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MAGNETIC SEPARATOR

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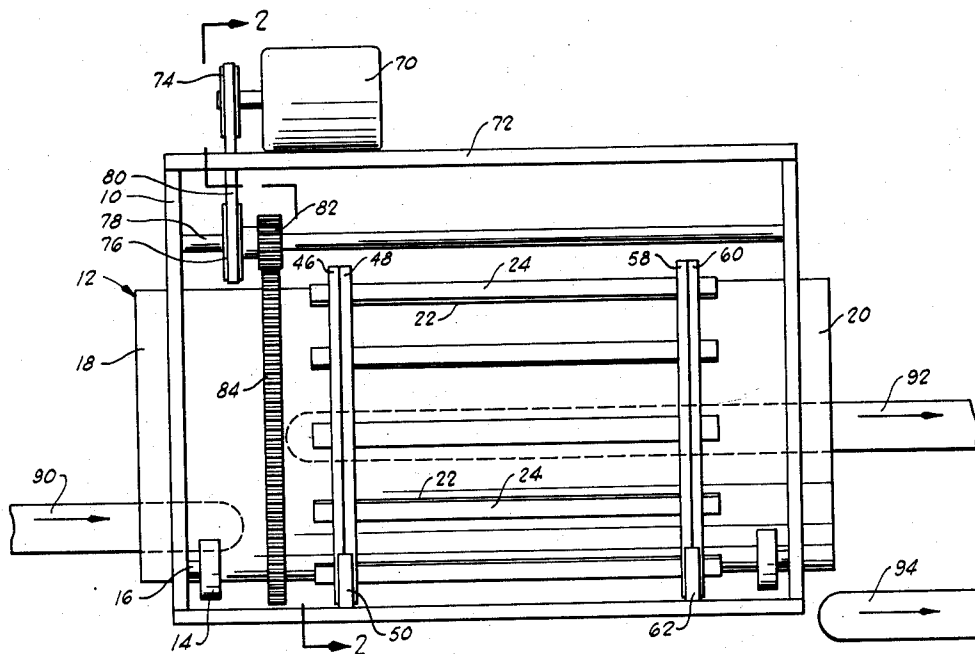


FIG. 1

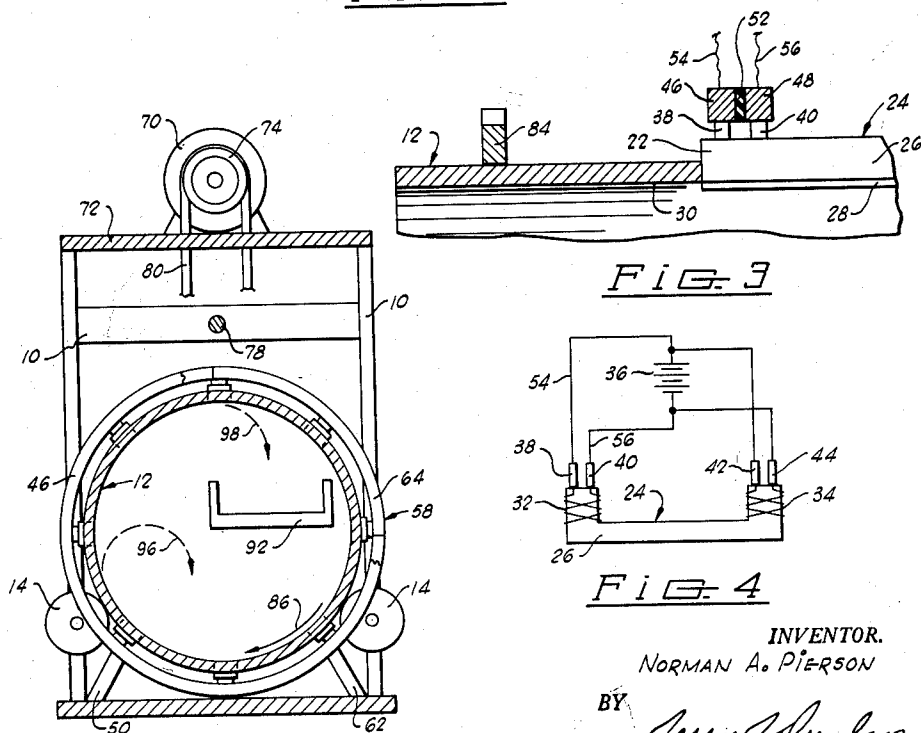


FIG. 3

FIG. 4

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FIG. 2

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This invention relates to an improved apparatus for separating the magnetic materials from a mixture of magnetic and non-magnetic materials.

