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COMPLETE SPECIFICATION

Magnetic Separator

We, CARPCO RESEARCH AND ENGINEERING, INC. a corporation organised and existing according to the Laws of the State of Florida, United States of America, of P.O. Box 3272, Jacksonville, Duval County, Florida, United States of America, do hereby declare the invention for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to magnetic separators for separating materials of differing magnetic susceptibility and, more particularly, to a magnetic separator adapted to separate materials of lower magnetic susceptibility from materials of relatively high magnetic susceptibility.

Magnetic separators long have been known to the art and have been particularly efficacious in the separation of strongly magnetic materials from nonmagnetic materials. Although the greatest success and commercial use of magnetic separators has been found in dry separation processes, some success in the separation of strongly magnetic materials under wet conditions has been achieved. Despite strenous efforts over a long period of time, however, there has yet to be developed a commercially satisfactory magnetic separator for the wet magnetic beneficiation of weakly magnetic materials, such as moybdenum or tungsten ores, under wet conditions.

The more successful magnetic separators developed and employed in the prior art usually have comprised an axially rotatable drum having disposed interiorly thereof a plurality of fixed magnets. The magnets normally are placed in close proximity to a desired area of the interior surface of the drum so that when magnetic particle-carrying matter is fed against that peripheral portion of the drum overlying the fixed magnets, the magnetic particles adhere to the drum and are then carried to a discharge position. The nonmagnetic material, unaffected by the magnetic field, normally is permitted to fall under the force of gravity for separate collection. When such equipment is employed for wet separating processes, a slurry or pulp of the material to be separated either is fed to the periphery of the drum in the same manner as dry material or, where more dilute slurries, pulps or suspensions of materials are employed as the feed, the rotating drum often is partly submerged in the liquid.

As indicated, processes employing such equipment have been quite successful with dry material and moderately successful with wet material where strongly magnetic particles were being separated from nonmagnetic particles. Under wet conditions, however, any relative movement between the particle-containing fluid and the magnetically actuated surface employed to effect the separation has tended to wash weakly magnetic particles away from the surface after contact has been attained. Reduction of rotor speed to avoid eddy current has so reduced the efficiency of the separation that the process has been found economically infeasible.

The extended effort to solve the problem of separating weakly magnetic materials, particularly under wet conditions, is exemplified by British patents 767124 and 883347 to Jones. However, these and other efforts have failed to provide the art with the practical commercial separator desired.

It is, therefore, the primary object of the present invention to provide a magnetic separator which effectively separates weakly magnetic materials from nonmagnetic or faintly magnetic materials under both dry and wet conditions.

A further object of the invention is a mag-

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netic separator which will effectively separate weakly magnetic materials from gangue materials in yields which are economically attractive.

An additional object of the invention is a magnetic separator which is economical to construct, has few moving parts and is readily serviceable.

Yet another object of the invention is a magnetic separator which does not require meticulous sizing of feed materials and is essentially self-cleaning.

A further object of the invention is a magnetic separator in which high field strengths over 24,000 gauss can be obtained with a relatively minor power input in the order of 2,000 watts in a commercial machine capable of separating over 2,000 pounds of material per hour.

Another object of the invention is a magnetic separator which does not require high pressure fluids for removal of magnetic materials from the apparatus and is economical in water requirement.

A further object of the invention is a magnetic separator which, when employed in the separation of weakly magnetic materials, does not become clogged or choked with ferromagnetic impurities which may be present in the feed.

Additional objects of the invention will become apparent during consideration of the general and detailed description to follow.

Generally described, the apparatus embodiment of the present invention is a device for separating materials of differing magnetic susceptibility in combination comprising at least one magnet producing a magnetic field between oppositely disposed field poles integral with said magnet, at least one induced pole piece moveable relative to the field poles to permit the induced pole piece to pass between the field poles, means for moving the induced pole piece and the field poles relative to each other so that the induced pole piece passes into and out of the effective magnetic field, and means for contacting the material to be separated with the induced pole piece in the magnetic field.

