United States Patent [19]

Barrett et al.

[11] **3,809,239**

[45] **May 7, 1974**

[54] **MAGNETIC REFUSE SEPARATOR**

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[73] Assignee: **Wehr Corporation,** Milwaukee, Wis.

[22] Filed: **Dec. 26, 1972**

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[52] **U.S. Cl.** ..... **209/111.8,** 209/223 A

[51] **Int. Cl.** **B07c 5/344**

[58] **Field of Search** ..... 209/111.8, 81 A, 223 R, 209/223 A, 73

[56] **References Cited**

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Attorney, Agent, or Firm—Michael, Best & Friedrich

[57] **ABSTRACT**

A magnetic separator is located at the discharge end of a refuse conveyor. The separator includes a continuous belt revolving in a closed path and having a curve in its path other than at its head or end pulley. A magnetic assembly generates a magnetic field at the belt curve and on both the upstream and downstream as sides thereof. The refuse conveyor runs at an angle toward and discharges its burden into the belt in the upstream portion of the magnetic field. Magnetic material in the burden is attracted to the belt and non-magnetic material falls away. The magnetic material travels with the belt around the curve causing some agitation to dislodge any non-magnetic material being carried along with the magnetic material. Downstream of the curve, the belt, and the magnetic material, move out of the magnetic field whereupon the magnetic material falls away from the belt. The magnetic separator is supported above a receptacle into which the thus separated magnetic and non-magnetic materials fall into segregated areas. The separator's position is adjustable horizontally to accommodate different levels of burden on the refuse conveyor.

12 Claims, 3 Drawing Figures

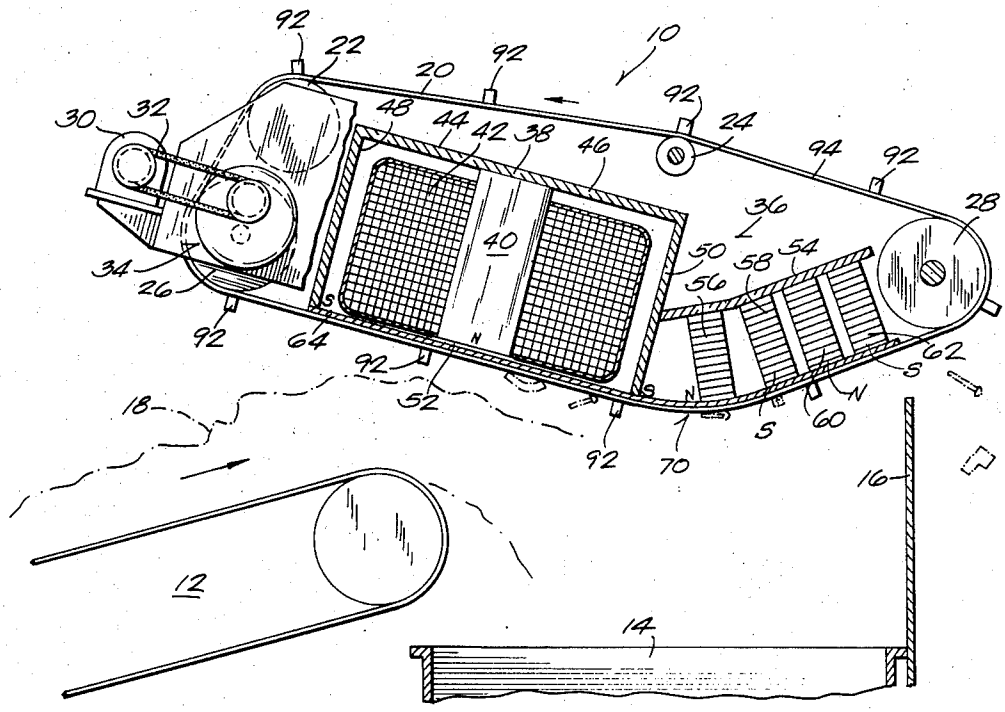
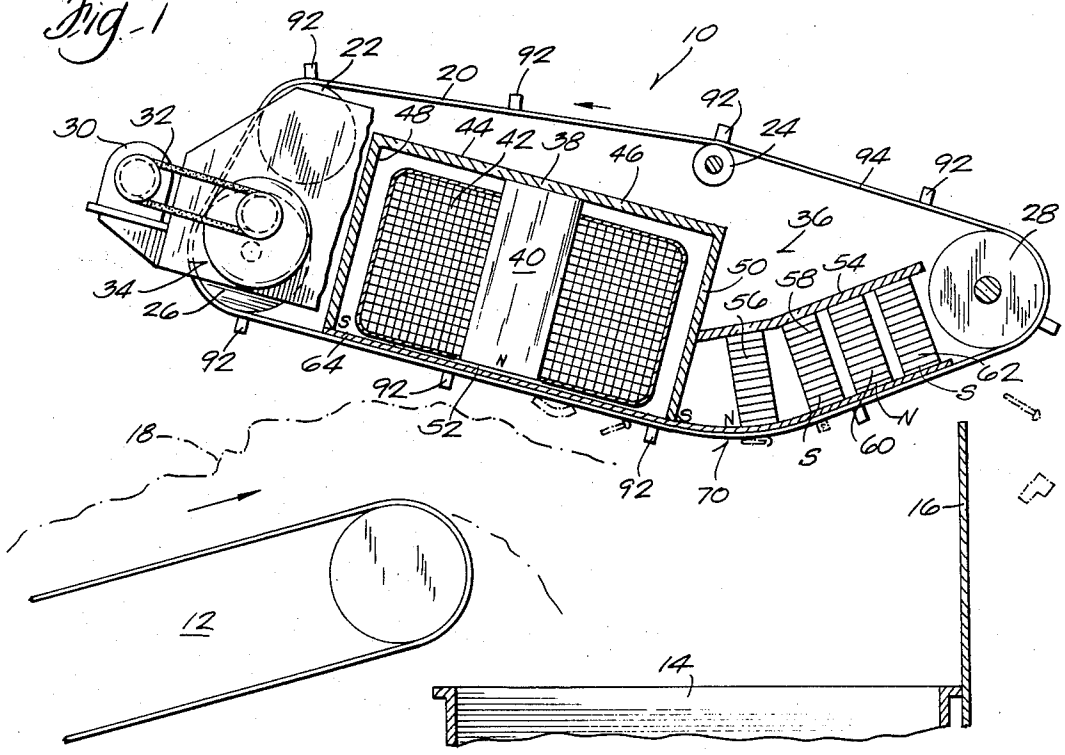


