Aug. 19, 1952 W. H. NEWTON 2,607,478

MAGNETIC SEPARATOR

Filed Sept. 29, 1948 2 SHEETS—SHEET 1

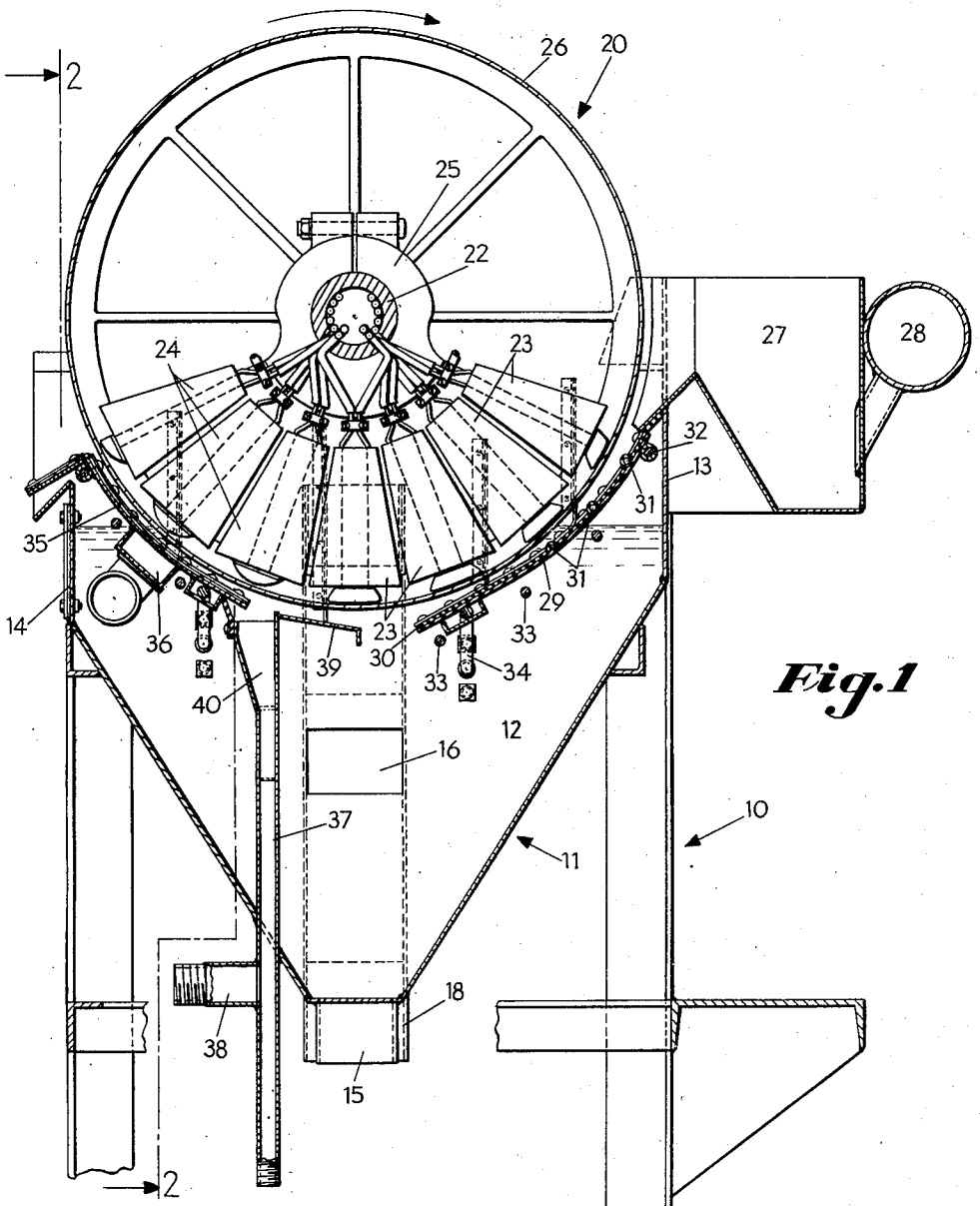

Fig. 1

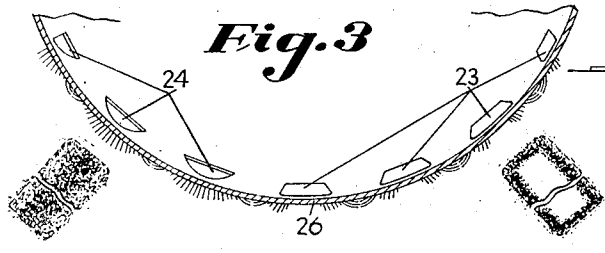

Fig. 3

INVENTOR;
WILLIAM H. NEWTON,
BY
Harlow H. Nielson
ATT'Y.

