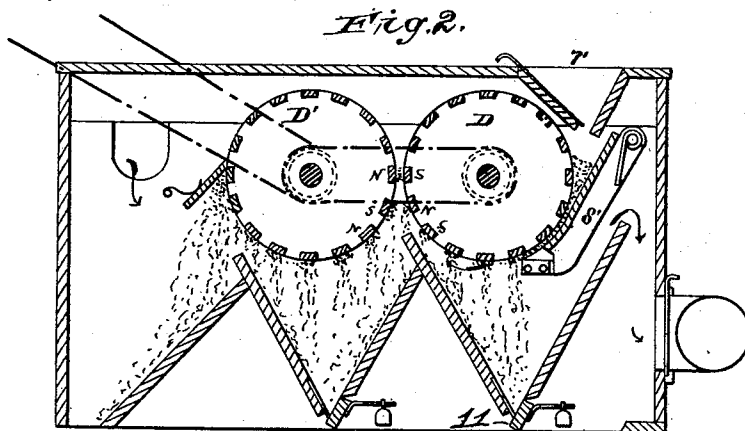
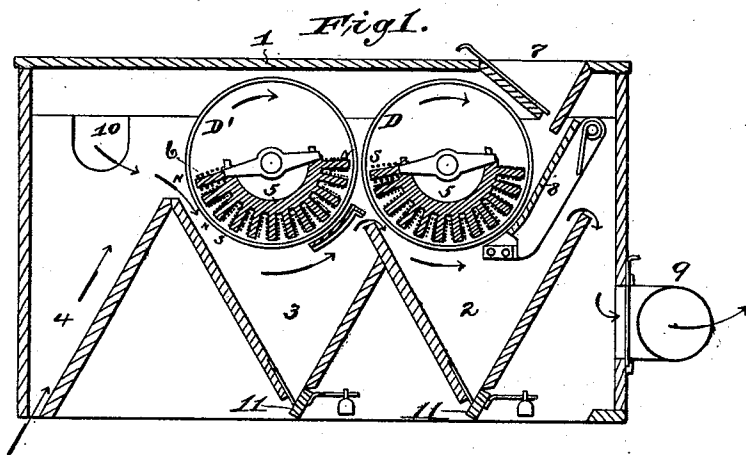


(No Model.)

C. M. BALL & S. NORTON.
MAGNETIC SEPARATOR.

No. 478,551.

Patented July 12, 1892.



Attest;
J. C. Grigg
J. C. Spence

Inventors:
Clinton M. Ball and
Sheldon Norton
by Read W. Worthington
their Attorneys.

UNITED STATES PATENT OFFICE.

CLINTON M. BALL, OF TROY, NEW YORK, AND SHELDON NORTON, OF
HOKENDAUQUA, PENNSYLVANIA.

MAGNETIC SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 478,551, dated July 12, 1892.

Application filed October 12, 1891. Serial No. 408,524. (No model.)

To all whom it may concern:

Be it known that we, CLINTON M. BALL, residing at Troy, in the county of Rensselaer and State of New York, and SHELDON NORTON, residing at Hokendauqua, in the county of Lehigh and State of Pennsylvania, citizens of the United States, have invented certain new and useful Improvements in Ore-Separators; and we 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.

This invention relates to improved apparatus for separating iron or its crushed ore from the impurities with which such are generally found associated and for grading the separated parts according to their character. In United States Patent No. 449,726, of April 7, 1891, issued to us, is described a method of and apparatus for separating iron from its ores in which are used two rotating drums or cylinders moving in magnetic fields, the ore being fed upon one cylinder or drum and carried past a succession of magnetic poles of alternate polarity and then transferred to a second drum and submitted to a similar operation under a greater degree of centrifugal force. The ore is forced by the rotation of the cylinder past the magnetic poles and the iron particles are caused to rotate end for end, the non-magnetic material being expelled by centrifugal force, while the iron is held magnetically upon the drum until it reaches a point without the magnetic field, when, being no longer held magnetically, it is thrown off tangentially and falls upon the second drum, where it is again held magnetically during its enforced movement until it passes without the magnetic field of this drum, when it is finally expelled as a grade of iron of high purity.