Fig. 1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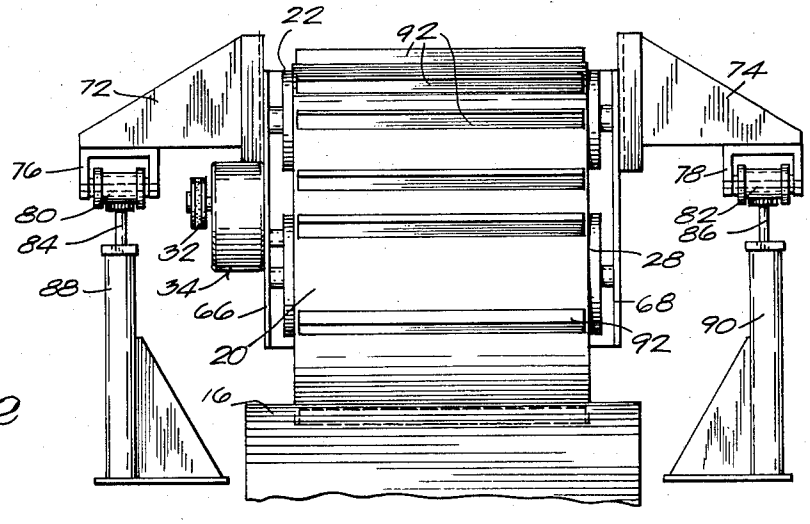
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Fig. 2

