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CROSS-BELT MAGNETIC SEPARATOR

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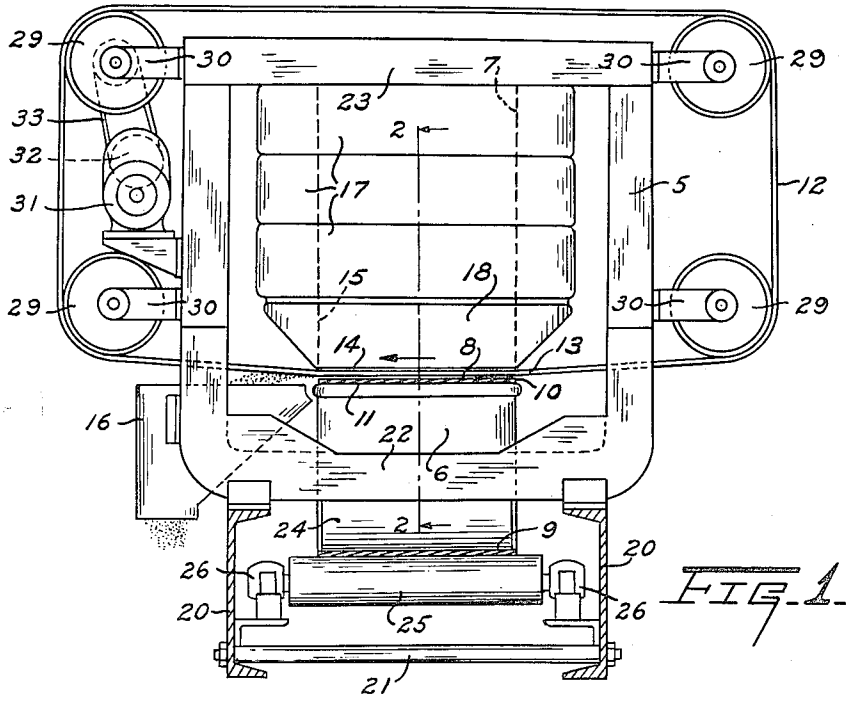


FIG. 1.

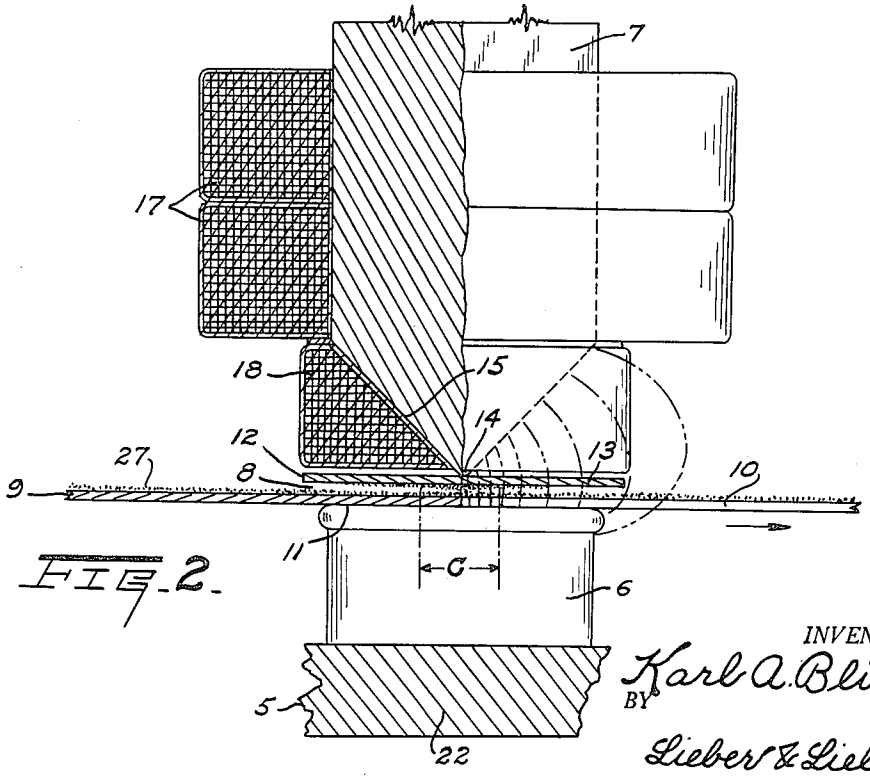


FIG. 2.