Generally described, a further embodiment of the present invention is a method for separating materials of lower magnetic susceptibility from materials of relatively high magnetic susceptibility which comprises: passing a mixture of the materials to be separated into a continuous magnetic field in contact with at least one body of highly permeable material having such physical configuration that converging lines of force are produced within the magnetic field; flushing the feed material of lower magnetic susceptibility from the feed material of relatively higher magnetic susceptibility while both materials and the said body of highly permeable material are within the continuous magnetic field; separately collecting the said material of lower magnetic susceptibility; removing the feed material of relatively higher magnetic susceptibility and the body of highly permeable material from the continuous magnetic field; removing the feed material of relatively higher magnetic susceptibility from contact with the body of highly permeable material; and separately collecting the feed material of relatively higher magnetic susceptibility.

In accordance with the present invention, an induced pole piece is a piece of highly permeable material which will function as a pole piece when disposed in and activated by a magnetic field. Such pole piece preferably is characterized by a number of sharp edges, corners or surfaces causing convergence of the lines of force of the effective magnetic field in which the piece is disposed, thus providing optimum points for attracting and retaining magnetic materials. Pole pieces operable in the present invention include without limitation plates, grooved plates, helical rods resembling drill bits, cubes, spheres, deformed metallic screen and the like. As used in the specification and claims, the term "effective magnetic field" defines an area where any substantial amount of magnetic material in the feed to the separator adheres to the induced pole pieces.

Either electromagnets or permanent magnets may be employed in the apparatus and method of the invention. Because of their greater strength electromagnets are preferred. The magnet cores, magnet field poles and induced pole pieces may be fabricated from any highly permeable material. Preferably these members are fabricated from low carbon steel or an alloy of iron and cobalt.

In accordance with a preferred embodiment of the invention, a plurality of pole pieces presenting a large number of sharp edges are carried by an annular container rotably mounted to pass between the field poles of one or more magnets. Alternately, the induced pole pieces may pass between the field poles of one or more magnets on a substantially straight line or in an arcuate path. Whether the induced pole pieces are passed between the field poles of the magnet or magnets in a curvilinear or straight line, such passage through the effective magnetic field formed by the magnet or magnets may be reciprocal. In other words, the pole pieces may be passed through the effective magnetic field between the field poles of one or more magnets in one direction and then the direction of passage may be reversed to cause the induced pole pieces to pass through the effective magnetic field in the opposite direction.

In any of the embodiments specifically described or other embodiments which will occur to those skilled in the art, the induced pole pieces will be contacted with the material to be separated while the pole pieces are

in the effective magnetic field between the field poles of the magnet. The feed material unaffected by the magnetic field, will fall past or between individual induced pole pieces for collection below. A flushing fluid which need not be highly pressurized preferably is employed at this point to assist in the removal of the feed materials not retained by the induced pole pieces. The magnetic materials are retained on the surface of the induced pole piece or pieces and as the pole pieces are removed from the effective magnetic field, either by passing entirely through the region between the field poles of the magnet or by being withdrawn from the effective magnetic field along the path of entry, the magnetic material falls therefrom. Preferably the removal of the magnetic material from the induced pole pieces also will be accelerated by a flushing fluid. Again, a high pressure wash is unnecessary since the induced pole pieces have been removed from the effective magnetic field. The magnetic material whether released and removed from the induced pole pieces by the force of gravity or by the fluid flush, is collected below. The separately collected magnetic and nonmagnetic materials preferably fall into launders disposed on opposite sides of a divider but may be collected in any suitable manner.

In accordance with a preferred embodiment of the invention, the induced pole pieces, after the magnetic materials have been removed and collected, are passed through a degaussing unit in order to remove any ferromagnetic materials contained in the feed which have not been removed by the flushing fluid following exit of the induced pole pieces from the magnetic field. Such degaussing equipment may be chosen from any degaussing equipment known to the art and preferably will consist of coils disposed on opposite sides of the induced pole pieces and powered by an alternating current of sufficient strength to effect any degaussing necessary.

