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MAGNETIC SEPARATOR

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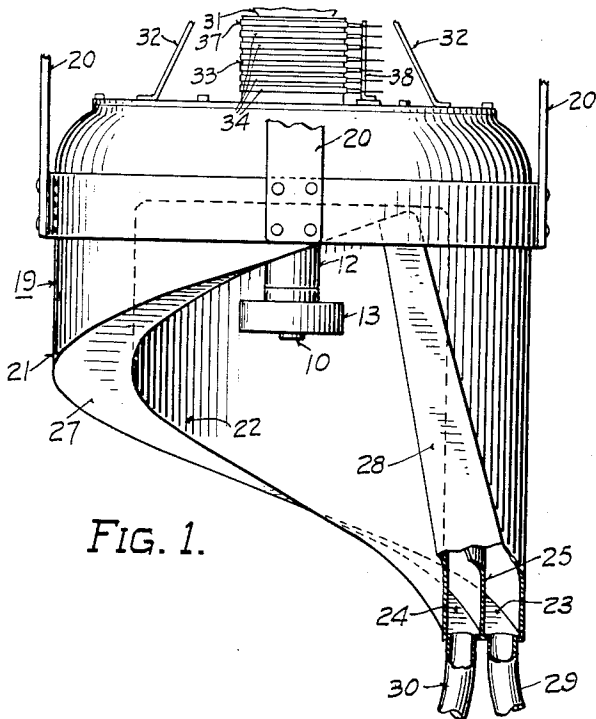


FIG. 1.

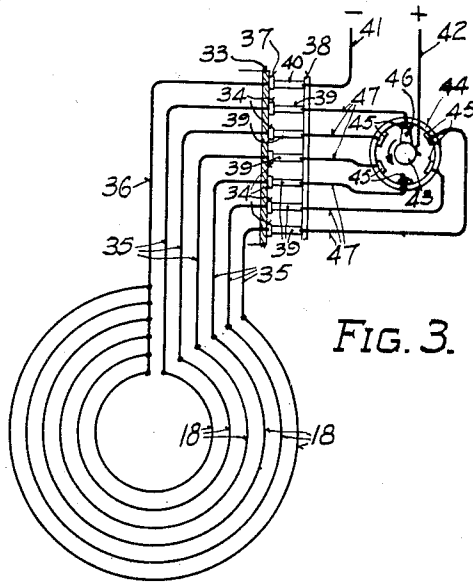


FIG. 3.

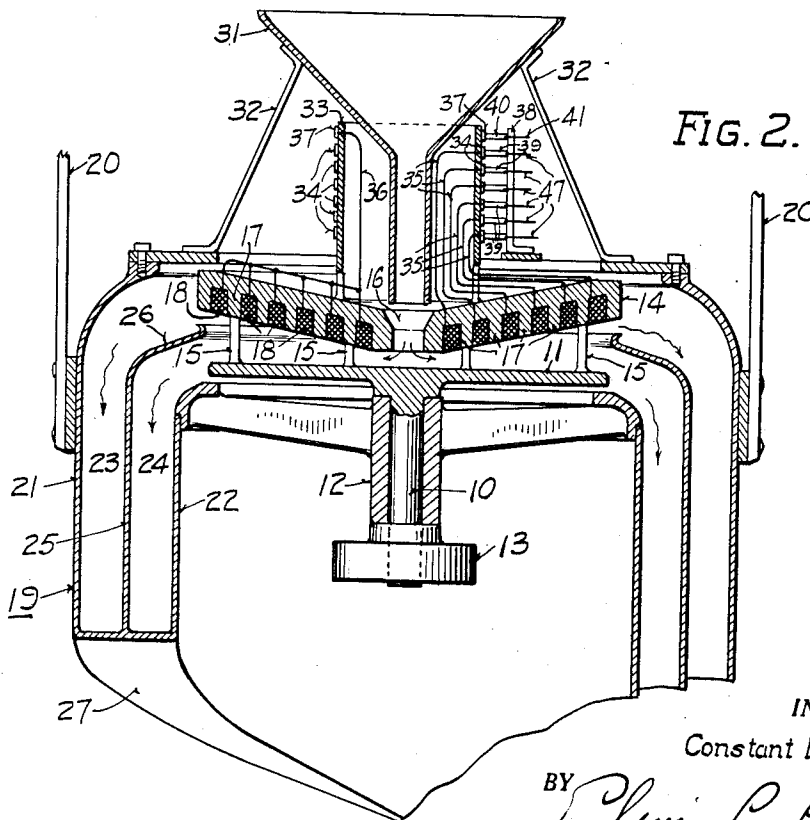


FIG. 2.