INVENTOR.
Karl A. Blind
BY
Lieber & Lieber
ATTORNEYS.

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CROSS-BELT MAGNETIC SEPARATOR

Karl A. Blind, Thiensville, Wis., assignor to Dings Magnetic Separator Co., Milwaukee, Wis., a corporation of Wisconsin

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The present invention relates generally to improvements in the art of magnetic separation, and relates more particularly to improvements in the construction and operation of electrically energized magnetic separators of the cross-belt type wherein mixed granular magnetic and non-magnetic particles are transported by a main conveyor deck through a magnetic field and the magnetic particles are withdrawn from the mixture by magnetic influence and are removed by an auxiliary conveyor deck travelling transversely of the path of the main conveyor.

The primary object of my present invention is to provide improved means for energizing the magnet of an electro-magnetic cross-belt separator so that most effective removal of the magnetic particles will be accomplished.

It has heretofore been common commercial practice to utilize so-called cross-belt separators for removing magnetic particles from bulk mixtures of granular magnetic and non-magnetic materials while being transported in the form of a relatively thin layer through a magnetic field between main and auxiliary conveyor decks travelling transversely of each other. In some of these prior separators the magnetic separating zone or field is disposed within a magnetic loop having complementary internal magnet poles one of which has a flat pole face located beneath the main conveyor while the other has a single or multiple wedge-shaped pole face directly above the auxiliary conveyor, and wherein the wedge pole is embraced by electric energizing windings for the entire magnet disposed remote from its wedge face.

In order to insure most efficient separation of the magnetic ingredients from the mixture, it is necessary to concentrate the flux lines spanning the magnetic separating zone or gap between the complementary pole faces, near the apex of each wedge, and it has heretofore been proposed to utilize pole tips for the wedge face or faces formed of special materials such as cobalt alloy. While this procedure improves the flux concentration to some extent, it is difficult and costly to construct such wedge poles, and I have found that a far greater and more satisfactory concentration of these flux lines is obtainable by surrounding or embracing the wedge tip with an electric energizing winding or coil which is disposed near the wedge apex and closely adjacent to the auxiliary conveyor deck which removes the separated magnetic particles.

It is therefore an important object of the present invention to improve the concentration of flux lines within the most effective area of the separating zone of a cross-belt magnetic separator, by locating a portion of the electro-magnet energizing winding about the apex or apices of the wedge face or faces of the magnetic particle removing magnet closely adjacent to the separating zone.

Another important object of the invention is to enhance the efficiency of the separating magnet of an electro-magnetic cross-belt separator having a wedge shaped pole face, by more effectively applying the magnetomotive force with the aid of additional ampere turns located as near as possible to the apex of the wedge.

Still another important object of this invention is to provide an improved electro-magnet assemblage for cross-belt magnetic separators which will most effectively concentrate the flux within the separating zone so as to insure maximum separation of the magnetic particles without necessarily providing wedge-shaped pole tips formed of special metals.

These and other more specific objects and advantages of the invention will be apparent from the following detailed description from which it will be noted that the gist of my invention is the provision of a cross-belt magnetic separator comprising a magnet having complementary poles between which transversely movable conveyor decks travel through a magnetic field or separating zone, and wherein one pole has a flat face cooperating with one of the decks at one side of the zone of separation while the other pole has a wedge face cooperating with the other deck on the opposite side of the zone and the magnet is energized by electric windings embracing the wedge pole and surrounding the wedge tip closely adjacent to its apex and to the separating zone.

A clear conception of the improved features constituting the present invention, and of the construction and operation of a typical cross-belt magnetic separator embodying the same, may be had by referring to the drawing accompanying and forming a part of this specification in which like reference characters designate the same or similar parts in different views.

