

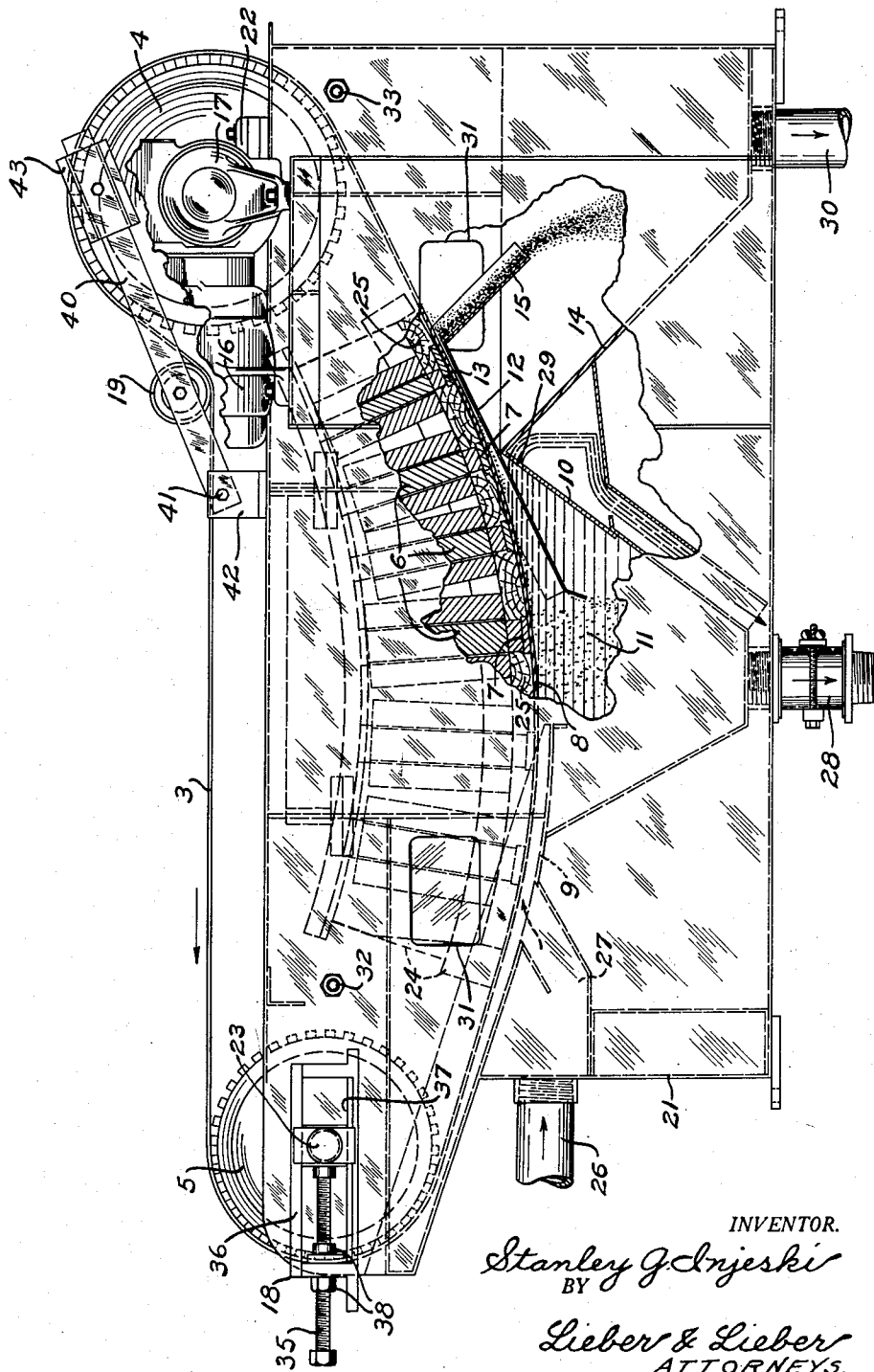
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ENDLESS BELT MAGNETIC SEPARATOR

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## ENDLESS BELT MAGNETIC SEPARATOR

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The present invention relates in general to improvements in the art of separating mixed magnetic and non-magnetic materials, and relates more specifically to improvements in the construction and operation of endless belt magnetic separators for effecting automatic separation of magnetic particles from non-magnetic substances with which the former are intermingled.

