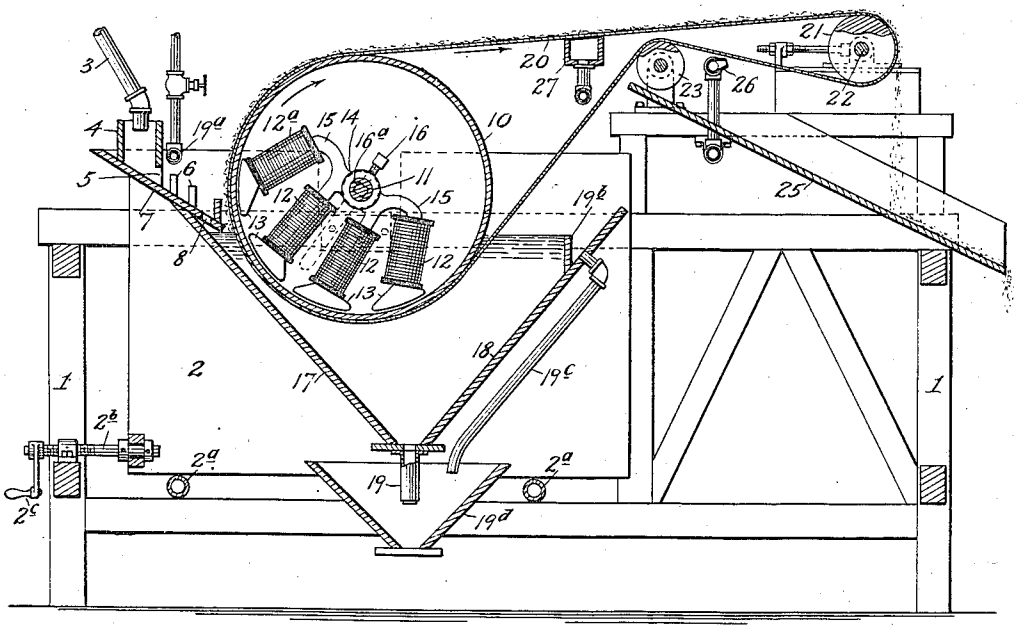
F. B. DUTTON & B. E. McKECHNIE.

MAGNETIC SEPARATION OF ORE.

APPLICATION FILED APR. 2, 1912.

1,146,140. Patented July 13, 1915.



Witnesses:
O. F. Nehol
E. Vandenhoff

Inventors:
Francis B. Dutton
Benjamin E. McKechnie
By their Attys:
Philip Dawyer Lee & Kennedy

UNITED STATES PATENT OFFICE.

FRANCIS B. DUTTON AND BENJAMIN E. McKECHNIE, OF LEBANON, PENNSYLVANIA, ASSIGNORS TO PENNSYLVANIA STEEL COMPANY, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

MAGNETIC SEPARATION OF ORE.

1,146,140. Specification of Letters Patent. Patented July 13, 1915.

Application filed April 2, 1912. Serial No. 687,981.

To all whom it may concern:

Be it known that we, FRANCIS B. DUTTON and BENJAMIN E. McKECHNIE, citizens of the United States, residing at Lebanon, county of Lebanon, and State of Pennsylvania, have invented certain new and useful Improvements in Magnetic Separation of Ore, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to an improved method of separating magnetic material, particularly magnetic iron ore, from material of a non-magnetic nature.

The invention has for its object the novel treatment of crushed magnetic iron ore consisting of particles of magnetic iron mixed with non-magnetic impurities, whereby the magnetic particles of iron may be more readily and effectively separated from the impurities with which they are mixed and removed therefrom than by methods heretofore suggested, and a better concentrate obtained.

The desired results are obtained by causing the magnetic iron ore in a crushed or powdered condition, preferably suspended in water or other suitable fluid carrier, to be acted upon by magnets in such a way that the magnetic action on the ore is gradual, whereby the magnetic particles are separated from the non-magnetic particles according to their magnetic quality, the purest particles being first separated from the non-magnetic particles with which they are mixed. Preferably the improved method consists in bringing the mass of magnetic ore and its impurities suspended in the carrying liquid gradually into the field of a number of magnets of substantially the same strength, and removing the particles as they are separated, the separation of the particles being effected beneath the surface of the carrying liquid and the removal being effected in a direction reverse or counter to the direction in which the crushed ore is brought into the magnetic field. Preferably also the removed particles are somewhat dried or drained of the carrying liquid between their removal or separation and their delivery from the apparatus employed in carrying out the method.