Aug. 19, 1952 W. H. NEWTON 2,607,478

MAGNETIC SEPARATOR

Filed Sept. 29, 1948 2 SHEETS—SHEET 2

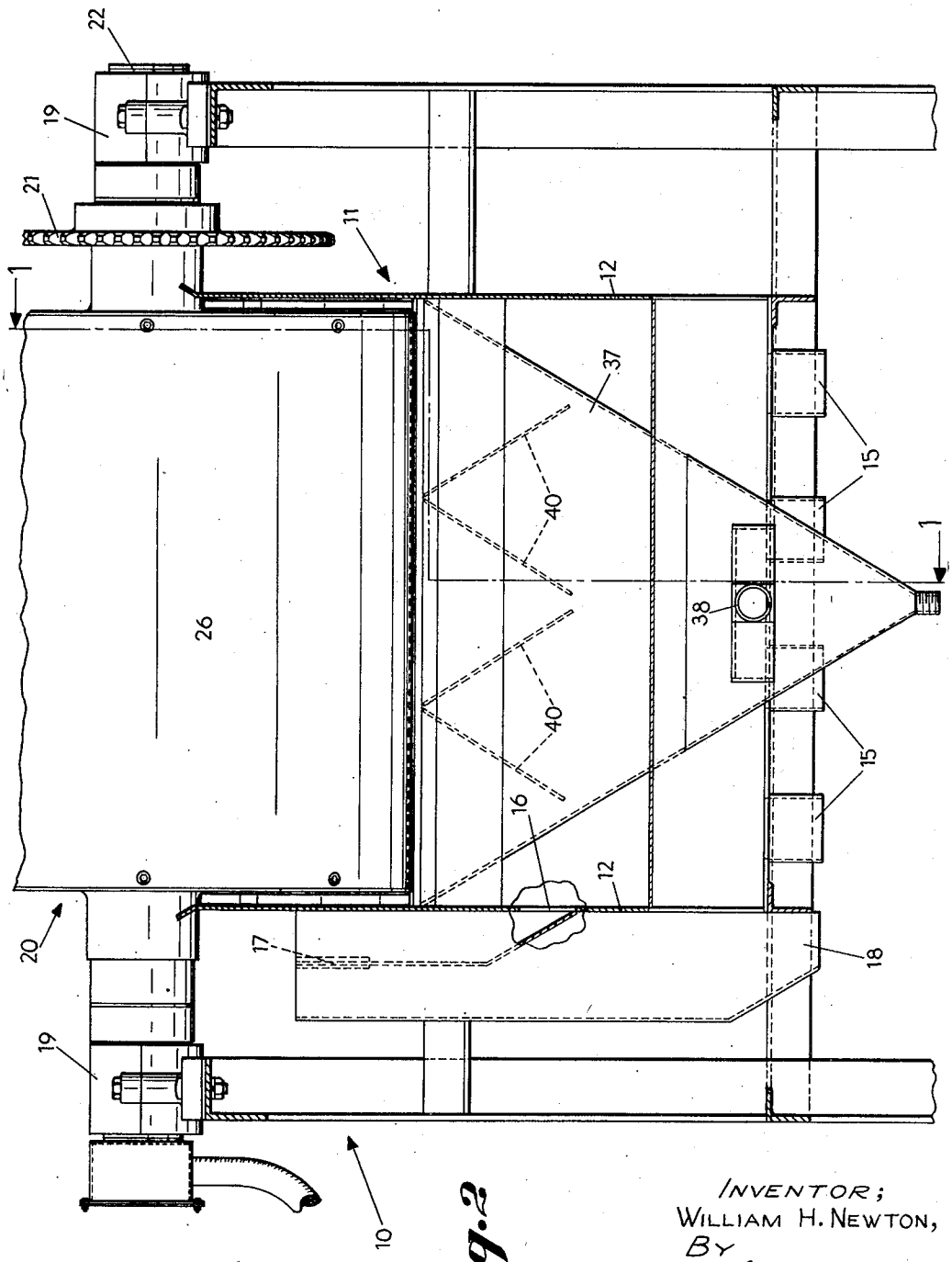

Fig. 2

INVENTOR;
WILLIAM H. NEWTON,
BY
Hanlon & Hattson,
ATT'Y.

Patented Aug. 19, 1952

2,607,478

UNITED STATES PATENT OFFICE

2,607,478

MAGNETIC SEPARATOR

William H. Newton, Upper Arlington, Ohio, assignor to The Jeffrey Manufacturing Company, a corporation of Ohio

Application September 29, 1948, Serial No. 51,723

5 Claims. (Cl. 209—39)

1

This invention relates to a magnetic separator, and an object of the invention is to provide improved apparatus of this type.

A more specific object of the invention is to provide a magnetic separator in which the magnetic or ferrous components of iron ore are removed from the gangue or tailings by moving along a rotating non-magnetic drum over a feed plate which is close to but spaced from the periphery of the drum and in which in the preferred arrangement there are substantially flat faced magnetic poles within the drum opposite said feed plate; the gangue or tailings being free to discharge over the lower end of said feed plate into a tailings tank or chamber; there also being a wash plate adjacent the drum near the discharged or clean material side thereof adjacent which the ore is washed. There preferably are magnetic poles opposite said wash plate which have faces which are segments of small radius cylinders; there also preferably being an upward current classifier chute or compartment within the tailings tank which receives the released material which falls off the lower edge of the wash plate. The upward current after flowing through the wash plate classifier preferably flows into the tailings tank.

Another object of the invention is to provide a magnetic drum with a plurality of magnets, the pole faces of which are adjacent the inner peripheral cylindrical surface of the drum, some of the faces being preferably flat, the others formed as segments of a small radius cylinder.