In various industrial fields, mixtures of magnetic and non-magnetic materials occur, and it is frequently desirable to separate the magnetic materials from the non-magnetic materials for purposes of reclamation or a separate processing of the magnetic and non-magnetic materials. For example, municipal refuse contains a substantial proportion of magnetic materials and it is highly desirable to separate these magnetic materials from the remainder of the refuse prior to disposal of the refuse, since the magnetic materials are usually valuable and can be easily sold to various industries.

Various types of magnetic separators have been devised, but none of those presently on the market provide an acceptable degree of separation of magnetic materials from a mixture, and none of the previous magnetic separators have been widely accepted. One type of previous magnetic separator utilizes a magnetic drum over which the material is passed, and operates on the theory that the magnetic materials will cling to the drum and may be removed from the downwardly moving side of the drum, after the other non-magnetic materials have been removed at a higher level. However, when a mixture of magnetic and non-magnetic materials are merely passed over a drum, the magnetic materials frequently never come in contact with the drum and are taken off the drum along with the non-magnetic materials. Also, in this type of construction, an appreciable amount of non-magnetic materials are separated with the magnetic materials.

The present invention contemplates a novel magnetic separator wherein a mixture of magnetic and non-magnetic materials are directed through a rotating drum, such that the materials are turned a plurality of times during passage of the materials through the drum, and the magnetic materials are effectively brought into contact with the inner periphery of the drum. Magnet devices carried by the drum pick up these magnetic materials and efficiently separate them from the non-magnetic materials. Broadly stated, the present invention may be defined as an apparatus for separating the magnetic materials from a mixture of magnetic and non-magnetic materials, comprising a non-magnetic material tubular drum which is open at its opposite ends, support means rotatably supporting the drum in an inclined position, means for rotating the drum around its longitudinal axis, means for feeding the mixture into the higher end of the drum, discharge conveyor means extending into the drum adjacent the downwardly moving side of the drum, a plurality of magnetic field producing means carried in circumferentially spaced relation around the periphery of the drum, each of said magnetic field producing means being arranged to produce a separate magnetic field in the drum for attracting magnetic materials in the mixture in the drum, and means for de-magnetizing the magnetic field producing means in the upper half of the downwardly moving side of the drum for dropping the attracted magnetic materials into said discharge conveyor means.

An important object of this invention is to provide an efficient separation of the magnetic materials from a mixture of magnetic and non-magnetic materials.

Another object of this invention is to provide a magnetic separator wherein all of the materials directed

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through the separator are thoroughly turned and brought into contact with magnetic elements to efficiently separate the magnetic materials from the non-magnetic materials in the mixture.

Another object of this invention is to provide a novel magnetic separator wherein a mixture of magnetic and non-magnetic materials is passed through the separator, and wherein the magnetic field producing elements of the separator are alternately magnetized and de-magnetized with the production of a minimum voltage.

A further object of this invention is to provide a novel magnetic separator utilizing a hollow drum which is rotated while a mixture of magnetic and non-magnetic materials is passed therethrough, and wherein the minimum power is required for rotating the drum.

A still further object of this invention is to provide a magnetic separator which is simple in construction, may be economically manufactured and which will have a long service life.

Other objects and advantages of the invention will be evident from the following detailed description, when read in conjunction with the accompanying drawings which illustrate my invention.

In the drawings:

FIGURE 1 is a partially schematic side elevational view of an apparatus constructed in accordance with this invention.

FIGURE 2 is a sectional view as taken along lines 2-2 of FIG. 1 with a portion of the slip rings 46 and 48 broken away to show the construction of the slip rings 58 and 60.

FIGURE 3 is an enlarged detailed sectional view through a portion of one end of the drum.

FIGURE 4 is a schematic wiring diagram illustrating the connection of the magnetic field producing means.