With this method a very thorough and effective separation of the magnetic particles is produced, and a higher grade concentrate obtained, and this method permits of the employment of very simple and convenient apparatus for carrying out the method.

One suitable and convenient apparatus for practising the method consists generally of a tank to which the crushed or powdered ore, suspended in water or other suitable carrying liquid, is supplied. In the tank is a rotating water tight drum of non-magnetic material partially immersed in the liquid, within which drum stationarily are mounted a plurality of suitable magnets. A carrier for removing the magnetic material as it is separated from the impurities is provided, which may be an endless belt, preferably of canvas or fine mesh wire, encircling the drum, and leading to a suitable depository for the concentrates. The side walls of the tank at the end thereof where the crushed ore suspended in the carrying liquid is admitted slope or incline toward the drum, so that the crushed ore introduced into the tank is brought gradually within the influence of the magnets in order that as the richer particles are first separated from the impurities by the action of the magnets they are removed by the conveyer or carrier, the magnetic particles being separated according to their purity, the impurities or sludge settling in the tank and being drawn off in a suitable manner.

Such an apparatus in simple form is shown in the accompanying drawing, in which the figure is a vertical section of so much of the apparatus as is necessary for an understanding of the invention.

Referring to this figure, 1 indicates a suitable framework on which the operative parts of the apparatus are supported. On the framework 1 is mounted a tank construction 2, which may be of suitable configuration for effecting the results desired. For reasons hereinafter referred to, the tank 2 is movably supported on the framework, as by rollers 2^a, and can be moved on the frame by means of a screw threaded rod 2^b secured to the tank and a crank 2^c. The ore, in a crushed or powdered condition and suspended in water, is supplied to the tank 2 through a suitable feed pipe 3 delivering to a feed box

4 having a feed opening or slot 5, which regulates the flow of the ore. From the feed box 4 the ore is delivered against a number of baffles 6 on a feed board 7 which, at its lower or delivery end, is slotted or apertured, as at 8. The baffles insure an even distribution of the crushed ore in solution or "pulp", as it is termed, and an even and regular supply to the tank. Within the tank is a drum 10 supported on a non-rotating shaft 11 so as to be rotatable, suitable bearings being provided for the shaft. The drum 10 is of non-magnetic material, as brass, and is supported so as to be partially immersed, or submerged, in the liquid in the tank. The drum is, therefore, water tight. Within the drum are located a plurality of magnets 12, 12^a having suitable pole pieces 13 arranged to be in close proximity to but free from the interior surface of the drum. The magnets 12, 12^a, are supported in any suitable manner, as by spider 14 having arms 15, the spider being fast on the shaft 11, being fastened thereto as by a set screw 16. The shaft 11 is provided beyond its bearing, at one end, with a squared portion 16^a (shown in dotted lines) which is adapted to receive a lever or other suitable tool by which the shaft may be turned or rocked in its bearings and the position of the magnets carried by the shaft adjusted in the drum as desired. The bottom of the tank 2 before referred to comprises walls 17, 18, the wall 17 being at the feed end of the tank. This wall is inclined, or sloped, inclining toward the drum tangentially so that the space between the drum and the wall of the tank through which the crushed ore is fed narrows, being wider at the top or feed end and narrowing as it approaches the drum. By moving the tank on the rollers 2^b, before referred to, the distance between the wall of the tank and the drum may be adjusted, as necessary. With this construction the crushed ore is brought gradually under the influence of the magnets and the magnetic particles of the iron are separated out according to their richness, the richest being first removed. This results in a better grade of concentrates, and cleaner tailings, in that the material may be brought closer to the magnets and consequently through a stronger field after the bulk of the magnetic particles has been removed, then if the whole separation were made at approximately one point, in which case the richer portion would be separated out so violently that many particles of non-magnetic material would be drawn out with those magnetic. Furthermore, by feeding the ore as described tangentially to the drum, and subjecting it to the action of the magnets as it is so fed, the magnetic particles are separated or picked out by some of the magnets laterally in a sidewise direction, and these magnets do not have to work directly against gravity. This results in an improved separation, in that the particles falling freely past the magnets are more readily acted on by them, and the magnets acting to pick the particles out beneath the surface of the water do not have to overcome the surface tension of the water and thus may be operated mechanically and to much greater advantage. Preferably the opposite wall 18 of the tank likewise slopes in order to permit the sludge or non-magnetic impurities to be more readily drawn off through a suitable tail pipe 19, the sludge settling readily and being guided to the tail pipe by the sloping walls of the tank.