Other objects of the invention will appear hereinafter, the novel features and combinations being set forth in the appended claims.

In the accompanying drawings,

Fig. 1 is a sectional elevational view of a magnetic separator comprising my invention, and taken on the line 1—1 of Fig. 2 looking in the direction of the arrows;

Fig. 2 is a transverse sectional view taken on the line 2—2 of Fig. 1, with certain parts omitted; and

Fig. 3 is a schematic illustration of a drum and associated pole faces, illustrating particularly the general pattern of the magnetic material carried by the drum.

The magnetic separator includes a main frame 10 upon which a tank or box 11 is mounted. The tank or box 11 has spaced vertical side walls 12, a front feed wall 13 and back discharge wall 14, the bottoms of which walls 13 and 14 converge downwardly, leading to tailings or gangue discharge spouts 15. One side wall 12

2

has a door 16 through which water, which normally fills said tank to the level indicated in Fig. 1, may flow over a controllable height weir 17 and discharged by way of pipe 18. The height of the water in the tank or box 11 may be adjusted by adjusting the weir 17.

Mounted in bearings 19 carried by the mainframe 10 is a drum assembly 20 which is preferably driven by a drive means, including a sprocket 21, in the direction of the arrow, as suggested in Fig. 1 of the drawings.

The drum assembly 20 includes a stationary shaft 22 to which a plurality of radially extending magnets 23 and 24 are attached by a removable bracket 25. The magnets 23 and 24 are preferably of the electro-magnetic type, though they may be of a permanent type if desired. Their lateral dimension or width is preferably substantially coextensive with the width or axial dimension of an enclosing non-magnetic cylindrical drum 26 which is preferably fluid tight, having disc like ends rigidly attached to the cylindrical interposed portion.