The flushing fluid employed may be liquid or gaseous, or a suitable mixture of liquid and gas. Water and/or air constitute the preferred flushing fluids.

Having generally described the present invention, a more detailed illustration will now be described with reference to the accompanying drawings given by way of example and in which

Fig. 1 is a plan view of a two-magnet, rotary separator in accordance with the invention;

Fig. 2 is a sectional side view of the two-magnet, rotary separator of Fig. 1 taken on line 2—2 of Fig. 1;

Fig. 3 is a side view of the two-magnet, rotary separator showing the drive motor in position and the operating parts suitably encased;

Fig. 4 is a fragmentary plan view showing a plurality of induced pole pieces in their rotating ring container;

Fig. 5 is an elevational view of a spiral rod-type induced pole piece in accordance with a preferred embodiment of the invention;

Fig. 6 is a diagrammatic showing of the sequence of introduction of feed and fluid washes and the removal of the separated fractions in accordance with one embodiment of the invention;

Fig. 7 is a schematic plan view of a ten-magnet, rotary separator in accordance with the invention;

Fig. 8 is a plan view of a three-magnet, in-line separator in accordance with the invention; and

Fig. 9 is a side view of the three-magnet, in-line separator of Fig. 8;

all in accordance with various embodiments of the present invention.

Referring particularly to Figs. 1 to 5, a nonmagnetic support frame 1 supports two electromagnet assemblies 2. Each magnet assembly contains a pair of cores 3 3′ bolted to an insert 4 adjacent the support 1. At their top ends, field pole pieces 5 and 6 are secured to the magnet cores 3, 3′ and define therebetween a gap 7. Core windings, 8 8′ are wound around core members 3, 3′. Sixty-six thousand ampere turns are required to produce a field strength of 100,000 lines of force and a field having a strength of 26,000 gauss. The joints between cores 3, 3′, insert 4 and field pole pieces 5 and 6 are ground to a smooth finish to provide a maximum flux path. All edges of the complete core assemblies are rounded to prevent leakage of stray flux. The field pole pieces 5 and 6 may be tapered toward the operating gap to provide the highest saturated flux possible in the area between the pieces. Pole pieces 5 and 6 may be moveably mounted to obtain the closest possible tolerances in the working gap. A jack screw 9 of nonmagnetic matreial of high strength, such as stainless steel, is employed to keep the magnetic pole pieces from buckling together. Aluminum shields 10 surround the outside coils for protection against mechanical abuse. The shields are spaced out from the coils and preferably are painted black inside and out to provide maximum cooling.

A center structural support member 11 supports drive mechanism 12. Preferably the support member 11 is formed of nonmagnetic material such as stainless steel. Support member 11 is secured to the pole pieces 5 by supporting bolts 13. A nonmagnetic head member 14, preferably an aluminum casting, is mounted on stationary stub shaft 15 by means of a sleeve bearing 16 and a thrust bearing 17. A motor drive mechanism 18 is mounted on and bolted to the supporting head member 14. A hollow annular ring 19 is formed by annular members 20 and 21.

The hollow annular ring 19 is held apart in the magnetic field by supporting members subsequently described and is closed at the bottom by means of an annular screen 22. The hollow annular ring member 19 being bolted to support member 14, is rotatable by motor drive mechanism 18. The mechanical drive preferably is a gear head motor 23 provided with slip rings so that the power from the motor is transferred through hollow shaft 24 allowing the motor to rotate with the support member 14.

The hollow annular ring member 19 forms a container or box (Figs. 2 and 4) for induced pole pieces 25. In this instance, helical rods (Fig. 5) of low carbon steel are packed vertically into the container and are held in place by the annular screen 22 at the bottom of the container and annular screen 26 at the top of the container. Spaced supporting members 27, formed by silver soldering together a plurality of the helical induced pole pieces 25, are soldered to annular rings 20 and 21. The support members 27 divide the annular container member 19 into a plurality of compartments 28'.