Referring to the drawings in detail, and particularly FIG. 1, reference character 10 designates a suitable framework for supporting a tubular drum 12 through the medium of a plurality of rollers 14. The rollers 14 are suitably secured to the framework 12, as by shafts 16, and at least two of the rollers 14 are provided on each side of the longitudinal centerline through the drum 12 to engage the lower outer periphery of the drum and support the drum for rotation about its longitudinal axis. It may also be noted here that the rollers 14 are preferably positioned such that the drum 12 will be slightly inclined, with the inlet end 18 of the drum slightly higher than the outlet end 20 of the drum, to produce movement of the mixture to be separated through the drum, as will be set forth in detail below.

The drum 12 is formed of a non-magnetic material having the desired strength characteristics, such as stainless steel. A plurality of elongated slots 22 are provided in circumferentially spaced relation around the drum 12 to receive magnetic flux producing devices 24. As shown in FIG. 3, each magnetic flux producing device 24 includes a magnetic material bar 26 secured in the respective slot 22 in any desired manner with the inner surface 28 of the bar being curved on the same radius as, and being positioned conterminous with, the inner periphery 30 of the drum 12. It will also be understood that each bar 26 completely fills the respective slot 22 to, in effect, provide a solid wall for the drum 12. Furthermore, since the inner surfaces 28 of the bar 26 are conterminous with the inner periphery 30 of the drum 12, the drum 12 will be smooth-walled throughout its entire length. The magnetic flux producing devices 24 extend through an appreciable portion of the length of the drum 12, but the opposite ends of the devices 24 are maintained in spaced relation from the respective ends of the drum 12 to provide smooth surfaces on the outer periphery of the drum 12 which are contacted by the supporting rollers 14.

Each device 24 may be of any desired construction,

such as an electromagnet, which will produce an individual or separate magnetic field inside of the drum 12 extending lengthwise along the drum. It may also be noted that each device 24 and its associated elements should be so constructed that the magnetic field produced by the device will be collapsed during a portion of the rotation of the drum 12 to provide a dropping of magnetic materials from the inner periphery of the drum, as will be described in more detail below. In a preferred construction, each bar 26 is provided with a magnetizing winding 32 (see FIG. 4) and a bucking winding 34 suitably cross-connected to a source 36 of direct current energy, such that the magnetizing winding 32 will produce the desired magnetic field and the bucking winding 34 will collapse this magnetic field when the bucking winding is energized. To connect the windings 32 and 34 to the source 36 of direct current energy, I provide a pair of brushes 38 and 40 connected to the opposite ends of each magnetizing winding, and a pair of brushes 42 and 44 connected to the opposite ends of each bucking winding 34.

The brushes 38 and 40 of each device 24 are suitably secured on the device 24 to slidably engage a pair of slip rings 46 and 48, as shown in FIGS. 2 and 3. The slip rings 46 and 48 are formed of an electrically conductive material and are suitably secured in the framework 10, as by suitable braces 50, concentrically around the drum 12 and adjacent one set of ends of the devices 24. Also, suitable insulation 52 is provided between the slip rings 46 and 48, and the slip rings 46 and 48 are connected to the source 36 of direct current energy by suitable conductors 54 and 56 to continuously energize the rings 46 and 48. It will thus be apparent that the magnetizing winding 32 of each device 24 will be continuously energized during rotation of the drum 12.

Another pair of slip rings 58 and 60 are supported concentrically around the drum 12 opposite the brushes 42 and 44, respectively, by suitable braces 62. Each of the slip rings 58 and 60 (see the slip ring 58 in FIG. 2) is provided with a section 64 extending around the upper half of the downwardly moving side of the drum 12 which is formed of electrically conductive material, but the remaining portion of each of the rings 58 and 60 is preferably formed of a non-conductor. The electrically conductive sections 64 of the rings 58 and 60 are suitably connected to the source 36 of direct current energy in an opposite direction with respect to the connection of the slip rings 46 and 48, previously described. Therefore, as the brushes 42 and 44 of each device 24 are moved around the slip rings 58 and 60 during rotation of the drum 12, the respective bucking winding 34 will be energized only during the time the bucking winding is positioned opposite the electrically conductive sections 64 of the slip rings 58 and 60. As a result, the magnetic field produced by each device 24 will be collapsed during the time the device is opposite the upper half of the downwardly moving side of the drum 12, to release magnetic material previously held to the inner periphery of the drum by the magnetic field, as will be described in more detail below.