Fig. 1 is a part sectional somewhat diagrammatic side view of a typical cross-belt magnetic separator unit, looking longitudinally of the main conveyor belt, and showing this belt and the supporting beams of the separator in section; and

Fig. 2 is an enlarged transverse fragmentary section through the cross-belt separator, taken partially along the line 2—2 of Fig. 1, but also showing some of the elements in elevation.

While the invention has been shown and described as applied to only a single cross-belt magnetic separating unit associated with the main conveyor and as embodying an upper pole provided with but a single depending wedge tip and which is formed entirely of ordinary magnetic material, it is not the intent to unnecessarily restrict the improvement to such a limited structure; and it is also contemplated that specific descriptive terms employed herein be given the broadest possible interpretation consistent with the disclosure.

Referring to the drawing, the typical single cross-belt magnetic separating unit shown, comprises in general, an electro-magnet having an upright magnetic loop 5 provided with lower and upper internal poles 6, 7 respectively spaced apart to provide an intervening magnetic field gap or separating zone 8; a main endless conveyor 9 having an upper horizontal mixed material transporting deck 10 extending transversely of the loop 5 through the zone 8 and coacting with the upper flat face 11 of the lower pole 6; an auxiliary endless conveyor 12 having a lower horizontal magnetic particle removing deck 13 extending laterally of the loop 5 and across the deck 10 through the zone 8 and coacting longitudinally with the apex 14 of the lower wedge projection or face 15 of the upper pole 7; a magnetic material discharge hopper 16 mounted upon the loop 5 beneath the deck 13 and laterally beyond the separating zone 8; and upper and lower annular magnet energizing coils or windings 17, 18 respectively embracing the upper pole 7 and its pole face 15 within the loop 5, the lower winding 18 being disposed closely adjacent to the wedge apex 14 and to the magnetic gap and having an increasing number of ampere turns approaching this apex.

The substantially rectangular upright magnetic loop 5 of the electro-magnet may be supported upon channel

bars 20 firmly interconnected by tie-rods 21, and the lower pole 6 rests directly upon the bottom beam 22 of the loop 5 while the upper pole 7 is suspended directly from the top beam 23 of this loop. The upper deck 10 of the main endless belt conveyor 9 rests directly upon and is slidable across the upper flat face 11 of the lower pole 6, and this main conveyor 9 coacts with end pulleys 24 also supported from the channel bars 20 and has its lower run cooperable with transverse supporting rollers 25 which are likewise journalled in bearings 26 mounted upon the frame bars 20. This main conveyor 9 may be driven in any suitable manner to cause its upper deck 10 to constantly transport a relatively thin layer of mixed magnetic and non-magnetic material 27 through the separating zone 8 and between the two conveyor decks 10, 13 as illustrated in Fig. 2.

The lower run or deck 13 of the auxiliary endless belt conveyor 12 directly engages and is slidable along the slightly rounded apex 14 of the lower wedge shaped projection or face 15 of the upper pole 7, and this auxiliary conveyor 12 coacts with pulleys 29 journalled in bearings 30 carried by the magnetic loop 5. One of the pulleys 29 may be driven by an electric motor 31 also mounted upon the loop 5, and through reduction gearing 32 and a belt drive 33, to cause the lower conveyor deck 13 to constantly advance through the separating zone 8 and toward the magnetic particle discharge hopper 16, as depicted in Fig. 1. The hopper 16 which is also secured to and supported by the magnet loop 5, should extend along and beneath the lower deck 13 of the auxiliary conveyor 12 closely adjacent to but laterally beyond the separating zone 8, and the windings 17, 18 which energize the entire magnet and which surround the upper pole 7 may be connected to any suitable source of electric current.