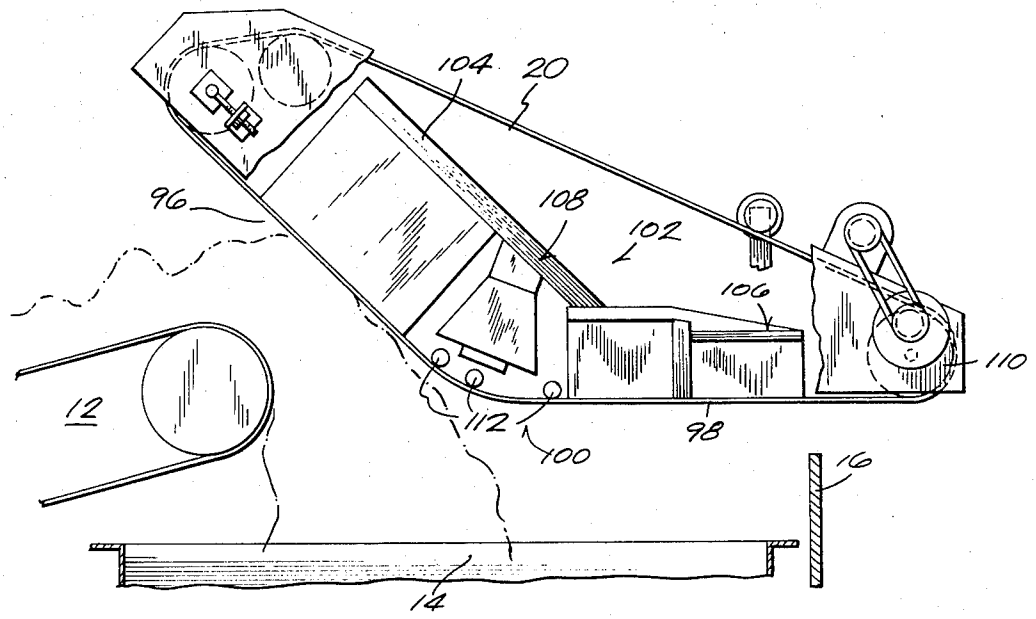

Fig. 3

MAGNETIC REFUSE SEPARATOR

BACKGROUND OF INVENTION

This invention relates to magnetic separators and, more particularly, to magnetic separation of magnetic material in refuse.

With more and more emphasis being placed on recycling, it is becoming more desirable to recover salvageable articles from otherwise discarded material. Much of the metallic material discarded as refuse can generally be recycled for one purpose or another, provided it can be efficiently separated from the remainder of the refuse. The portions intended to be recaptured being metallic are generally also magnetic so that magnetic separation is a possibility for recapture. However, the remainder of the refuse, i.e, other than the metallic articles, although generally not magnetic (e.g., paper), is usually light and tangled with the magnetic portions and thus is carried along with the magnetic material making complete separation difficult if not impossible. Also, in some cases it may be desired to separate the lighter material (e.g., paper) for recycling and again, it is desirable to separate the lighter material from the metallic.

There are various designs of magnetic separators, none of which, to the inventor's knowledge, are well suited to this refuse separator problem because of an inability to insure thorough separation of magnetics from non-magnetics in that environment.

This invention is concerned with this problem and has as one of its objects the provision of effective separation of the magnetic portions of refuse from the non-magnetic portions thereof.

SUMMARY OF INVENTION

For the achievement of that and other objects, this invention proposes a magnetic separator having a continuous belt moving past a magnetic assembly which generates a magnetic field through which the belt moves. The belt is supported such that it has a curve in the lower portion of its path of movement and a straight line portion upstream of the curve. The magnetic assembly is located and generates a magnetic field in the area of the straight line portion and the curve. The magnetic assembly, and the field generated thereby, extend on both the upstream and downstream sides of the curve, i.e., relative to the direction of travel of the belt. On the upstream side of the curve the belt follows a straight line path and, if desired, the belt may also follow a straight line path on the downstream side of the curve. Material being attracted to the belt by the magnetic assembly and thus traveling along with the belt, must negotiate the curve and at the curve there will be some displacement, i.e., agitation, of the material traveling with the belt. This agitation tends to dislodge any non-magnetics being carried along with the magnetics.

In a preferred embodiment the magnetic assembly also includes a magnetic portion at the curve to insure a magnetic field in that area strong enough to prevent the magnetics from falling completely away from the belt. Also, agitation is further enhanced by the magnetic assembly presenting alternating polarities to the belt and thus to the material attracted thereto.

Preferably the belt on both the upstream and downstream sides of the curve is disposed at an angle to the horizontal thereby taking better advantage of gravity, with the agitation, to achieve complete separation.

The supply conveyor which delivers the refuse to the separator runs at an angle to the upstream portion of the magnetic field and the portion of the belt in that area. It is advantageous to mount the magnetic separator for movement toward and away from the end of the supply conveyor to accommodate different burden depths on the conveyor.

To counteract wear of the belt, the belt can be driven from the head pulley so that the back or non-working side of the continous belt loop is under tension and the lower or working side can be relatively slack. In addition, or as an alternative, rollers can be provided at the curve to support the belt.