The drum assembly 20 is obviously mounted on a transverse horizontal axis and the bottom portion thereof as so mounted extends downwardly into the tank or box 11, preferably appreciably below the normal water level therein. The magnets 23 and 24 may be rotatably adjusted relative to the drum 20 in a well known manner and locked in any fixed position. Said magnets preferably are attached approximately in the positions illustrated in Fig. 1 of the drawings in which their pole faces extend substantially entirely across the drum 26 and so that the magnets 23 which have flat pole faces are grouped at one side of a plane extending axially through the drum 26 and the magnets 24, which have cylindrical pole faces, are grouped at the other side of the plane.

Adjacent the right hand side, as viewed in Fig. 1 of the drawings, is an ore feed box 27 which may be supplied with water from a water pipe 28. The ore to be treated is, of course, previously crushed or ground so that the magnetic ferrous or iron constituents may be readily separated by the magnetic separator from the gangue tailings or non-magnetic constituents. In other words, as is customary with magnetic separators, the primary function is to effect a separation of magnetic and non-magnetic materials which are commingled, such as in raw ore which has merely been reduced in size. Other instances of commingled magnetic and non-magnetic materials which can readily be separated by a magnetic

separator are well known to those skilled in the art.

Cooperating with and fed by the feed box 27 is a feed plate 29 which is positioned in the tank 11 so as to receive the ore as it is first fed into said box, it extending roughly in an arc near to but slightly spaced from the periphery of the drum 20 and preferably extending both above and below the water level and through an arc which is less than a quadrant, the lower end of said feed plate 29 terminating near the lowermost position of the drum 20 or, in other words, near a vertical plane through the axis of the drum 20.

The feed plate 29 extends laterally substantially the entire width of the tank 11. It is preferably covered with rubber 30 on the material supporting surface, the rubber extending beyond the lateral edges thereof so as to have a close wiping contact with the side walls 12 of said box 11. Adjacent its upper portion it is also preferably corrugated or riffled, the corrugation being effected by transversely extending rods or wires 31 between the plate 29 and said rubber cover 30.

The feed plate 29 is preferably mounted so that it can be effectively adjusted toward and from the drum 20 and to this end its upper end is pivoted at 32 to the tank 11, it being adjustable up to the limits of stops 33 away from said drum 20 by means of adjusting crank 34, one end of which may project through one of the walls 12 of the tank and be provided with an operating lever or merely a hex-head, not shown. Experience indicates that friction between the rubber cover 30 and the side walls 12 is adequate to hold the plate 29 in any position to which it is adjusted.

Material which is delivered to the upper end of the feed plate 29 is subjected to action of the magnetic field developed by the pole faces opposite said feed plate 29 which includes the first three of the four magnetic poles 23. This, of course, is a primary separation of magnetic material adhering to the non-magnetic drum 20 as it rotates across the pole faces of said poles 23. The non-magnetic material comprising the gangue or tailings will spill over the bottom edge of the feed plate 29 into the bottom of the tank 11 where it can be slushed out.

The four poles 23 have what is designated in the claims as generally flat shaped pole faces. Actually they are not exactly plane faces but they are segments of a cylinder which has substantially the same radius as the drum 20. This might be defined as a large radius cylinder. This is desirable because it produces a pattern of magnetic material on the non-magnetic drum 20 which is conducive to a rough separation; that is, very little of the magnetic material will be lost and as a consequence the tailings or gangue discharged over the bottom of the feed plate 29 will be substantially free of magnetic components of the feed.

The pattern produced on said drum opposite each pole will be that there is a high concentration of magnetic material around the periphery of the pole. The center part of the pole will have very little material, in fact, it will be almost devoid of material. In other words, this pole will produce a pattern of magnetic material on the surface of the drum 20 opposite it which resembles or suggests the traditional haircut of a monk. This pattern is illustrated in Fig. 3 of the drawings. Between adjacent poles 23 on the drum 20 the material will lie quite flat and be rather heavy. This is also suggested in Fig. 3 of the drawings.