The primary object of my invention is to provide an improved endless belt type of magnetic separator which is exceedingly simple and compact in construction, and which is also highly efficient in operation.

It is common practice in the mining industry, to separate magnetic ore particles from non-magnetic substances with the aid of a bank of magnets coacting with the sagging lower run of an endless material conveying belt, and wherein the mixture is fed against the lower face of the belt at one end of the magnet group and the separated magnetic particles are delivered from the belt beyond the magnets while the tailings are removed between the feed and discharge zones. This separation is usually effected in a bath of liquid with the aid of a rubber surfaced material advancing belt which should constantly snugly engage the magnet bank; and in order to maintain the lower belt run in proper engagement with the magnetic poles it has heretofore been customary to utilize a manually operable belt tightener for periodically spreading the belt supporting pulleys apart whenever undesirable belt stretch became apparent to the operator. This prior method of compensating for belt wear and stretch is not satisfactory unless operating conditions are continually and carefully observed; and while some of the prior separators of this type have also been provided with the various devices for preventing delivery of excess treating liquid with the concentrates, these have also

proven to be a constant source of annoyance. It is therefore an important object of the present invention to provide improved mechanism for constantly and effectively compensating for variations in belt lengths in magnetic separators of the endless belt type, with minimum attention on the part of the operators, while also insuring most effective driving contact between the belts and their driving pulleys.

Another important object of this invention is to provide improved structure for automatically and effectively dewatering the concentrates or magnetic material delivered by an endless belt magnetic separator, without the use of complicated mechanism, and for also removing excess treating liquid from the separating zone.

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A further important object of the invention is to provide a compact but highly efficient magnetic separator of great capacity, all relatively delicate parts of which are normally well protected while being readily accessible for inspection and adjustment.

Still another important object of my invention is to provide a simple and durable automatically functioning magnetic separator especially adapted for the constant and effective treatment of low grade ferrous ore with minimum loss of time due to necessary repairs.

These and other more specific objects and advantages of the invention will be apparent from the following detailed description.

A clear conception of the several features constituting my invention, and of the construction and operation of a typical endless belt magnetic separator embodying the same, may be had by referring to the drawing which accompanies and forms a part of this specification, and wherein like reference characters designate the same or similar parts of the structure.

The single figure of the drawing is a somewhat diagrammatic side elevation of one of my improved magnetic separating units, looking toward the driving mechanism and with a portion of the casings broken away so as to reveal a normally concealed structure.

The gist of the present invention is the provision of improved instrumentalities for insuring proper advancement and coaction of the endless conveyor belt with the pulleys and magnets, and for handling the treating liquid so as to constantly remove the excess and to prevent undesirable escape of polluted liquid with the concentrates, and while the typical embodiment illustrated involves a conveying belt having its lower stretch or run substantially disposed along a catenary curve and cooperating with the magnets to produce only a single separation of concentrates from tailings, it is not my desire or intent to unnecessarily restrict the utility of the improvement by virtue of this limited showing. It is also contemplated that specific descriptive terms used herein be given the broadest possible interpretation consistent with the actual disclosure.