When the improved cross-belt magnetic separator has been properly constructed as above described, its normal operation is as follows. The magnet may be constantly electrically energized with the aid of the coils 17, 18 to produce magnetic flux lines such as shown in dot- and dash lines in Fig. 2, spanning the entire separating gap or zone 8 between the poles 6, 7, and with the greatest concentration of flux at the wedge apex 14 due to the formation of the coil 18 with an increasing number of ampere turns approaching the wedge apex. The conveyors 9, 12 should then be operated to continuously advance their cooperating decks, 10, 13 respectively through the separating zone 8 as indicated by the arrows in Figs. 2 and 1. The mixture 27 of granular magnetic and non-magnetic particles should then be deposited in the form of a relatively thin and uniform layer upon the upper surface of the advancing lower deck 10 as it approaches the zone 8, and as the layer of material passes through the magnetic gap the magnetic particles are withdrawn from the mixture and are deposited upon the lower face of the advancing upper conveyor deck 13 while the non-magnetic particles are transported out of the separating zone 8 by the deck 10. The withdrawn magnetic particles will adhere to the upper deck 13 until they are carried out of the zone of magnetic influence and then drop by gravity into the discharge hopper 16. The separation is thus effected continuously and automatically with the greatest concentration along the apex 14 of the wedge shaped pole face or tip 15; and while the upper windings 17 produce the major portion of the energization of the magnet the gradually increasing number of ampere turns introduced by the tip embracing winding 18 are very important for several specific reasons.

The improved placement or provision of the gradually increasing number of ampere turns in the coil or winding 18 as it approaches the separating zone, serves to most effectively concentrate the flux lines within the area C along the entire length of the wedge apex 14, and it also acts as a partial magnetic shield or insulator which prevents excessive leakage losses and results in increased field strength. These advantages are obtainable whether the pole tip is formed or ordinary metal throughout or whether it is constructed with a special cobalt alloy tip, since the concentration of flux lines improves the lifting force which is proportional to the field strength and to the gradient of field strength available in each flux tube. It has been found in actual practice, that the use of the winding 18 embracing the wedge tip 15 of the lefting pole 7 vastly improves the ability to separate and pick up feebly magnetic particles and to thereby increase the amount of magnetic material extracted, and since the cross-belt magnetic separator is primarily adapted to handle ore embodying such particles the invention is especially adapted for application to such machines. The improved structure can be manufactured at moderate cost, and has proven highly satisfactory and successful in actual commercial use.

It should be understood that it is not desired to limit this invention to the exact details of construction of the cross-belt magnetic separator unit herein shown and described, for various modifications within the scope of the appended claims may occur to persons skilled in the art.

I claim:

1. In a cross-belt magnetic separator, a main conveyor deck constantly movable to transport mixed magnetic and non-magnetic particles in one direction along a definite path, a magnet pole having a flat face extending locally across said path beneath said deck, an auxiliary conveyor deck spaced from the top of said main deck and movable across said path above said flat pole, a complementary magnet pole above said auxiliary deck having at least one depending wedge projection extending across said path and cooperating through said decks with said flat pole face to lift magnetic particles from said mixture onto the bottom of the auxiliary deck, and an electric energizing coil for said magnet poles surrounding said wedge projection closely adjacent to said auxiliary deck and having an increasing number of ampere turns approaching the wedge apex.

2. In a cross-belt magnetic separator, a main conveyor deck constantly movable to transport mixed magnetic and non-magnetic particles in one direction along a definite path, a magnet pole having a flat face extending locally across said path beneath said deck, an auxiliary conveyor deck spaced from the top of said main deck and movable across said path above said flat pole, a complementary magnet pole above said auxiliary deck having a depending wedge-shaped face extending across said path and cooperating through said decks with said flat pole face to lift magnetic particles from said mixture onto the bottom of the auxiliary deck, and an electric energizing coil for said magnet poles embracing said wedge-shaped pole face closely adjacent to the apex of the wedge and having an increasing number of ampere turns approaching said wedge apex.