Feed nozzles 28 for the material to be separated are disposed above annular container 19 immediately adjacent pole pieces 5 and 6 as shown in Figs. 1 and 3. A nozzle 29 for introducing washing fluid is disposed above the annular container 19 in substantially the center of the gap between pole pieces 5 and 6. Nozzles 30 for washing fluid are disposed above the annular container 19 adjacent the pole pieces 6 at the opposite end of the working gap from the feed nozzles 28.

A degaussing unit 31, consisting of a magnetic yoke 32 powered by alternating current, is situated at one point in the circular travel of the container 19. A nozzle 33 for washing fluid is disposed over the annular container 19 at a point adjacent the degaussing unit 31 for removal of ferromagnetic material released from the induced pole pieces 25 as a result of the degaussing action.

Launders 34 and 35 are disposed beneath the annular member 19 for receiving, respectively, the nonmagnetic and magnetic fractions separated. Launder 34 is equipped with an outlet 36, while launder 35 is equipped with an outlet 37.

The magnetic separator above described in conjunction with Figs. 1 to 6 operates as follows:

The motor 23 is started, causing annular ring container 19 to rotate carrying the induced pole pieces 25 successively between field pole pieces 5 and 6 of the two magnets 2 disposed at opposite sides of the separator. Power is supplied to the magnet assemblies to provide strong magnetic fields between the pole pieces 5 and 6 of the two electromagnets. A slurry of the material to be separated is introduced through feed delivery nozzles 28. Wash water is introduced through the nozzles 29, 30 and 33. The nonmagnetic material, unaffected by the magnetic fields, falls through the induced pole pieces 25 and screen retaining members 22 and 26 under the influence of gravity and the fluid wash from nozzles 29. The magnetic material is retained on the induced pole pieces 25, principally on the sharp, helical edges. As the pole pieces 25 leave the operating gaps between field pole pieces 5 and 6 of the magnets, they pass from the magnetic field and the magnetic particles are removed from the induced pole pieces 25 by gravity and the water wash from the nozzles 30. The nonmagnetic material removed in the magnetic fields is collected in the launder 34 and is removed through outlet 36. The magnetic material is collected in the launder 35 and removed through outlet 37. As the annular ring container 19 rotates, the induced pole pieces 25 pass through the field of the degaussing unit 31. Any ferromagnetic materials retained in the container 19 are released and are removed from the induced pole pieces 25 by the water wash from the nozzle 33 and are collected in launder 35.

The separator shown in Figs. 1, 2 and 3, when employing dimensions and the power shown in the table below, was employed to separate molybdenum ore containing 0.05% by weight of molybdenum oxide. The capacity of the separator was found to be in excess of 4,000 pounds per hour; the yield was 93.7% of the recoverable molybdenum.

Dimensions of Magnet Cores	10 in. × 10 in. square
Dimensions of Pole Pieces	6 in. × 8 in.
Width of Gap	2.5 in.
Average Number of Helical Induced Pole Pieces	3,000
Number of Ampere Turns	132,000
Strength of Field	26,000 gauss
Watts Required to Energize Magnets	4,000
Watts Required to Drive Motor	400

In Fig. 7, a ten-magnet, rotary separator is shown. Except for the increased number of magnets, the separator of Fig. 7 is constructed and functions the same as the separa-

tor described in conjunction with Figs. 1 to 6.

An annular ring member 40 is rotatably mounted to pass between field poles 41 and 42 of the ten magnets 43. Ring member 40 is filled with induced pole pieces, such as the helical rods 25 of Fig. 5, cubes, spheres, and the like, made of highly permeable material. Feed material such as a slurry of comminuted molybdenum ore is introduced through feed nozzles 44. The nonmagnetic material passes through the induced pole pieces with the assistance of a fluid wash provided by wash nozzle 45. As the ring container 40 is rotated to remove the magnetic material adhering to the induced pole pieces from the field, such magnetic material is removed with the assistance of wash fluid provided by wash nozzle 46. The separated fractions are suitably collected in launders (not shown). A degaussing unit (not shown) may be employed as in the separator of Figs. 1 to 3.