The present invention relates, specifically considered, to an improvement in the invention described in that patent.

The invention is, however, not limited to a machine of the particular type therein described, but is applicable to any machine in which the ore is passed through two or more stages of separation for its grading or purification.

The essential features of the present invention are two or more traveling separating-surfaces, upon which the ore is held magnetically, with means for effecting a transfer of the ore between the surfaces. In the preferred form of the invention cylindrical surfaces are used, upon which the ore is held during its separation, the magnetic poles which hold the ore upon the surface being so arranged that at the point at which the ore is transferred from one to the other they will be of unlike sign, so that the transfer will be magnetically assisted instead of being retarded, as would be the case if the poles were of like sign. The attracting-pole is preferably placed somewhat in advance of the pole from which the ore is transferred, so that the iron particles will be free to obey the attracting-pole. It is not, however, essential that the surfaces should be cylindrical, as they might be in the form of belts caused to travel by passing over rollers and yield similar results. The surfaces are preferably caused to travel at different rates of speed, so that a greater centrifugal effort will be exerted upon one than upon the other, the ore being thereby graded.

The present invention, therefore, broadly consists in two or more traveling surfaces approaching each other at some point in their travel and arranged to transfer the ore from one to the other while in operation.

It also comprises magnets so arranged as to attract the ore from one surface to the other, the transfer of the ore from one to the other being assisted by the co-operation of unlike magnetic poles.

The invention also consists in an organization with the receiving-pole at the point of transfer in advance of the delivery-pole.

More specifically the invention comprises two or more co-operating non-magnetic screens by which the ore is caused to travel past a series of magnet-poles of alternate polarity, the poles at the point of approach of the two screens being of unlike polarity.

In the accompanying drawings, which illustrate the invention, Figure 1 is a sectional view of an ore-separator constructed in accordance with my invention. Figs. 2 and 3 illustrate modified forms of apparatus by

which a similar though inferior result might be attained.

In the apparatus illustrated in Fig. 1, D and D' represent separating-drums mounted so as to rotate in a chest 1, in which is arranged a series of hoppers 2 3 4 to receive the products of separation. The drums are preferably made of non-magnetic material, such as brass, copper, wood, indurated fiber, paper, hard rubber, &c. Inside of each drum and upon its shaft is suspended a cylindrical segment of magnetic material 5, provided with a series of magnets 6, radiating from its lower surface. The magnets may be permanent or electro magnets, the latter being preferred. The exciting-coils surround the poles and are connected in series, the terminals being carried outside of the drum and connected with any suitable source of electric energy. The magnets when once adjusted are rigidly fixed, so that the drum may be rapidly rotated around them without disturbing their position. The poles of the magnets alternate in polarity, as indicated by N S N S, and are so arranged that at the point where the two drums approach poles of unlike sign will confront each other as illustrated. The receiving-pole on the second drum is placed slightly in advance of the terminal pole on the first drum. The iron particles will thus be free to obey the attraction of the receiving-pole while still containing residual magnetism imparted by the delivery-pole, while the lines of force streaming across the space between the drums will act as a dam and prevent any iron being carried beyond the field of attraction of the receiving-pole, thus overcoming its inertia and permitting its free transfer to and through the magnetic field of the second drum. In the top of the chest is a hopper 7, through which the ore to be graded or separated is introduced to the machine, whence it falls upon an apron 8, by which it is guided against the drum D. The apron is elastically supported, so that it may yield and permit lumps of ore to pass between it and the drum without injuring the latter. A pipe 9 is provided at one end of the chest and an opening 10 at the opposite end, the partitions forming the several receiving-hoppers being so arranged that when pipe 9 is connected with an exhaust-fan a current of air will be drawn in the direction indicated by the arrows, so as to carry the fine dust which is thrown off with the gangue out of and away from the machine. The two drums may be geared so as to rotate at the same or different speeds, but are preferably driven at different speeds, so that a low grade of ore separated from the gangue by the first drum will be rejected by the second drum, thus depositing in hopper 3 a middle grade of ore, while in hoppers 2 and 4 are deposited gangue and concentrate, respectively. Valves 11 may be provided at the bottom of the receiving-hoppers for automatically discharging ore or gangue. The ore being fed through hopper 7 is guided by apron 8 upon the drum D and