In the left hand portion of the tank 11, as seen in Fig. 1, there is a wash plate 35 which is generally quite similar in construction and position to the feed plate 29, except that it is located in the adjoining quadrant, and rubber gaskets are provided only adjacent the lateral edges thereof and do not cover it, said gaskets cooperating with the side walls 12 of the tank 11. The wash plate 35 which extends both above and below the water line, is adjustable by means similar to that described in connection with feed plate 29. Its upper end terminates in a material discharge ledge which is adapted to receive the cleaned magnetic material which may be removed from the drum 20 in any desired manner, such as being washed off or allowed to fall off by gravity as it passes out of the path of the last magnetic pole 24.

Extending transversely substantially its full width the wash plate 35 carries a wash chamber 36 which is connected by flexible means, not shown, to a source of water, the plate 35 opposite the chamber 36 being perforated so that wash water may wash the surface of the drum 20 opposite said plate 35, it, of course, running downward over the lower edge of said wash plate 35.

The faces of the poles 24 which are generally opposite the wash plate 35 have a configuration which is the segment of a relatively small radius cylinder. The expression "small radius" as used in the claims is to be understood as a radius which is appreciably less than the radius of the drum 20; for example, at most, not more than one-half of this radius and one which is preferably not more than twice as long as the arcuate dimension of said face of pole 24 measured in a plane at right angles to the axis of the drum 20.

The purpose of such a large radius cylinder pole face is to provide a pattern of magnetic material opposite the wash plate 35, in which there is a more even distribution of the material which projects generally radially and is opposite each of the pole faces on the drum 20, there being a graduated concentration of the material opposite the center of the pole face as suggested in Fig. 3 of the drawings. There will also be some material lying flat between the poles but there will not be as much of this flat material between said poles 24 as there is between the previously described poles 23. This is also suggested in Fig. 3 of the drawings.

The pattern of the magnetic material opposite the small radius cylinder pole faces of poles 24 may be described as suggesting a crew haircut. This particular pattern of magnetic material tends to release any trapped gangue or refuse which is free to be washed off by the wash water from wash chamber 36. Any material which is washed from the wash plate 35 will fall off the lower edge thereof and instead of allowing it to fall into the tailings compartment or main tank 11 where it will be lost, it is preferably directed into the upper open end of a wash column 37 which may be considered as an upward current classifier, since it is supplied with water, by way of pipe 38, at such a rate that at least part of the water flows upwardly through the column 37 and over the right hand edge thereof, as viewed in Fig. 1, traveling over a substantially horizontal though slightly sloping flat plate 39 which is near but spaced from the drum 20.

The upper end of the wash column **37** is flared out both laterally and transversely, the lateral flaring being clearly illustrated in Fig. 2 of the drawings, the transverse flaring being illustrated in Fig. 1. Baffles **40** which are inclined downwardly are also provided at the upper portion of the wash column **37**.

Thus any material which drops off the lower edge of the wash plate **35** is not delivered directly to the tailings compartment and lost but is subjected to the action of an upward current classifier which carries the relatively fine portion of the material back up against the drum **20** where it may again be attracted to the drum, this material being subjected to this magnetic action of the poles **23** and the last pole **24** while the fluid flows from the classifier to the right, as viewed in Fig. 1, over the plate **39** and into the tank **11**. In other words, there is a counterflow action on any material which flows with a stream of water downwardly over the plate **35** or downwardly over the plate **39**. Furthermore the material which flows over the bottom edge of the plate **35** is subjected to a classifying treatment in which any large particles may move downwardly against the upwardly flowing stream and discharge out of the normally open bottom of said column **37**. This prevents a building up of particles on plate **39**.

There is, of course, no counterflow of fluid over the feed plate **29**, since the liquid through this area is substantially static, except insofar as a head is built up by the ore and water and to that extent the flow of the liquid will be with the direction of rotation of the drum **20**.

In the operation of the separator the intermingled particles of magnetic and non-magnetic material to be separated, such as crushed or ground iron ore, will be delivered to the feed box **27** together with a desired amount of water by way of the pipe **28**. This slurry will flow over the upper edge of the feed plate **29** and between it and the adjacent peripheral surface of the drum **20**. Riffles **31** will agitate the feed thereby tending to present all of the particles to the influence of the magnetic field developed particularly by the first three magnetic poles **23**. Magnetic constituents together with some non-magnetic fines will adhere to the drum **20** under the influence of the magnetic field developed by the group of poles **23**, it being noted that all of these poles **23** are grouped together as are the subsequent washing poles **24**.