Referring to the drawing, the improved magnetic ore separating unit shown therein comprises in general, a continuously advancing endless belt 3 coacting with an upper driving pulley 4 and with a lower idler pulley 5 both rotatable about parallel horizontal axes; an elongated arcuate series or bank of magnets 6 having lower poles or pole-pieces 7 disposed in close proximity

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to the top of the lower stretch or run 8 of the belt 3; a mixed material feed tray 9 for delivering a granular mixture of magnetic and non-magnetic particles suspended in liquid, to the lower face of the belt run 8 near the idler pulley 5; a non-magnetic material or tailings hopper 10 forming a liquid basin 11 at the delivery end of the feed tray 9 and in which the medial portion of the belt run 8 is constantly immersed; a stationary magnetic material or concentrate guiding and squeeze plate 12 extending upwardly from within the basin 11 along and gradually approaching but spaced from the lower face of the belt run 8 remote from the feed tray 9, and cooperating with a special end pole 13 at its uppermost delivery end; a concentrate discharge hopper 14 cooperating with a discharge spout 15 at the upper end of the squeeze plate 12; a motor 16 and speed reduction gearing 17 cooperating with the upper pulley 4 to constantly drive the same and to thereby likewise advance the belt 3 at any desired speed; a manually manipulable belt tightener 18 cooperating with the idler pulley 5 to initially tension the belt; and an automatic belt tensioning and contact roller 19 co-acting with the upper belt run near the driving pulley 4.

The various parts of the improved separating unit are mounted upon a sturdy main frame 21, and the pulleys 4, 5 are journaled for rotation in fixed and adjustable bearings 22, 23 respectively carried by the upper portion of the frame 21, while the magnets 6 are enclosed within a sealed casing 24 which together with the hoppers 10, 14 and the feed and discharge elements are secured to the opposite side walls of the main frame. The endless conveyor belt 3 is preferably formed of durable rubber or similar resilient material, and the lower run 8 of this belt should snugly engage but be freely slidable along the pole-pieces 7, 13 and the intervening spacer blocks 25 of the magnets 6 which may be electrically energized in a well known manner to produce opposite polarity in the successive pole-pieces 7, 13.

The mixture of magnetic and non-magnetic particles suspended in liquid, may be constantly fed to the feed tray 9 through one or more supply pipes 26 and a distributing chamber 27, and the tray 9 is spaced from but substantially follows the curved contour of the lower advancing belt run 8, terminating within the liquid basin 11. In order to permit variation of the level of the liquid which is maintained within the basin 11 and in which the medial portion of the belt stretch 8 is immersed, the tailings discharge hopper 10 is provided at its bottom with an adjustable outlet 28, and an overflow opening 29 at the upper portion of the hopper 10 beneath the squeeze plate serves to discharge excess liquid from the basin 11 which is not carried off by the outlet 28.

The inclined squeeze plate 12 gradually approaches the lower belt run 8 from a point within the basin 11 up to the special pole 13, and the delivery end of this plate 12 is located closely adjacent to but is spaced from the belt 8 and extends approximately parallel to the pole-piece 13 throughout the entire extent of the latter. The tapered area above the lower portion of the plate 12 serves as a washing and pick-up zone for the magnetic particles or concentrates, while the more restricted area directly beneath the special pole 13 functions to compress and to squeeze excess polluted liquid out of the mass of concen-

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trates and to return this liquid down the inclined plate 12 to the basin 11. The lower extremity of the concentrate discharge hopper 14 is provided with a concentrate outlet 30 and the delivery spout 15 at the end of the plate 12 is directed downwardly toward this outlet.

The housing for the separating zones and which constitutes a part of the main frame 21, is provided with inspection openings 31 near the feed and discharge zones, so that an attendant may readily observe the functioning of the machine; and this housing is also provided with fresh liquid spray inlets 32, 33, one of which serves to deliver a spray of clean liquid upon the inner surface of the advancing belt 3 while the other likewise projects cleansing liquid against the outer belt surface. The belt tightener 18 for initially tensioning the belt 3 is mounted upon the upper forward end of the main frame 21 and comprises a manually manipulable screw 35 coacting with each of the bearings 23 of the idler pulley 5, and with a bracket 36 so that rotation of the screws 35 will slide the corresponding bearings along parallel slots 37 formed in the opposite sides of the bracket 36. The screws 35 are adapted to be locked in adjusted position relative to the bracket 36 by means of nuts 38, and the initial belt tensioning effected with the aid of this tightener 18 may be accomplished whenever the separator is first assembled or when a new belt 3 is applied to the pulleys 4, 5.