In the in-line separator shown in Figs. 8 and 9, a foraminous bottomed box 50 is reciprocally mounted to pass between the field pole pieces 51 and 52 of a plurality of electromagnets 53. Reciprocal motion is imparted to the box 50 by drive assembly 54. In the box 50 are disposed induced pole pieces such as helical rods, cubes or spheres of highly permeable material.

Feed nozzles 55 and 56 are located above box 50 adjacent the outer edges of the field pole pieces 51 and 52. Material to be separated is led to nozzles 55 and 56 through feed line 57 and two-way valves 58. Fluid wash nozzles 59 are disposed above the box 50 at a point intermediate the feed nozzles 55 and 56.

Fluid wash nozzles 60 are disposed above the box 50 outside the gap between the pole pieces 51 and 52 and spaced from feed nozzles 55. Fluid wash nozzles 61 are disposed above the box 50 outside the gap between the pole pieces 51 and 52 and spaced from feed nozzle 56. Wash nozzles 60 and 61 are connected through valves 62 and 63 respectively to fluid line 64.

Launders 65, for collection of the magnetic material separated, are disposed below the box 50 and beneath wash nozzles 60 and 61. Launders 65 empty into header 66 from which the magnetic fraction is withdrawn from the separator. Launders 67, for collection of the nonmagnetic material separated, are disposed below box 50 and beneath wash nozzles 59. Launders 67 empty into header 68 from which the nonmagnetic fraction is withdrawn from the separator.

The separator of Figs. 8 and 9 operates as follows:

Drive mechanism 54 is actuated to move box 50 to the right. Feed material is introduced to the top of box 50 through valves 58 and feed nozzles 55, valve 58 preventing delivery of material to feed nozzles 56. As the feed material moves into the effective field between field pole pieces 51 and 52, the nonmagnetic material falls through the induced pole pieces and the foraminous bottom of box 50, while the magnetic material is retained on the induced pole pieces in box 50. The nonmagnetic material falls and/or is washed from the box 50 into launders 67 and is removed through headers 68. As the box 50 approaches the limit of travel, valves 58 shut off the flow of feed material through feed nozzle 55 while valve 63 is actuated to introduce wash water to the top of box 50 through wash nozzles 61. Magnetic material, now outside the effective magnetic fields of pole pieces 51 and 52, readily is washed from the induced pole pieces into launders 65 and is removed through headers 66.

At this point, the direction of travel of the box 50 is reversed. Valves 58 are now actuated to direct the flow of feed material through feed nozzles 56. Valves 63 are actuated to shut off the flow of wash water through nozzles 61 and valves 62 are actuated to initiate flow through wash nozzles 60.

The process above described is now repeated as the box 50 travels to the left between the pole pieces 51 and 52. Nonmagnetic material is washed from box 50 by wash water introduced through wash nozzle 59. Magnetic material is washed from the pole pieces by wash water from wash nozzles 60. Nonmagnetic material and magnetic material again are collected in launders 67 and 65, respectively, and removed as before.

Accordingly, it will be seen that the in-line separator of Figs. 8 and 9 is continuously operated, the process necessitating only actuation of a few valves to effect flow of feed material and wash fluid through the proper nozzles as the direction of travel of the box 50 changes.

In either a rotary or in-line separator, it is possible to employ a single magnet or as many magnets as may be desirable or practical in the operation.

The separators of the invention are economical to construct and operate and are readily serviced. Due to the small number of moving parts, the separators of the invention have proven essentially trouble-free in extended operation.

Since modifications in the equipment and methods herein disclosed will be apparent to those skilled in the art, it is intended that the invention be limited solely by the scope of the appended claims.

WHAT WE CLAIM IS:—

1. A device for separating materials of differing magnetic susceptibility comprising

tor described in conjunction with Figs. 1 to 6.