As the drum **20** rotates, the attracted particles will shift their pattern on the surface thereof so that there is generally a mat or flat bed of polarized particles between each of the poles **23** on the drum **20**, there being a monk's haircut pattern of polarized particles on said drum **20** around the periphery of each of the pole faces **23**. These polarized particles of the monk's haircut pattern will be projecting generally radially from the surface of the drum **20**.

The rotating drum will, of course, carry the particles of magnetic material with it, though it is understood that these particles will actually shift across the surface of the drum as they move out from under the influence of one of the poles **23** into the area of influence of an adjacent pole. The same, of course, applies to the movement of the particles between the last pole **23** and the first pole **24** as well as between successive poles **24**.

The pattern of polarized magnetic material is such that a very low percentage of magnetic material is discharged with the gangue over the lower edge of the feed plate **29**. As the material continues to be carried by the drum **20** past the last of the poles **23** it is subjected to a re-washing action which will be described subsequently.

As the material is carried under the poles **24** it assumes a different pattern from that under the poles **23**, in that opposite each pole **24** the material on the surface of drum **20** resembles or suggests a crew haircut, there being some flat material on said drum between the poles **24** and between the last pole **23** and the first pole **24**. This mat, however, will not be as heavy as that which exists between the poles **23**. As a consequence of this pattern the reverse or return flow of water delivered by the wash chamber **36** through the wash plate **35** will tend to form a flowing stream which flows downwardly over the wash plate **35**, thus carrying with it any released material which flows counter or opposite to the direction of rotation of the drum **20**. In other words, this is a counterflow stream. Any material thus washed from the drum **20** will be delivered to the open top of the classifier column **37** through which water moves upwardly adjacent the top, there being some water also moving downwardly to wash out the gangue or middlings received by it, said water being delivered by the pipe **38**. The large pieces of gangue or middlings will, of course, settle out against the upwardly flowing water in the classifier column **37**. This stream of water will flow over the plate **39** adjacent the drum **20**, thus also effecting a counterflow and carrying with it any material which does not flow down through the classifier column **37** which is not attracted to the drum **20**. Since there is a monk's haircut type or flat face pole **23** above this plate **39** there will be a further opportunity for any magnetic material to be again attached to the drum **20** for recovery.

Gangue or middlings which ultimately flow over the right hand edge of plate **39** will, of course, be discharged into the tailings tank **11** along with the tailings discharged from the bottom edge of the feed plate **29**.

It is to be understood that while in the drawings a single cell drum or separator is shown the parts illustrated may be essentially duplicated in one or more additional compartments.

Obviously those skilled in the art may make various changes in the details and arrangement of parts without departing from the spirit and scope of the invention as defined by the claims hereto appended, and I therefore wish not to be restricted to the precise construction herein disclosed.

Having thus described and shown an embodiment of my invention, what I desire to secure by Letters Patent of the United States is:

1. A magnetic separator including a rotatable drum of non-magnetic material mounted on a horizontal axis, magnets in said drum having pole faces near the lower portion of said drum, a tank adapted to hold water into which the lower portion of said drum extends, a feed plate in said tank on the feed end thereof and near and below said drum and extending between opposite side walls of said tank, said feed plate extending along an arcuate distance less than a quadrant and terminating near the lowermost portion of said drum, a wash plate in said tank near and on the discharge end thereof and near and below said drum and extending between opposite side walls of said tank, said wash plate extending along an arcuate distance less than a quadrant and also terminating near the lowermost portion of said

drum and spaced from said feed plate, the magnet pole faces opposite said feed plate being of generally flat shape whereby to provide a pattern of magnetic material on the surface of said drum opposite said flat faced poles which suggests a monk's haircut, the magnetic pole faces opposite said wash plate being convex and shaped generally as a segment of a short radius cylinder whereby to provide a pattern of magnetic material on the surface of said drum opposite said cylindrical faced poles which suggests a crew haircut, and means for spraying water on said drum adjacent said wash plate.