The drum 12 is rotated by means of a motor 70 suitably mounted on a top plate 72 of the framework 10. A pulley 74 is mounted on the drive shaft of the motor 70 and functions to turn a second pulley 76 mounted on a shaft 78 inside of the framework 10 directly above the drum 12 by means of a suitable belt 80. The shaft 78 may be secured in the framework 10 in any desired manner. A drive gear 82 is rotatably supported on the shaft 78 and is secured to the pulley 76 for rotation simultaneously with the pulley 76. A ring gear 84 is mounted around the outer periphery of the drum 12 in a position to be engaged by the drive gear 82. Thus, when the motor 70 is placed in operation, the drive gear 82 will be turned, to in turn engage the ring gear 84 and rotate the drum 12 in the desired direction, such as indicated by the arrow 86 in FIG. 2.

The mixture of magnetic and non-magnetic materials to be separated are fed to the inlet end 18 of the drum 12 by means of a suitable conveyor 90, as shown in FIG. 1, such that these materials will be dropped into the lower portion of the drum 12 for a flow through the drum by gravity. A magnetic material discharge conveyor 92 is extended into the drum 12, preferably from the outlet end 20 of the drum, to convey the magnetic materials which are separated from the remainder of the mixture by the present separator. It will be noted in FIG. 2 that the conveyor 92 is positioned under the upper half of the downwardly moving side of the drum 12, and may be supported at substantially any height in the drum, such as about the center of the drum. It will also be observed in FIG. 1 that the conveyor 92 extends a sufficient distance through the drum 12 to be opposite the magnetic field producing devices 24 and may be supported in the desired position in the drum 12 in any suitable manner (not shown). Finally, a second discharge conveyor 94 is suitably supported to extend underneath the outlet end 20 of the drum 12 in a position to receive that portion of the mixture passing through the drum 12 which is not separated by the magnetic field producing devices 24.

Operation

The present separator is particularly adapted to the separation of a substantially constant stream of materials comprising a mixture of magnetic and non-magnetic materials. As previously indicated, the mixture is fed into the lower portion of the drum 12 at the inlet 18 thereof. As the drum 12 is rotated by action of the motor 70 in the direction indicated by the arrow 86 in FIG. 2, all of the materials will be carried a short distance upwardly by the upwardly moving side of the drum 12, and the non-magnetic materials will then fall back to the lower portion of the drum as indicated by the arrow 96. It may also be noted that some of the materials falling along the path indicated by the arrow 96 may include a portion of the magnetic materials, as long as the mixture is adjacent the inlet end 18 of the drum. In any event, however, the rotation of the drum 12 provides a thorough turning of the mixture, such that all of the magnetic materials will come into direct contact with the inner periphery of the drum at some time during the passage of the materials through the drum.

Assuming that the magnetizing coils 32 of the devices 24 are connected to the power source 36 in the manner previously described, those magnetic materials coming into contact with the inner surfaces 28 of the bars 26 will be attracted to the bars by the magnetic field produced by the respective device 24. As a result, these magnetic materials will be carried upwardly to approximately the crown of the drum 12. As each device 24 reaches the crown of the drum 12, the respective brushes 42 and 44 come in contact with the sections 64 of the slip rings 58 and 60 whereupon the respective bucking coil 34 is energized to collapse the magnetic field produced by the respective device 24. When this magnetic field is collapsed, the previously attracted magnetic materials will fall by gravity, as indicated by the arrow 98, into the magnetic material discharge conveyor 92. It may also be noted that any magnetic materials dropped by the devices 24 at the crown portion of the drum 12 which do not fall into the conveyor 92 will fall back into the lower portion of the drum 12 to be recirculated, and will again have an opportunity to be attracted by one of the devices 24 for dropping into the conveyor 92. As the downwardly moving devices 24 are moved below the sections 64 of the slip rings 58 and 60, the brushes 42 and 44 will come into contact with non-conductive portions of the slip rings 58 and 60 to de-energize the respective bucking coil 34; whereupon the respective magnetizing coil 32 will again become effective to produce a magnetic field inside the drum 12 and extending lengthwise along the drum to again pick up that portion of the magnetic ma-

terials which come into contact with the respective device 24.