An annular ring member 40 is rotatably mounted to pass between field poles 41 and 42 of the ten magnets 43. Ring member 40 is filled with induced pole pieces, such as the helical rods 25 of Fig. 5, cubes, spheres, and the like, made of highly permeable material. Feed material such as a slurry of comminuted molybdenum ore is introduced through feed nozzles 44. The nonmagnetic material passes through the induced pole pieces with the assistance of a fluid wash provided by wash nozzle 45. As the ring container 40 is rotated to remove the magnetic material adhering to the induced pole pieces from the field, such magnetic material is removed with the assistance of wash fluid provided by wash nozzle 46. The separated fractions are suitably collected in launders (not shown). A degaussing unit (not shown) may be employed as in the separator of Figs. 1 to 3.

In the in-line separator shown in Figs. 8 and 9, a foraminous bottomed box 50 is reciprocally mounted to pass between the field pole pieces 51 and 52 of a plurality of electromagnets 53. Reciprocal motion is imparted to the box 50 by drive assembly 54. In the box 50 are disposed induced pole pieces such as helical rods, cubes or spheres of highly permeable material.

Feed nozzles 55 and 56 are located above box 50 adjacent the outer edges of the field pole pieces 51 and 52. Material to be separated is led to nozzles 55 and 56 through feed line 57 and two-way valves 58. Fluid wash nozzles 59 are disposed above the box 50 at a point intermediate the feed nozzles 55 and 56.

Fluid wash nozzles 60 are disposed above the box 50 outside the gap between the pole pieces 51 and 52 and spaced from feed nozzles 55. Fluid wash nozzles 61 are disposed above the box 50 outside the gap between the pole pieces 51 and 52 and spaced from feed nozzle 56. Wash nozzles 60 and 61 are connected through valves 62 and 63 respectively to fluid line 64.

Launders 65, for collection of the magnetic material separated, are disposed below the box 50 and beneath wash nozzles 60 and 61. Launders 65 empty into header 66 from which the magnetic fraction is withdrawn from the separator. Launders 67, for collection of the nonmagnetic material separated, are disposed below box 50 and beneath wash nozzles 59. Launders 67 empty into header 68 from which the nonmagnetic fraction is withdrawn from the separator.

The separator of Figs. 8 and 9 operates as follows:

Drive mechanism 54 is actuated to move box 50 to the right. Feed material is introduced to the top of box 50 through valves 58 and feed nozzles 55, valve 58 preventing delivery of material to feed nozzles 56. As the feed material moves into the effective field between field pole pieces 51 and 52, the nonmagnetic material falls through the induced pole pieces and the foraminous bottom of box 50, while the magnetic material is retained on the induced pole pieces in box 50. The nonmagnetic material falls and/or is washed from the box 50 into launders 67 and is removed through headers 68. As the box 50 approaches the limit of travel, valves 58 shut off the flow of feed material through feed nozzle 55 while valve 63 is actuated to introduce wash water to the top of box 50 through wash nozzles 61. Magnetic material, now outside the effective magnetic fields of pole pieces 51 and 52, readily is washed from the induced pole pieces into launders 65 and is removed through headers 66.

At this point, the direction of travel of the box 50 is reversed. Valves 58 are now actuated to direct the flow of feed material through feed nozzles 56. Valves 63 are actuated to shut off the flow of wash water through nozzles 61 and valves 62 are actuated to initiate flow through wash nozzles 60.

The process above described is now repeated as the box 50 travels to the left between the pole pieces 51 and 52. Nonmagnetic material is washed from box 50 by wash water introduced through wash nozzle 59. Magnetic material is washed from the pole pieces by wash water from wash nozzles 60. Nonmagnetic material and magnetic material again are collected in launders 67 and 65, respectively, and removed as before.

Accordingly, it will be seen that the in-line separator of Figs. 8 and 9 is continuously operated, the process necessitating only actuation of a few valves to effect flow of feed material and wash fluid through the proper nozzles as the direction of travel of the box 50 changes.

In either a rotary or in-line separator, it is possible to employ a single magnet or as many magnets as may be desirable or practical in the operation.