forced to travel in a circular path, the magnetic particles being held by the attraction of the magnets upon the surface of the drum. The rotation of the drum forces the ore past the series of magnetic poles, and by reason of the change of polarity the particles rotate end for end as they pass from one pole to the next, thus facilitating a thorough elimination of the gangue, which is thrown off by centrifugal force. The attracted particles will be held by the drum until they reach the last pole of the series, when they will be transferred by combined centrifugal and magnetic action to the drum D', the confronting poles in the two drums being of unlike polarity. The ore received upon drum D' is then subjected to a further purification and is finally expelled as concentrate after passing the last pole of the magnet within drum D', falling into receiving-hopper 4.

In Fig. 2 is illustrated another form of apparatus by which a double separation may be accomplished, the magnets in this case not being stationary, but rotating and picking up the ore by attraction from the apron 8', where it is fed by the hopper 7'. The magnetic particles being held by the magnets, the gangue is permitted to drop off as the attracted particles of iron approach the second drum. The centrifugal effort, aided by the magnets of opposite polarity upon the other drum, effects the transfer of the iron, when it is subjected to a second stage of separation by drum D'. The two drums should be belted or geared together, so that the co-operating magnet-poles will confront each other in the relation specified. Instead of having a series of independent magnets on each drum each drum might in itself be a single pole, as illustrated in Fig. 3, the two poles being of opposite polarity, but rotated at different speeds, so that the second one will reject a product which would be classed as middlings. It is evident that in this case the same principle is involved. The combined iron and gangue held upon the pole D by its magnetic attraction is carried in the direction of the arrow and the gangue thrown off by centrifugal force or gravity, or both, the iron particles being carried forward until approaching the pole D' of opposite magnetic sign, when it is transferred thereto and carried forward until removed by a scraper 11 or other equivalent therefor.

Having thus described our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. An ore-separator comprising a plurality of separating-surfaces and a magnetic field or fields in operative relation thereto, respectively, said field extending between adjacent separating-surfaces and assisting magnetically in the transfer of partially-separated ore from one surface to the other.

2. An ore-separator comprising two or more magnetic surfaces for withdrawing the iron from the gangue and means for effecting a transfer of the iron from one surface to the

other, the magnetic polarities near the point of transfer being dissimilar.

3. An ore-separator comprising two or more traveling surfaces upon which the ore is held
5 magnetically, said surfaces approaching each other and provided with co-operating magnetic poles of unlike sign, whereby the transfer of ore from one surface to the other is facilitated and a continuous operation with two
10 or more separating devices may be conducted.

4. An ore-separator comprising two or more rotating surfaces arranged in series and magnetic fields for causing the adherence of ore to said surfaces while the gangue is expelled,
15 the magnetic poles at adjoining points being of unlike sign to facilitate transfer of the ore.

5. An ore-separator comprising two or more magnetic fields and two or more non-magnetic screens moving in said fields, one screen ad-
20 joining another, so as to transfer ore thereto, the poles of the fields at the point of transfer being of unlike sign.

6. An ore-separator comprising two or more magnetic fields and two or more non-magnetic

25 screens moving in said fields, one screen adjoining another, so as to transfer ore thereto, the poles of the fields at the point of transfer being of unlike sign and the receiving-pole being in advance of the delivery-pole.

7. An ore-separator comprising two or more
30 groups of magnets arranged in succession, means for forcibly conveying the ore past the magnets and permitting the gangue to fall away, and means for effecting the transfer of ore from one group of magnets to the next,
35 the groups of magnets being co-operatively placed to assist magnetically in the transfer of the partially-separated ore.

In testimony whereof we affix our signatures in presence of two witnesses.

CLINTON M. BALL
SHELDON NORTON.

Witnesses as to C. M. Ball:

F. E. EGLOE,
JOHN H. TUPPER.

Witnesses as to Sheldon Norton:

D. W. MCFETRIDGE,
WM. H. GLACE.