DESCRIPTION OF DRAWINGS

FIG. 1 is a side view of a combination refuse separator and supply conveyor partially in section;

FIG. 2 is an end view of the refuse separator of FIG. 1; and

FIG. 3 is a side view similar to FIG. 1 but illustrating an alternative construction and arrangement of the refuse separator.

DESCRIPTION OF PREFERRED EMBODIMENT

With particular reference to the drawings; a refuse separator **10** is illustrated in combination with a supply conveyor **12**, receptacle **14** and a splitter baffle **16**. The function of the receptacle and splitter baffle is to physically segregate separated magnetic and non-magnetic material, therefore no particular form of either is necessary and in fact only one of the two could be used if desired.

The refuse separator is intended to receive burden **18** from supply conveyor **12** and carry the magnetic portion of the burden over splitter baffle **16** while the non-magnetic material falls, by reason of gravity, into receptacle **14**. To this end, the separator includes belt **20** which travels in a counterclockwise manner around idler rollers **22** and **24** and head and end pulleys **26** and **28**. Head pulley **26** is connected to drive motor **30** through a belt drive **32** and a gear box so that the head pulley becomes the drive member through which the driving force is imparted to belt **20**. In this manner, the belt travels in a continuous, closed path under the influence of drive pulley **26**. As viewed in FIG. **1**, the closed path has an upper portion (between end pulley **28** and idler **22**) and a lower portion (between head pulley **26** and end pulley **28**).

Magnetic assembly **36** is located within the area defined by belt **20**. The magnetic assembly consists of a lead magnet **38** having a central core **40** surrounded by an electrical coil **42** and housed within a U-shaped in cross section housing **44** with core **40** engaging the backplate **46** of the housing. This is a conventional electromagnet construction and when coil **42** is energized the end of core **40** adjacent belt **20** will assume one magnetic polarity, e.g. north, and the outer ends of sides **48** and **50** of the housing will assume an opposite magnetic polarity, south. Plate **52** is a pole piece provided to concentrate the emanation of flux at the belt.

Downstream of the lead magnet assembly is a trailing magnetic assembly consisting of a backplate **54** and four magnetic assemblies, **56, 58, 60,** and **62** projecting from the backplate **54** toward the belt. Each of the

magnetic assemblies can be made of permanent magnetic material such as barium titanate waffers, which are magnetized through their thickness dimension, i.e., at right angles to backplate **54,** and stacked with the thickness dimension of each magnetic waffer in an assembly **56, 58, 60,** or **62** extending in a common direction. By controlling the orientation of the magnetic waffers the magnetic polarity presented by each of the magnetic assemblies to the belt can be controlled so that, for example, a north magnetic polarity is presented by each of assemblies **56** and **60** and a south magnetic polarity is presented by each of assemblies **58** and **62.** It will be noted that the alternating polarity started at the lead magnetic assembly is maintained through the trailing magnetic assembly.

It will be appreciated further that the entire magnetic assembly could be made of electromagnets or permanent magnets as desired or as illustrated in it can be a combination of permanent and electro. To complete the magnet assembly a plate, either in one piece or a weldment, **64** extends between the magnetic assembly and the inside surface of belt **20.**

The idler rollers and pulleys and head pulley **26** together with the magnetic assembly are all supported from a common frame structure, a portion of which, **66** and **68,** is illustrated in FIG. **2.** Since a showing of the complete structural framework of the refuse separator is not necessary to an understanding of this invention, this general description of the support structure is believed to be adequate.

With reference to FIG. **1,** magnet assembly **36** generates a magnetic field at belt **20** and at the lower portion of the path through which the belt travels. Conveyor **12** is arranged so that it discharges burden **18** into this magnetic field and the magnetic material contained in the burden is attracted to the belt **20** in the area of lead magnet **38.** The non-magnetic material such as paper, will fall by gravity into receptacle **14** and the magnetic material travels with belt **20** beyond splitter **16** where the magnetic field terminates. The magnetics are discharged on the side of the splitter baffle opposite to the receptacle. Also, to take advantage of the fact that once the magnetics are attracted to the belt less magnetic force is required to hold them on the belt than to attract them initially, the magnets can be made to diminish in strength from lead magnet **38** through the trailing magnets. That is, magnetic assemblies **56, 58, 60,** and **62** can be made progressively weaker from the curve toward end pulley **28.**