The separated magnetic materials will be removed from the drum 12 by the conveyor 92 and the remainder of the mixture will fall by gravity from the outlet end 20 of the drum 12 onto the conveyor 94 for removal from the drum separately from the magnetic materials.

As will be readily understood by those skilled in the art, the size of the drum 12 and the number and magnetic strength of the devices 24 will govern the volume of mixture which may be passed through the drum 12 to provide an efficient separation of the magnetic materials. However, with the proper proportioning of these factors, the separator will efficiently turn the various materials in the mixture to such an extent that all of the magnetic materials will come into contact with the inner periphery of the drum for attraction by the devices 24, such that the major portion, if not 100%, of the magnetic materials will be separated and dropped into the conveyor 92.

From the foregoing, it will be apparent that the present invention provides a novel magnetic type separator which will efficiently separate the magnetic materials from a mixture of magnetic and non-magnetic materials. The mixture is thoroughly turned during passage through the separator to assure that all of the magnetic materials will come into contact with the magnetic field producing devices at some time during the passage of the materials through the separator. Separate magnetic fields are provided in circumferentially spaced relation around the separator extending lengthwise along the separator during that portion of the rotation of the separator in which the mixture is turned, and these various magnetic fields will be collapsed during a portion of the rotation of the separator to drop the separated magnetic materials into a separate discharge conveyor to provide a highly effective separating operation. It will further be apparent that the present apparatus is simple in construction, may be economically manufactured and will have a long service life.

Changes may be made in the combination and arrangement of parts or elements as heretofore set forth in the specification and shown in the drawings, it being understood that changes may be made in the precise embodiment disclosed without departing from the spirit and scope of the invention as defined in the following claims.

I claim:

1. Apparatus for separating the magnetic materials from municipal refuse and the like which includes a mixture of magnetic and nonmagnetic materials, comprising:
 - a nonmagnetic material tubular drum which is open at its opposite ends and has a plurality of circumferentially spaced slots therein extending lengthwise along the drum for a major portion of its length, support means rotatably supporting the drum in an inclined position,
 - means for rotating the drum around its longitudinal axis,
 - means for feeding the mixture into the higher end of the drum,

discharge conveyor means extending into the drum adjacent the downwardly moving side of the drum, said discharge conveyor means being of a size and positioned to extend substantially from a vertical plane passing through the center of the drum into proximity with the downwardly moving side of the drum,

a magnetic material bar secured in each of said slots and exposed to the interior of the drum,

a magnetizing winding and a bucking winding on each of said bars,

a pair of slip rings of electrically conductive material supported in fixed positions concentrically around the drum,

insulation between said slip rings,

a source of direct current energy connected to said slip rings, and

a pair of brushes carried by each bar in positions to slidably engage said slip rings during rotation of the drum, said brushes being connected to the opposite ends of the respective magnetizing windings whereby said bars are connected in electrical parallel to permit individual functioning thereof, and

means for energizing the bucking windings of the bars while the bars are in the upper half of the downwardly moving side of the drum whereby said magnetic materials adhere to said bars during approximately three-fourths of the period of rotation of said drum and are released from said bars during approximately one-fourth of the period of rotation of said drum.

2. Apparatus as defined in claim 1 wherein said means for energizing said bucking windings comprises a second pair of slip rings supported in fixed positions concentrically around the drum; each ring of said second pair of rings being formed of an electrically conductive material only around the upper half of the downwardly moving side of the drum, with the remainder thereof being formed of an insulating material; a second pair of brushes carried by each bar connected to the opposite ends of the respective bucking winding and positioned to slidably engage said second pair of slip rings during rotation of the drum whereby each bucking winding is connected in parallel with respect to the other bucking windings, and conductors connecting the electrically conductive portions of said second pair of slip rings to the source of direct current energy in a direction opposite to the connection of the first-mentioned slip rings.

References Cited in the file of this patent

UNITED STATES PATENTS

223,901	Fritz	Jan. 27, 1880
707,088	Dings	Aug. 19, 1902
867,744	McCabe	Oct. 8, 1907

FOREIGN PATENTS

5,568	Australia	Jan. 14, 1927
25,195	Great Britain	Nov. 4, 1912
132,813	Austria	Apr. 10, 1933