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MAGNETIC SEPARATOR

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10 Claims. (Cl. 209—222)

This invention relates to magnetic separators and especially to a magnetic separator in which the material under treatment is subjected to the combined action of a traveling magnetic field and centrifugal force.

An object of the present invention is to provide a magnetic separator which is capable of efficient operation with wide variations in production.

Another object is to provide auxiliary means to assist the magnetic field in obtaining a more effective and rapid separation of magnetic from non-magnetic material.

In accordance with the present invention, these and other objects are attained by means of a device comprising a hopper adapted and arranged to discharge the material to be treated onto the central portion of a rotating non-magnetic disk or plate above which a plurality of electromagnets are rotated. The electromagnets are adapted and arranged to give an outward travel of flux. As the material is discharged onto the non-magnetic disk or plate it is simultaneously subjected to the attraction of the electromagnets and to the centrifugal action of the disk or plate. The combination of the magnetic attraction, the outwardly moving field and the centrifugal action of the rotating electromagnets carries the magnetic particles to the outer periphery of the electromagnet assembly where they are removed. Centrifugal action carries the non-magnetic particles to the outer periphery of the rotating disk where they are removed.

For a more detailed description of the invention reference may be had to the accompanying drawing in which:

Figure 1 is an elevational view, with parts broken away, of the apparatus which is preferably employed in practicing the present invention;

Fig. 2 is a cross sectional view of the apparatus;

Fig. 3 is a schematic view of the electrical network which is preferably employed in practicing the present invention.

Referring to the drawing, a shaft 10 carrying a flat circular non-magnetic plate or disk 11 is journaled in a stationary housing 12 and is adapted to be rotated by power supplied to pulley 13 which is secured to the lower end thereof. An armature 14 which has substantially the same diameter as disk 11 is mounted directly above disk 11 by means of a plurality of studs or braces 15 and is rotated in unison therewith. While this is the preferred arrangement of mounting and rotating disk 11 and armature 14, armature 14 may be independently mounted and may be held sta-

tionary or may be rotated at a greater or less rate of speed than disk 11. A funnel-shaped opening 16 in the center of armature 14 is provided as a feed passage to feed the ore to the space between the disk 11 and armature 14. The lower face of armature 14 is provided with a plurality of circular pole pieces 17. A coil or winding 18 is disposed in the annular space between adjacent pole pieces to energize the pole pieces and produce a magnetic field which periodically travels outwardly from the central portion to the outer periphery of the armature.

Armature 14 is desirably in the shape of an inverted cone so that the intensity of the flux on the surface of the non-magnetic disk 11 is gradually decreased from the center of the disk toward the outer periphery.

A discharge hopper 19, which is suitably supported by brackets 20 is disposed annularly around the non-magnetic disk 11 and the armature 14 and is used to collect the separated magnetic and non-magnetic material. The hopper 19 is formed by the outer curved walls 21 and 22 and it is separated into compartments 23 and 24 by a partition 25 which is provided at the top with a sloping flange 26. The magnetic material is discharged from the outer periphery of armature 14 into compartment 23 and the non-magnetic material is discharged from the outer periphery of disk 11 into compartment 24. The inner rim of flange 26 is disposed between disk 11 and armature 14 to prevent mingling of magnetic and non-magnetic particles when they are discharged into compartments 23 and 24.

The discharge hopper has a sloping bottom wall 27 which gives the hopper a gradually increasing depth so that the particles when discharged into the top of the hopper will settle and gravitate along the sloping bottom thereof. An end wall 28 serves to enclose the compartments 23 and 24. While this is the preferred arrangement of removing magnetic and non-magnetic particles from the system, other arrangements may be used, the essential feature in all cases being that discharge compartments shall be provided adjacent the outer peripheries of armature 14 and disk 11, and that means shall be provided to prevent mingling of magnetic and non-magnetic material as they are discharged into the respective compartments.

The lower end of compartment 23 terminates in a discharge pipe 29 through which magnetic material is removed from the system and the lower end of compartment 24 terminates in a

discharge pipe 30 through which non-magnetic material is removed from the system.

A feeding hopper 31 for introducing material to be treated into the system is supported from the top or cover of the discharge hopper 19 by means of supports 32. The lower end of hopper 31 terminates above the funnel-shaped opening 16 in the center of armature 14.