The separators of the invention are economical to construct and operate and are readily serviced. Due to the small number of moving parts, the separators of the invention have proven essentially trouble-free in extended operation.

Since modifications in the equipment and methods herein disclosed will be apparent to those skilled in the art, it is intended that the invention be limited solely by the scope of the appended claims.

WHAT WE CLAIM IS:—

1. A device for separating materials of differing magnetic susceptibility comprising

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in combination at least one magnet producing a magnetic field between oppositely disposed field poles integral with said magnet, a movable container disposed between the field poles, said container having at least one foraminous wall, a plurality of induced pole pieces packed into the container and retained therein by the foraminous wall, means for moving the container and the induced pole pieces retained therein relative to the field poles so that the induced pole pieces pass into and out of the effective magnetic field, and means for contacting the material to be separated with the induced pole pieces in the magnetic field.

2. A device according to claim 1 and having means for removing the separated material from the device.

3. A device according to claim 1 comprising, a plurality of magnets, each of said magnets producing a magnetic field between oppositely disposed field poles integral therewith, said movable container being disposed between the field poles of the magnets so that said induced pole pieces retained therein successively pass into and out of the effective magnetic fields so the magnets and means for contacting the material to be separated with the induced pole pieces in the effective magnetic field of the said magnets.

4. A device according to claim 3 having means for removing the separated material from the device.

5. A device according to claim 1 or 2 wherein said plurality of induced pole pieces are individually moveable relative to each other.

6. A device according to claims 3 or 4 wherein said plurality of induced pole pieces are individually moveable relative to each other.

7. A device according to claim 1 or 2 wherein said means for moving the container and the induced pole pieces retained therein relative to the field poles so that the induced pole pieces pass into and out of the effective magnetic field comprises means for reciprocating the container.

8. A device according to claims 3 or 4 wherein said means for moving the container and the induced pole pieces retained therein relative to the field poles of the magnets so that the induced pole pieces pass into and out of the effective magnetic fields comprises means for reciprocating the container.

9. A device according to claim 1 or 2 wherein said container comprises an annular member rotably mounted to pass between the field poles of the magnet.

10. A device according to claim 3 or 4 wherein said container comprises an annular member rotably mounted to pass between the field poles of the magnets.

11. A device for separating granular materials of differing magnetic susceptibility comprising in combination at least one magnet producing a magnetic field between oppositely disposed field poles integral with said magnet a foraminous bottomed annular container mounted to pass in a substantially horizontal plane through the gap between the field poles of said magnet, induced pole pieces packed into said container and retained therein by the foraminous bottom of the container, said induced pole pieces being sufficiently spaced apart to permit the passage of granular material therebetween, inlet means for feeding granular material to the upper portion of the container in the effective magnetic field produced by said magnet, inlet means for delivering a first flushing fluid to the upper portion of the container at a point within the gap between the field poles of said magnet, inlet means for delivering a second flushing fluid to the upper portion of the annular container at a point outside the gap between the field poles of said magnet, collecting means for granular material disposed below the annular container at a point where the container passes through the gap between the field poles of said magnet, and collecting means for granular material disposed below the annular container at a point below the inlet means delivering the second flushing fluid.

12. A device in accordance with claim 11 wherein the magnet is an electromagnet.

13. A device in accordance with claim 11 or 12 wherein the annular container is formed from magnetic material.

14. A device in accordance with claim 11 or 12 or 13 wherein the induced pole pieces are formed with a plurality of surfaces providing areas of convergence for lines of force.

15. A device in accordance with any of claims 11 to 14 wherein the induced pole pieces are helical rods of low carbon steel packed into the annular container in essentially co-axial relationship with the axis of rotation of the container.

16. A device in accordance with claim 11, 12 or 13 wherein the induced pole pieces are spheres of highly permeable material.

17. A device according to claim 11 wherein the foraminous bottomed annular container rotably mounted to pass in a substantially horizontal plane through the gap between the field poles of said magnet, and wherein degaussing means is provided for said annular container and induced pole pieces retained therein disposed outside the magnetic field of the said magnet.