The liquid level in the tank is maintained so that the magnets which effect the separation of magnetic iron are below the level of the liquid in the tank. For various reasons it may not be desirable that the liquid level in the tank be maintained by adding more or less water to the pulp before it enters feed pipe 3. It is preferable that the liquid be furnished from an auxiliary source. To effect this, there is provided a suitable perforated water supply pipe 19^a connected with a suitable source of water supply (not shown) which supplies additional needed water to the tank preferably in the form of a spray to assist in the even distribution of the feed of the pulp. This water supply pipe 19^a is positioned just in front of the feed box 4, before referred to, so as to evenly distribute the water supplied over the pulp as it issues from the box. On the wall 18 of the tank before referred to is a dam 19^b, the top of this dam being of sufficient height so as to maintain the liquid in the tank at the desired level.

Preferably, in practice, the water is supplied from the pipe 19^a in such quantity as to just flow over this dam 19^b, this excess escaping through a suitable pipe 19^c to the outlet box 19^d. It may be here observed that the magnets are preferably so adjusted in the drum that one magnet as 12^a is positioned above the level of the liquid in the tank. This magnet does not operate to separate the magnetic iron, but acts to hold the separated particles on the carrier belt and prevents them from falling back into the tank, the remaining magnets effecting the separation.

Suitable means are provided for removing the magnetic particles from the tank as they are attracted by the magnets, which means may be somewhat varied. A convenient construction includes a carrier which may be an endless belt 20 encircling the drum 10 and a smaller drum or roll 21, on a shaft 22. This roll 21 is adjustable and affords a suitable belt-tightening or adjusting device. A roller 23 is provided to lift the belt out of the tank at the delivery end.

This carrier belt 20 is driven to run in a direction reverse or counter to the direction of feed of the crushed ore, as indicated by the arrows. The belt 20 thus carries away the material as it is separated out and delivers it to a suitable apparatus, which may consist of an inclined chute 25 mounted on the framework 1 from which the concentrates are delivered as desired. The chute 25 is located below the roll 21, over which the carrier 20 runs. As the carrier turns about this roll, the major part of the concentrates fall from the belt of their own weight into the chute. A portion may, however, adhere to the belt, and to remove it there is provided any suitable means, as a nozzle 26, for supplying water or air under pressure, which also tends to keep the belt clean.

It is preferable, when the wet method of separation is employed, that the concentrates be delivered in as dry a condition as practicable. The run of the belt is therefore somewhat longer than necessary for the removal of the concentrates from the tank. While the concentrates are to some extent dried by the course of the belt from the drum 10 to the roll 21, they may be much more thoroughly dried by the provision of further drying means. To this end therefore the carrying belt is made of canvas, fine wire mesh or other porous material, and there is provided a suction apparatus 27 located under the belt at a suitable point, and connected with a suitable suction pump (not shown) so that as the concentrates pass along on the carrying belt the moisture is to a large extent removed therefrom.

No claims are herein made to the apparatus described. This apparatus, however, forms the subject-matter of a separate application Serial No. 687,982, filed April 2, 1912, by us, in which the novel features are claimed.

What is claimed is:—

1. The method of separating magnetic material from nonmagnetic, which consists in mixing the material in a crushed condition with a carrying liquid, feeding the material in a downward direction past a magnetic field and subjecting it while so fed to the magnetic action while beneath the surface of a liquid in such manner that the strength of the magnetic action on the material increases progressively and the particles are separated beneath the surface of the liquid progressively according to their magnetic purity, and then removing the magnetic particles as they are separated, in a counter direction to that in which they were brought into the magnetic field.

2. The method of separating magnetic material from nonmagnetic, which consists in mixing the material in a crushed condition with a carrying liquid, feeding the material tangentially past a magnetic field while beneath the surface of the liquid so that the strength of the magnetic action on the material increases progressively and the particles are separated beneath the surface of the liquid progressively according to their magnetic purity, and then removing the magnetic particles as they are separated, in a counter direction to that in which they were fed into the magnetic field.

3. The method of separating magnetic material from nonmagnetic, which consists in mixing the material in a crushed condition with a carrying liquid, feeding the material tangentially by the action of gravity past a magnetic field while beneath the surface of the liquid so that the strength of the magnetic action on the material increases progressively and the particles are separated beneath the surface of the liquid laterally or in a lateral direction and progressively according to their magnetic purity, the nonmagnetic particles continuing under the influence of gravity, and then removing the magnetic particles as they are separated, in a counter direction to that in which they were brought into the magnetic field.

In testimony whereof we have hereunto set our hands in the presence of two subscribing witnesses.

FRANCIS B. DUTTON.
BENJAMIN E. McKECHNIE.

Witnesses:
HOWARD C. SHIRK,
C. BESSIE LOSER.