3. In a cross-belt magnetic separator, a main conveyor deck constantly movable to transport mixed magnetic and non-magnetic particles in one direction along a definite path, a magnetic loop surrounding said deck and being provided with an inner lower magnet pole having a flat face extending locally across said path beneath said deck, an auxiliary conveyor deck spaced from the top of said main deck and movable across said path above said flat pole, an upper magnet pole associated with and disposed within said loop above said auxiliary deck and having at least one wedge-shaped face extending across said path and cooperating through said decks with said flat pole face to lift magnetic particles from said mixture onto the bottom of the auxiliary deck, and an electric energizing coil for said loop and said poles having a portion of gradually increasing ampere turns approaching and surrounding said wedge-shaped pole face closely adjacent to the apex of the wedge.

4. In a cross-belt magnetic separator, an upright magnetic loop, a main conveyor deck constantly movable to transport mixed magnetic and non-magnetic particles through said loop in one direction along a definite path, a magnet pole mounted upon the bottom of said loop and having a flat face extending locally across said path beneath said deck, an auxiliary conveyor deck spaced from the top of said main deck and movable across said path above said flat pole, a complementary magnet pole suspended from the top of said loop above said auxiliary deck and having a wedge-shaped face extending across said path and cooperating through said decks with said flat pole face to lift magnetic particles from said mixture onto the bottom of the auxiliary deck, and an electric energizing winding for said loop and said poles having a portion of gradually increasing ampere turns approaching and embracing said wedge-shaped pole face directly adjacent to said auxiliary deck so as to concentrate the magnetic flux at the apex of the wedge.

5. In a cross-belt magnetic separator, an upright magnetic loop, a main conveyor deck constantly movable through said loop to transport mixed magnetic and non-magnetic particles along a definite path, a magnet pole within said loop having a flat face extending locally across said path beneath said deck, an auxiliary conveyor deck spaced from the top of said main deck and movable laterally of said loop across said path above said flat pole, a complementary magnet pole within said loop above said auxiliary deck and having a depending wedge face extending across said path and cooperating through said decks with said flat pole face to lift magnetic particles from said mixture onto the bottom of the auxiliary deck, and an electric energizing coil for said magnet poles surrounding and having a gradually increasing number of ampere turns approaching said wedge projection closely adjacent to said auxiliary deck.

6. In a cross-belt magnetic separator, an upright magnetic loop, a main conveyor deck constantly movable to transport mixed magnetic and non-magnetic particles through said loop along a definite path, a lower magnet pole within said loop having a flat face extending locally across said path beneath said deck, an auxiliary conveyor deck spaced from the top of said main deck and movable across said path above said flat pole, a complementary upper magnet pole suspended from said loop above said auxiliary deck and having a depending wedge-shaped face extending across said path and cooperating through said decks with said flat pole face to lift magnetic particles from said mixture onto the bottom of the auxiliary deck, and an electric energizing coil for said magnet poles embracing and having a gradually increasing number of ampere turns approaching said wedge-shaped pole face closely adjacent to the apex of the wedge.

7. In a cross-belt magnetic separator, a main conveyor deck constantly movable to transport mixed magnetic and non-magnetic particles horizontally, a magnet pole having a flat face extending locally across said path and coacting with the bottom of said deck, an auxiliary conveyor deck spaced from the top of said main deck and movable horizontally across said path, a complementary magnet pole above said auxiliary deck having a depending wedge shaped face extending across said path and provided with an apex coacting longitudinally with the top of said auxiliary deck, and an electric energizing coil for said magnet poles surrounding and having an increasing number of ampere turns approaching the apex of said wedge projection closely adjacent to said auxiliary deck.

8. In a cross-belt magnetic separator, a main conveyor deck constantly movable to transport mixed magnetic and non-magnetic particles along a definite path, a magnet pole having a flat face extending across said path and coacting with the bottom of said deck, an auxiliary conveyor deck spaced from the top of said main deck and movable across said path, a complementary magnet pole above said auxiliary deck having a depending wedge-shaped face the apex of which coacts longitudinally with the top of said auxiliary deck, and an electric energizing coil for said magnet embracing said complementary pole and having an increasing number of ampere turns approaching the apex of said wedge-shaped pole face closely adjacent to the apex of the wedge.

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