Paper and like non-magnetic material, being relatively light, is extremely prone to being tangled with the magnetic material and carried along with it into engagement with and on belt **20** such that it cannot fall into receptacle **14.** To provide means for dislodging this entrapped non-magnetic material, this invention intends to provide agitation of the burden carried by belt **20** without losing the magnetic material. To this end, a curve **70** is provided in the lower portion of the path of belt **20** in the area of the magnetic assembly. With respect to the direction of travel of belt **20** and, still in the lower portion of the path, the belt follows straight line paths on both the upstream and downstream sides of the curve and all lead magnet **38** is located upstream of curve **70** and the trailing magnet portion of the magnetic assembly is located downstream of the curve. Because of the curve **70,** the material adhered to the belt must change direction at the curve and since the non-magnetic material does not have the magnetic attractive force to hold it on the belt, it tends, due to centrifugal force, to proceed in a straight line trajectory rather than make the curve. Also it has been observed that, again due to centrifugal force, some physical separation of the magnetic material from the belt occurs at the curve, but not completely from the magnetic field so that the magnetic material returns to the belt after the curve has been negotiated, and this causes agitation at the curve which further tends to dislodge the non-magnetic material.

Also, the preferred embodiment illustrated in FIG. **1** shows the upstream and downstream portions of the belt adjacent curve **70** both positioned at an angle to a horizontal plane, this arrangement makes maximum use of the force of gravity in separating the non-magnetics. That is, the turn at the curve utilizes basic inertia and gravity to achieve some separation and the belt proceeding generally upward from the curve increases the pull of gravity on the non-magnetic materials to enhance separation.

For effective introduction of the burden from supply conveyor **12** to the magnetic separator, conveyor **12** is arranged at an angle to the magnetic separator. Conveyor **12** is arranged at an angle for the horizontal so that the burden comes into the belt in the area of lead magnet **38** at an angle. This brings the material into the belt generally in the direction of the flux lines making up the magnetic field for most effective separation.

In order to accommodate different depths of burden, the entire refuse separator is supported for horizontal movement toward and away from the conveyor **12.** More specifically, and with reference to FIG. **2,** a pair of support brackets **72** and **74** extend from frame member **66** and **68** on opposite sides of the refuse separator. Two pairs of these support brackets are provided. One at the head end and one at the opposite end of the magnetic separator but only one is illustrated in the drawings. The support brackets have an elongated channel member **76** and **78** attached to their undersides and each supports a roller **80** and **82.** The rollers engage I-beam rails **84** and **86** which are mounted on frames **88** and **90.** The refuse separator can then be moved horizontally toward and away from the discharge end of the supply conveyor, this can be accomplished either manually or through some suitable mechanical arrangement.

A plurality of conventional lugs **92** are provided on the working face of belt **20** to assist in carrying the material along with the belt.

At this point, it should also be noted that certain advantages attach to utilizing the head pulley **26** as the drive pulley. By doing this, it is the backside **94** of the belt which is maintained under tension and the working side of the belt, i.e., that passing through the magnetic field, can be supported to hang relatively slack. This has a tendency to minimize belt wear.

Also, the alternating magnetic polarities along the path of travel of the belt provide agitation of the magnetic material attracted to the belt to further enhance separation. That is, the magnetics being forced to pass through alternately different magnetic fields will, in effect, roll around and not hold a stationary position on the belt.

FIG. **3** illustrates an alternative construction of the refuse separator and arrangement with respect to supply conveyor **12,** receptacle **14** and splitter baffle **16.**

In this embodiment, the upstream portion **96** of belt **20** is arranged at a sharper angle to the horizontal than in FIG. **1** and the downstream portion **98** is in a horizontal plane. Magnetic assembly **102** again includes lead magnet **104** which generates a magnetic field at the end of conveyor **12** and in the area of the upstream portion **96** of the belt and a trailing portion **106** which is positioned downstream of the curve and generates a magnetic field in that area. These magnetic assemblies can be constructed the same as illustrated in connection with FIG. **1** again maintaining the alternating magnetic polarities.

In the FIG. **3** embodiment a third magnetic assembly **108** is provided at curve **100** to insure an adequate magnetic field at the curve to prevent loss of the magnetics. The additional magnetic assembly **108** maintains the alternating polarities discussed previously.

In the FIG. **3** embodiment the drive for belt **20** is provided through end pulley **110.** With this arrangement, the working portion of the belt will now be under tension and to miminize wear at curve **100** a plurality of stainless steel rollers **112** are provided in that area as support for the belt.