The automatic belt tensioning and contact roller 19 which coacts with the upper belt stretch or run near the driving pulley 4, functions not only to compensate for subsequent wear and stretching of the belt 3, but also serves to materially increase the driving contact between the pulley 4 and the inner belt surface considerably beyond 180°. The roller 19 is relatively heavy and rests by gravity upon the upper run of the belt 3, being journaled for free rotation in a pair of laterally spaced levers 40. The levers 40 are swingably mounted upon a transverse pivot rod 41 carried by bracket member 42 supported upon the upper deck of the main frame 21, and the swinging end of each lever 40 beyond the roller 19 is provided with a longitudinally adjustable weight 43. These weights 43 augment the pressure exerted by the roller 19 against the belt 3, and they may be adjusted independently of each other in order to equalize this pressure throughout the belt width.

When the improved endless belt magnetic separating unit has been properly constructed, assembled and adjusted as above described, its normal operation is as follows. The propelling motor 16 may be operated to rotate the pulley 4 at the desired speed, thereby constantly advancing the endless belt 3 in the direction indicated by the arrow. The magnets 6 should be energized and fresh liquid should be admitted through the inlets 32, 33 whereupon liquid containing the mixture of magnetic particles and non-magnetic substances may be constantly supplied through the feed pipe 26 and chamber 27 to the feed tray 9. As the feed mixture flows along and over the end of the tray 9 beneath the advancing lower run 8 of the belt 3 and through the magnetic field produced by the magnets 6, the particles of magnetic material will be attracted by the successive pole-pieces 7 and will adhere to the lower outer belt surface.

The liquid admitted with the feed mixture

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will then accumulate in the tailings hopper 10 to form the liquid basin 11 within which the tray 8 and the lowermost curved portion of the belt run 3 should be constantly immersed, and the level of the liquid within the basin 11 may be varied by regulating the outlet valve 23 while excessive rising of this liquid level will be avoided by the overflow opening 29. As the belt run 3 proceeds through the liquid basin 11, the magnet poles 7 which are of successive opposite polarity, will tend to agitate the magnetic particles adhering to the belt 3 thus washing therefrom entrained non-magnetic particles and other substances which descend through the hopper 10 with the liquid. Upon reaching the discharge plate 12, the advancing magnetic particles adhering to the belt run 3 will be carried through the tapering liquid filled space produced by the lower end of the plate 12 cooperating with the adjacent portion of the advancing belt, and these particles will be gradually positively confined within the field of magnetic influence produced by the magnets so that any magnetic particles which may be dislodged from the belt surface will promptly be picked up and restored to this surface.

The magnetic particles clinging to the belt 3 will eventually be carried upwardly along the plate 12 above the level of the liquid in the basin 11 and will thereafter be subjected to a confining and squeezing action by the plate 12 and the powerful magnetic influence of the considerably wider pole-piece 13. This compression or squeezing of the concentrates will express the polluted liquid therefrom and the removed liquid will flow down the spaced inclined plate 12 into the basin 11 while the clean magnetic concentrates will drop by gravity from the belt 3 onto the spout 15 after they pass the zone of magnetic influence created by the magnets, 6. The fresh liquid spray admitted through the inlet 33 will then wash the outer surface of the belt 3 before this belt proceeds beneath the automatic tensioning roller 19, and this fresh washing liquid will also assist in carrying the concentrates down the spout 15 to the outlet 30; while the fresh liquid spray admitted through the inlet 32 will also wash the inner surface of the belt 3 free from abrasive particles and will lubricate the surfaces of the magnetic poles 7, 13 thereby reducing friction losses to a minimum.