2. A drum assembly for a magnetic separator including a cylindrical drum of non-magnetic material adapted to be rotated on its axis, and a plurality of magnets inside said drum having pole faces adjacent the inner drum surfaces, some of said magnets having generally flat pole faces and others shaped convexly and as segments of short radius cylinders, the flat faced poles being grouped at one side of a plane extending axially through said drum and adjacent a group of cylindrically faced poles, the flat faced poles on the opposite side of said plane producing a pattern of magnetic material on the drum surface opposite them which suggests a monk's haircut, and the cylindrical faced poles providing a pattern of magnetic material on the drum surface opposite them which suggests a crew haircut.

3. A magnetic separator including a rotatable drum of non-magnetic material mounted on a horizontal axis, magnets in said drum having pole faces near the lower portion of said drum, a tank adapted to hold water into which the lower portion of said drum extends, a feed plate in said tank on the feed end thereof and near and below said drum and extending between opposite side walls of said tank, said feed plate extending along an arcuate distance less than a quadrant and terminating near the lowermost portion of said drum, a wash plate in said tank near and on the discharge end thereof and near and below said drum and extending between opposite side walls of said tank, said wash plate extending along an arcuate distance less than a quadrant and also terminating near the lowermost portion of said drum and spaced from said feed plate, the lower edge of said feed plate discharging gangue into said tank, means for spraying water on said drum adjacent said wash plate, an upward current classifier through which water flows upwardly toward said drum, said classifier comprising a separate washing cell extending upwardly through said tank and positioned with its open top adjacent the bottom of said wash plate and adapted to receive material washed from said drum adjacent said wash plate, and a flat plate adjacent the upper end of said upward current classifier and near but spaced from said drum and between said classifier and said feed plate, over which flat plate material carried upwardly by water flowing through said classifier will flow counter to the rotation of said drum and into said tank.

4. A magnetic separator including a movable nonmagnetic carrier, magnets having pole faces near and above said carrier, a tank adapted to hold water into which said carrier submerges on one side of said tank and emerges on the other side, a feed plate in said tank on one side thereof and below and near said carrier, means for feeding material to be separated to one end of said feed plate, means for moving said carrier in a direction away from said one end, said feed plate having another end submerged in said tank below the normal water level therein, gangue being free to discharge over said other end of said feed plate, a wash plate in said tank on the other side thereof from said feed plate and below and near said carrier, said wash plate having a discharge edge above said normal water level and another edge below said water level, a substantially horizontal plate interposed between said feed plate and said wash plate and having opposite edges spaced from each other, means for feeding wash water to material on said carrier adjacent said wash plate which wash water flows downwardly thereover, and an upward current classifier having an open top adjacent the lower edge of said wash plate and one edge of said horizontal plate and operable to receive and classify material washed over said lower edge of said wash plate and into said classifier.

5. A magnetic separator including a movable non-magnetic carrier, magnets having pole faces near and above said carrier, a tank adapted to hold water into which said carrier submerges on one side of said tank and emerges on the other side, a feed plate in said tank on one side thereof and below and near said carrier, means for feeding material to be separated to one end of said feed plate on that side of said tank where the carrier is submerged, means for moving said carrier in a direction away from said one end and in the direction of movement of material over said feed plate, said feed plate having another end submerged in said tank below the normal water level therein, gangue being free to discharge over said other end of said feed plate, a wash plate in said tank on the other side thereof from said feed plate and below and near said carrier, said wash plate having a discharge edge above said normal water level and another edge below said water level, means for feeding wash water to material on said carrier adjacent said wash plate which wash water flows downwardly thereover, and an upward current classifier having an open top adjacent the lower edge of said wash plate and operable to receive and classify material washed over said lower edge of said wash plate and into said classifier.

WILLIAM H. NEWTON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
455,984	Eiske	July 14, 1891
946,394	Ohrn	Jan. 11, 1910
954,015	Bent	Apr. 5, 1910
2,160,628	Steffensen	May 30, 1939