18. A device according to claim 11 comprising a plurality of magnets producing a magnetic field between oppositely disposed field poles integral with each said magnet, the foraminous bottomed annular container being rotably mounted to pass in a substantially horizontal plane through the gap between

the field poles of each said magnet and including inlet means for feeding granular material to the upper portion of the container in the effective magnetic field produced by each said magnet, inlet means for delivering a first flushing fluid to the upper portion of the container at a point within the gap between the field poles of each said magnet, inlet means for delivering a second flushing fluid to the upper portion of the annular container at a point outside the gap between the field poles of each said magnet; collecting means for granular material disposed below the annular container at a point where the container passes through the gap between the field poles of each said magnet, and collecting means for granular material disposed below the annular container at a point below each inlet means delivering the second flushing fluid.

19. A device in accordance with claim 18 wherein the magnets are electromagnets.

20. A device in accordance with claim 18 or 19 wherein the annular container is formed from magnetic material.

21. A device in accordance with claim 18 or 19 or 20 wherein the induced pole pieces are formed with a plurality of surfaces providing areas of convergence for lines of force.

22. A device in accordance with any of claims 18 to 21 wherein the induced pole pieces are helical rods of low carbon steel packed into the annular container in essentially co-axial relationship with the axis of rotation of the container.

23. A device according to claim 18, 19 or 20 wherein the induced pole pieces are spheres of highly permeable material.

24. A device according to claim 11 comprising a plurality of magnets producing a magnetic field between oppositely disposed field poles integral with each said magnet, the foraminous bottomed annular container being rotably mounted to pass in a substantially horizontal plane through the gap between the field poles of each of said magnets, and including inlet means for feeding granular material to the upper portion of the container in the effective magnetic field produced by each said magnet; inlet means for delivering a first flushing fluid to the upper portion of the container at a point within the gap between the field poles of each said magnet, inlet means for delivering a second flushing fluid to the upper portion of the annular container at a point outside the gap between the field poles of each said magnet, collecting means for granular material disposed below the annular container at a point where the container passes through the gap between the field poles of each said magnet; collecting means for granular material disposed below the annular container at a point below each inlet means delivering the second flushing fluid; and degaussing means for said annular container and induced pole pieces retained therein disposed outside the magnetic field of the said magnets.

25. A method for separating materials of lower magnetic susceptibility from materials of relatively high magnetic susceptibility which comprises; passing a feed mixture of the materials to be separated into a continuous magnetic field in contact with a plurality of individually movable bodies of highly permeable material having such physical configuration that converging lines of force are produced within the magnetic field, flushing the feed material of lower magnetic susceptibility from the feed material of relatively higher magnetic susceptibility while both materials and the said bodies of highly permeable material are within the continuous magnetic field, separately collecting the said material of lower magnetic susceptibility, removing the feed material of relatively higher magnetic susceptibility and the said bodies of highly permeable material from the continuous magnetic field, removing the feed material of relatively higher magnetic susceptibility from contact with the bodies of highly permeable material and separately collecting the feed material of relatively higher magnetic susceptibility.

26. A method for separating materials of lower magnetic susceptibility from materials of relatively high magnetic susceptibility which comprises: passing a feed mixture of the materials to be separated into a magnetic field in contact with a plurality of individually movable bodies of highly permeable material induced in the magnetic field to provide converging lines of force; flushing the feed material of lower magnetic susceptibility from the feed material of relatively higher magnetic susceptibility while both materials and the said bodies of highly permeable material are within the continuous magnetic field; separately collecting the said material of lower magnetic susceptibility; removing the feed material of relatively higher magnetic susceptibility and the said bodies of highly permeable material from the continuous magnetic field; and removing the feed material of relatively higher magnetic susceptibility from contact with the bodies of highly permeable material.

27. A device for separating materials of differing magnetic susceptibility substantially as hereinbefore described with reference to the accompanying drawings.

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28. A method for separating materials of differing magnetic susceptibility substantially as hereinbefore described with reference to the accompanying drawings.

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