While the belt tightener 18 may be adjusted to initially tension the endless belt 3 and to maintain the lower arcuate run 8 thereof in proper engagement with the pole-pieces 7, 13 and spacer blocks 25, the flexible belt 3 may contract or stretch slightly, and may also wear somewhat during normal operation. In order to avoid necessity of constantly watching for such changes in the belt length, the roller 19 will automatically compensate for such variations, and the weights 43 may be readily adjusted to produce the desired belt tension. By locating the roller 19 in close proximity to the driving pulley 4, additional and most effective driving contact between the pulley 4 and the belt is also obtained and undesirable slippage is avoided. The unit will thus function most effectively with very little attention, and the normal operation may be observed through the openings 31 while the feed inlet and tailings discharge may be controlled so as to insure maximum efficiency and capacity of the unit.

From the foregoing detailed description it should be apparent that my invention in fact provides an endless belt magnetic separator

which is simple, compact and durable in construction and which is also highly efficient in operation and flexible in its adaptation for the treatment of variable mixtures of magnetic and non-magnetic particles. With the aid of the combined manual and automatic belt tensioning devices, the belt 3 may be constantly maintained in proper coaction with the arcuate bank of magnets 6 which bulges downwardly beyond the lower common tangent plane of the pulleys 4, 5, thus prolonging the life of the belt as much as possible while still permitting rapid and convenient belt replacement. The downward bulging of the magnets 6 permits the active portion of the belt run 8 to be immersed in the basin 11 without submerging the pulleys 4, 5; and the floating belt tensioning roller 19 also causes the belt 3 to contact the driving pulley 4 for a considerable portion of the pulley periphery. The improved squeeze plate 12 also insures the production of clean and unadulterated concentrates without causing these concentrates to cling to the belt after leaving the magnetic field, while the overflow opening 29 located beneath this plate permits discharge of excess polluted liquid entirely within the unit where this liquid may be conducted away with the tailings. All parts of the improved assemblage are also well protected while still being readily accessible for inspection, and the structure has proven highly satisfactory and successful in actual use especially for the treatment of low grade iron ore.

It should be understood that it is not desired to limit this invention to the exact details of construction or to the precise mode of operation of the magnetic separator herein specifically 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 magnetic separator, horizontally spaced pulleys, a series of electro-magnets located between said pulleys and having poles formed to create an arcuate magnetic field the medial portion of which extends downwardly below the lowermost portions of both of the pulleys, an endless conveyor belt coacting with said pulleys and having its lower run longitudinally movable through said field and along said magnet poles, means forming a liquid basin within which the medial portions of said belt run and of said magnetic field are immersed, means for feeding mixed magnetic and non-magnetic particles toward the lower face of said belt run at one end of said basin, and a substantially straight and imperforate inclined guide plate of non-magnetic material having its lower end immersed within the liquid near the opposite end of said basin and its upper end portion gradually approaching said belt run and terminating above said liquid closely adjacent to the last pole of said magnet series, said last pole also being above said liquid and cooperating with its energizing magnet to produce increased flux intensity at the point of closest approach of said plate toward said belt face.

2. In a magnetic separator, horizontally spaced pulleys, a series of electro-magnets located between said pulleys and having poles formed to create an arcuate magnetic field the medial portion of which extends downwardly below the lowermost portions of both of the pulleys, an endless conveyor belt coacting with said pulleys and having its lower run longitudinally movable through said field and along said magnet poles,

means forming a liquid basin within which the medial portions of said belt run and of said magnetic field are immersed, means for feeding mixed magnetic and non-magnetic particles toward the lower face of said belt run at one end of said basin, a substantially straight and imperforate inclined guide plate of non-magnetic material having its lower end immersed within the liquid near the opposite end of said basin and its upper end portion gradually approaching said belt run and terminating above said liquid closely adjacent to the last pole of said magnet series, said last pole also being above said liquid and cooperating with its energizing magnet to produce increased flux intensity at the point of closest approach of said plate toward said belt face, and means forming an overflow for excess liquid from said basin directly beneath the medial portion of said inclined guide plate.

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