A circular non-conducting sleeve 33 is secured to the top central portion of the armature 14. Spaced conducting rings 34 are mounted on the sleeve and each ring is connected through a lead 35 to one terminal of its respective magnet coil 18. The opposite terminals of the magnet coils 18 are connected to a common return wire 36 which leads to another spaced conducting ring 37 on the sleeve 33.

An upright insulating member 38 is secured to the top or cover of the discharge hopper 19. Spaced contact brushes 39 and 40 are mounted on the insulating member 38 so as to give a brushing contact with the conducting rings 34 and 37 respectively. The ring 37 is connected to one terminal of a direct current source through the contact brush 40 and lead 41. The other terminal of the direct current source is connected through lead 42 and a brush contact to the common conductor or shaft 43 of a segmented stator 44. Equally spaced segments 45 are mounted on the stator and a conducting contact arm 46 is mounted on shaft 43 so as to give a brushing contact with the equally spaced segments when the shaft is rotated. Each conducting segment 45 is connected with its respective contact brush 39 by a lead 47.

When the direct current circuit is closed and the shaft 43 is driven in the direction of the arrow shown in Fig. 3, direct current is supplied successively to the magnet coils 18 through the terminal wire 42, shaft 43, contact arm 46, segments 45, leads 47, brushes 39, rings 34, leads 35 to the magnet coils 18. The circuit is completed by the common return wire 36, conducting ring 37, brush 40 and lead 41.

While the above arrangement is preferred for creating the moving magnetic field, other arrangements may be employed, the essential feature being that the magnet coils shall be energized periodically so that the field will travel outwardly from the central portion to the outer periphery of the electromagnetic disk. It is also to be understood that a larger or a smaller number of coils and pole pieces may be disposed on the face of the electromagnet.

As illustrative of the method of operation, disk 11 and armature 14 are rotated and the contact arm 46 is rotated to progressively energize the successive pole pieces 17 on armature 14. The material to be treated, such as magnetic iron ore which has been pulverized to break the bond between magnetic and non-magnetic particles, is fed into the hopper 31. From hopper 31, the material passes downwardly by gravity through the funnel-shaped opening 16 and is discharged onto the central portion of the non-magnetic disk 11. As the material strikes the disk, it is simultaneously subjected to centrifugal force exerted by the rotating disk 11 and to magnetic attraction exerted by the pole pieces 17. The magnetic particles in the material are attracted and drawn to the face of the energized pole pieces. Since the inner pole pieces are relatively close to the non-magnetic disk, the field at the center of the plate is stronger and the slightly magnetic

particles as well as the highly magnetic particles are attracted.

To obtain efficient separation, it is desirable that the relatively intense magnetic field at the center of the rotating disk shall pick up all the free magnetic particles in the material. The magnetic particles move outwardly end over end from pole piece to pole piece under the influence of the outwardly moving field. The outward travel of the magnetic particles is accelerated by centrifugal action since they are carried around by the rotating pole pieces. As the particles travel outwardly, the centrifugal force on the particles is increased by the increasing annular speed of the electromagnet. When the component of the centrifugal force and gravity exceeds the magnetic attraction, the slightly magnetic particles will drop onto the rotating non-magnetic disk 11. The speed of rotation and the strength of the field are regulated so that the highly magnetic particles will continue to move along the face of armature 14 until they reach its outer periphery where the centrifugal force overcomes the magnetic attraction and the particles are discharged into compartment 23.

As the non-magnetic particles on disk 11 move outwardly they are agitated and swirled by the action of the revolving disk. This action exposes the highly magnetic particles which are mingled with the non-magnetic material and they are picked up by the armature 14 as the magnetic flux moves outwardly. When the non-magnetic particles reach the outer periphery of disk 11, they are discharged into compartment 24.

The magnetic and non-magnetic particles accumulate on the sloping bottoms of compartments 23 and 24 from whence they pass by gravity to the lower ends of the compartments and they are removed through discharge pipes 29 and 30, respectively.

While this method of removing the magnetic and the non-magnetic particles from compartments 23 and 24 is satisfactory, it is evident that a quicker removal may be obtained by connecting an exhaust fan to the discharge pipes 29 and 30 to create a suction in the compartments.

Although the invention has been specifically described with reference to the separation of dry materials, it is to be understood that the described embodiment is also useful for separating wet materials or slurries.

I claim:

1. A magnetic separator which comprises a non-magnetic plate adapted and arranged to be rotated, a conical electromagnet disposed above the plate with its base horizontal and uppermost, means to create a magnetic field which travels outwardly from the center to the outer periphery thereof, and means for introducing material to be treated intermediate said plate and said electromagnet.

2. A magnetic separator which comprises a non-magnetic plate adapted and arranged to be rotated in a horizontal plane, an inverted conical electromagnet disposed over said plate adapted and arranged to be rotated with its base in a horizontal plane, means to produce a magnetic field which travels outwardly from the central portion of the magnet, and means for charging material to be treated onto the central portion of the non-magnetic plate.

3. A magnetic separator which comprises a non-magnetic plate adapted and arranged to be rotated, an electromagnet disposed adjacent said plate adapted and arranged to be rotated and to

create a magnetic field which periodically moves outwardly from the central portion of said plate, means for charging material to be treated onto the central portion of said plate, a discharge compartment adjacent the outer periphery of said electromagnet for collecting magnetic material, and a discharge compartment adjacent the outer periphery of said plate for collecting non-magnetic particles.

4. A magnetic separator which comprises a non-magnetic plate adapted and arranged to be rotated, an electromagnet disposed adjacent said plate adapted and arranged to be rotated and to create a magnetic field which periodically moves outwardly from the central portion of said plate, means for charging material to be treated onto the central portion of said plate, a discharge compartment adjacent the outer periphery of said electromagnet for collecting magnetic material, a discharge hopper adjacent the outer periphery of said plate for collecting non-magnetic material, and a flange member intermediate the outer periphery of said plate and electromagnet to prevent mingling of magnetic and non-magnetic material.

5. A magnetic separator which comprises a non-magnetic plate adapted and arranged to be rotated, an electromagnet disposed above said plate adapted and arranged to be rotated and to create a magnetic field which periodically moves outwardly from the central portion to the outer periphery of said plate, means for charging material to be treated through the central portion of said electromagnet onto the central portion of said plate, a discharge compartment having a sloping bottom portion adjacent the outer periphery of said armature for collecting magnetic material, a discharge compartment having a sloping bottom portion adjacent the outer periphery of said plate for collecting non-magnetic material, and a flange member intermediate the outer periphery of said plate and the outer periphery of said electromagnet to prevent mingling of magnetic and non-magnetic material.

6. A magnetic separator which comprises a rotatable horizontal non-magnetic plate, a conical armature spaced from said plate and forming an upwardly sloping upper wall of an enclosure, a feed conduit which discharges centrally into the enclosure, a plurality of spaced pole pieces distributed on the armature, means for repeatedly energizing the pole pieces in a progressive manner from the center toward the periphery of the armature, and means for disposing and rotating the plate and armature on a common axis.

7. A magnetic separator which comprises a rotatable horizontally disposed plate composed of

substantially non-magnetic material, a substantially conically shaped armature spaced above said plate with its basal plane parallel to the plate and its lateral surface sloping upwardly, said armature having a central feed passage therethrough, electromagnetically excitable pole pieces distributed on the armature, means to rotate the plate and armature in unison on a common vertically disposed axis, and means for repeatedly and progressively energizing the pole pieces with direct current in the order of their spacing from the center.

8. A magnetic separator which comprises a rotatable non-magnetic plate, a rotatable magnetic plate spaced above said non-magnetic plate bearing a plurality of current carrying elements, means to excite the elements to create a magnetic field which travels outwardly from the center to the periphery of the magnetic plate, a chute for feeding the material to be treated onto the central portion of the non-magnetic plate, and a circumferential partition disposed with its edge in an intermediate position with respect to the plates for preventing the commingling of the particles which are discharged from the outer edges of the magnetic and non-magnetic plates respectively.

9. A magnetic separator which comprises a rotatable non-magnetic plate, a rotatable magnetic plate bearing a plurality of current carrying elements, said magnetic plate having a central opening therein, means to excite the elements to create a magnetic field which travels outwardly from the center to the periphery of the plate, means for feeding the material to be treated through said central opening onto the surface of the non-magnetic plate, and a circumferential partition disposed with its edge in an intermediate position with respect to the plates for preventing the commingling of the particles which are discharged from the outer edges of the magnetic and non-magnetic plates respectively.

10. A magnetic separator which comprises a rotatable non-magnetic plate having an upwardly disposed horizontal surface, a rotatable magnetic plate spaced above said non-magnetic plate bearing a plurality of electro-magnetic elements, said magnetic plate being shaped to increase the spacing at the peripheries, means to excite the elements to create a magnetic field which travels outwardly from the central portion of the plate and decreases in intensity as the periphery of the plate is approached, and means for charging material to be treated onto the central portion of the non-magnetic plate.

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