Again, the refuse separator of FIG. **3** can be positioned for horizontal movement relative to the end of conveyor **12** and it will again be noted that the burden is discharged into the face of belt portion **96** so that it is generally in line with the magnetic lines of flux making up the magnetic field.

As in FIG. **1,** magnetics will be attracted to the lower portion of the path of travel of belt **20** as the burden is discharged from supply conveyor **12.** The non-magnetics fall into receptacle **14,** and the magnetic material is agitated as it travels along with the belt through the magnetic field to further dislodge non-magnetics before splitter **16** is reached at which point the magnetics fall from the belt behind the splitter baffle.

Although this invention has been illustrated and described in connection with particular embodiments thereof, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

We claim:

1. A magnetic separator comprising, in combination,

a belt,

means supporting said belt for movement around a closed path in continuous fashion with said path having an upper and a lower portion,

a magnetic assembly having an extension along said lower portion of said closed path,

means supporting said magnetic assembly to generate a magnetic field along said lower portion of said closed path and through which said belt moves,

said means supporting said belt also defining, in said lower portion of said path, a curve and, upstream of said curve, a generally straight line path along which said belt moves up to said curve,

and said magnetic assembly disposed with a portion thereof located, relative to the path of travel of said belt, on both sides of said curve so that magnetic material in said field is attracted to and travels with said belt along said straight line path and around said curve.

2. The magnetic separator of claim **1** wherein said magnetic assembly also includes a portion located at said curve to generate a magnetic field at said curve and maintain an attractive force on magnetic material traveling with said belt around said curve.

3. The magnetic separator of claim **2** including a plurality of idler rollers at said curve for engaging said belt.

4. The magnetic separator of claim **1** wherein said magnetic assembly varies in magnetic intensity the downstream portions thereof generating a lesser strength magnetic field than the upstream portions thereof.

5. The magnetic separator of claim **1**

wherein said magnetic assembly includes a head pulley and an end pulley located, relative to the path of travel of said belt, upstream and downstream, respectively of said curve,

including drive means for moving said belt through said closed path, said drive means connected to and rotating said drive pulley to drive said belt,

and wherein said belt is supported in a relatively slack condition between said head and end pulleys and around said curve to minimize belt wear.

6. The magnetic separator of claim **1** wherein the portions of said belt upstream and downstream of said curve are both supported for movement along generally straight line paths and both paths are at an angle to the horizontal.

7. The magnetic separator of claim **1** wherein the portion of said belt upstream of said curve is at an angle to the horizontal.

8. The magnetic separator of claim **1** in combination with

a supply conveyor for delivering a burden consisting of magnetic and non-magnetic material to said belt upstream of said curve and into the magnetic field generated by said magnetic assembly,

means for supporting said magnetic separator over a receptacle into which non-magnetic material falls,

and a splitter baffle located in the area of the downstream end of said magnetic assembly so that magnetic material adhered to said belt is held on said belt up to said splitter baffle after which it leaves said magnetic field and falls from said belt.

9. The magnetic separator of claim **1** in combination with

a supply conveyor for delivering a burden consisting of magnetic and non-magnetic material to said belt upstream of said curve and into the magnetic field generated by said magnetic assembly, said supply conveyor disposed at an angle to the portion of said belt upstream of said curve,

and means for moving said magnetic separator relative to said supply conveyor.

10. The magnetic separator of claim **8** wherein said magnetic assembly also includes a portion located at said curve to generate a magnetic field at said curve and maintain an attractive force on magnetic material traveling with said belt around said curve.

11. The magnetic separator of claim **8** wherein the portion of said belt upstream of said curve is at an angle to the horizontal.

12. The magnetic separator of claim **1** in combination with a supply conveyor for delivering a burden consisting of magnetic and non-magnetic material to said belt upstream of said curve and into the magnetic field generated by said magnetic assembly.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,809,239 Dated May 7, 1974

Inventor(s) William T. Barrett and Newton I. Potter

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, Lines 60-63, after "20" delete:

"and, still in the lower portion of the path, the belt follows straight line paths on both the upstream and downstream sides of the curve and all".

Column 3, Line 59, after "20" insert:

--and, still in the lower portion of the path, the belt follows straight line paths on both the upstream and downstream sides of the curve and all--.

Signed and sealed this 17th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents