

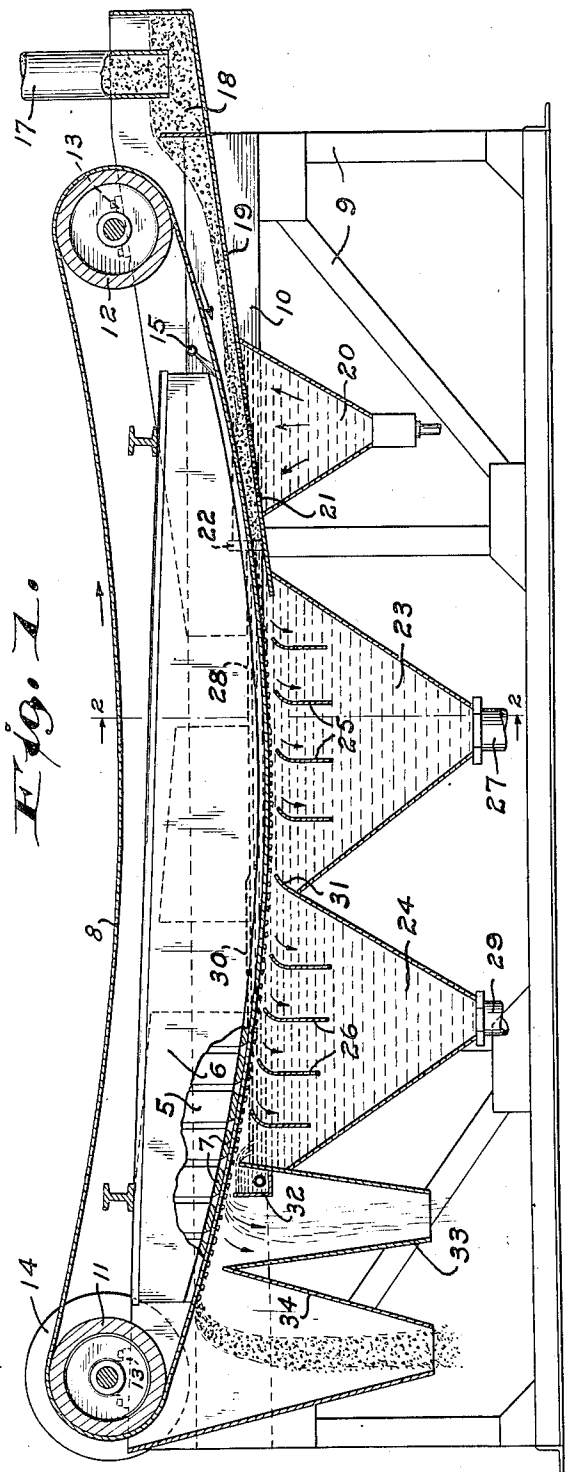
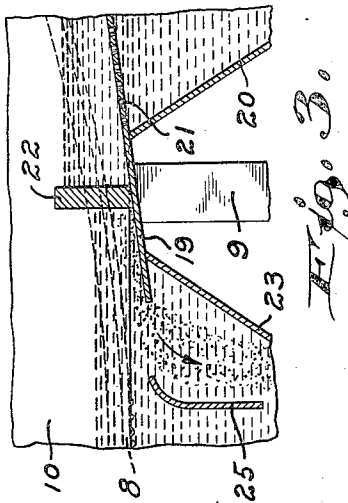
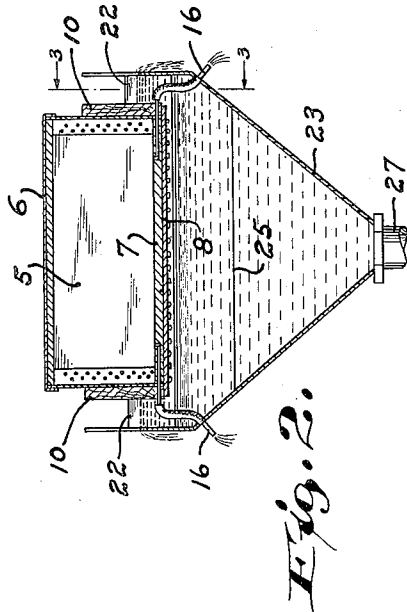
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SEPARATING APPARATUS

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SEPARATING APPARATUS

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The present invention relates in general to improvements in the construction and operation of apparatus for separating mixed magnetic and non-magnetic materials from each other.

A general object of the present invention is to provide improved apparatus for separating magnetic particles from non-magnetic material, both automatically and in a most efficient manner.

It has previously been proposed as shown and described in my prior Patent No. 2,003,430, granted June 4, 1935, to separate ore concentrates and middlings from each other and from the tailings, with the aid of a belt traveling along a substantially catenary curve through a magnetic field and while immersed in liquid, and this method of separation has proven highly successful in actual commercial use. While the earlier machines of this type were entirely satisfactory in operation, they lacked certain refinements which tend to enhance to a maximum the operating efficiency, and they were also relatively complex as to certain structural details.

It is therefore a more specific object of the present invention to provide various improvements in the details of construction of magnetic separators of the general type disclosed in said prior patent, whereby the efficiency is enhanced to a maximum with machines of relatively simple structure.

Another specific object of the invention is to provide improved structure for dewatering the separated magnetic material or concentrates before the same are finally discharged from a separating machine.

A further specific object of the invention is to provide improved baffles for directing separated non-magnetic particles away from the zone of separation within a liquid basin.

Still another specific object of the invention is to provide improved means for protecting the separating magnets against undesirable entry of grit, by providing effective seals between the material transporting belt and the magnet housing or support, and by also providing a counter-flow of clear liquid through the seals.

An additional specific object of the invention is to provide an improved mode of hydraulically lubricating the material transporting belt of a separator so as to eliminate excessive friction and wear.

Another specific object of the invention is to provide improved means for introducing fresh liquid in a manner whereby absolute de-sliming of the final concentrate is assured.

A further specific object of the invention is to

provide improved feed structure for a separating machine, whereby all of the entering material is properly subjected to the magnetic action and loss of magnetic particles with the tailings is avoided.

Still another specific object of the invention is to provide drainage structure for removing leakage and other liquid, from within the magnet housing of a separating machine wherein the magnetic field is disposed within a liquid basin.

An additional specific object of the invention is to provide an improved hydraulic type of magnetic separator which may be constructed and operated at relatively low cost, and which is continuous and automatic in operation.

These and other objects and advantages will be apparent from the following detailed description, and some of the novel features of separator construction, disclosed but not specifically claimed herein, form the subject of my Patent No. 2,003,430, granted June 4, 1935, previously referred to.

A clear conception of the nature of the several improved features, and of the mode of constructing and of operating magnetic separators built in accordance with the present invention, 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 the various views:

Fig. 1 is a somewhat diagrammatic longitudinal vertical section through one of the improved magnetic separators;

Fig. 2 is a transverse vertical section through the machine of Fig. 1, taken along the line 2—2; and

Fig. 3 is a somewhat enlarged longitudinal vertical section through a fragment of the feed structure of the machine, taken along the line 3—3 of Fig. 2.

While the invention has been shown and described herein as being specifically applied to a particular type of magnetic ore separator, it is not intended to unnecessarily restrict the scope by such specific embodiment, since some of the novel features may obviously be capable of more general application to other types of separators.

Referring to the drawing, the improved magnetic separator comprises in general a series of magnets 5 concealed within a water-proof housing 6 and having lower pole-pieces 7 the bottom faces of which cooperate to form a substantially catenary curve extending longitudinally of the machine; an endless conveyor belt 8 having its lower stretch movable along and in close prox-

imity to the bottom faces of the pole-pieces 7; feed structure for delivering mixed magnetic and non-magnetic granular material in the form of a relatively thin layer to one end of the lower surface of the belt 8; hydraulic means for washing the material being transported through the magnetic field by the belt 8; and final discharge means for removing excess liquid from the separated magnetic material or concentrates and for delivering the latter from the machine.

The magnets 5 are of well-known construction, and alternate magnets of the series, preferably have like polarity whereas the intermediate magnets have opposite polarity, so as to produce successive magnetic field sections having reversed polarity. The magnets 5 at the beginning and delivery end of the series are also preferably of greater intensity than the intermediate magnets of the group, and the pole-pieces 7 are preferably located as close as possible to the upper face of the adjacent belt stretch, without actually contacting the belt 8. The magnet housing 6 may be supported from the main frame 9 of the machine, by means of suitable I-beams as shown, and parallel planks 10 disposed on opposite sides of the housing have their lower edges of substantially catenary formation and preferably contact with the opposite edge portions of the belt 8 to provide side seals located laterally beyond the magnetic field.

The endless conveyor belt 8 coacts with and is suspended from driving and idler drums 11, 12 respectively, which are rotatably supported in bearings 13 mounted upon the main frame 9, and the driving drum 11 is adapted to be driven by a pulley 14. This method of suspending the belt 8, causes the upper and lower stretches thereof to assume substantially catenary curves, and in order to prevent excessive drag and consequent wear on the inner surface of the belt 8 passing directly beneath the pole-pieces 7, this surface is lubricated by a film of clean water delivered to the belt from a supply nozzle 15 as shown in Fig. 1. This water after performing its lubricating function, passes outwardly through the side seals between the beams 10 and the edge portions of the belt 8, thereby flushing these seals and positively preventing grit or other foreign matter from entering the slight gap between the pole-pieces 7 and the belt 8. While the magnet housing 6 is preferably made water-tight, moisture may accidentally reach the interior of this housing, and in order to remove such moisture, the housing 6 may be provided with drains 16 at the lowermost portion thereof as clearly shown in Fig. 2. These drains preferably communicate with the interior of the magnet housing 6 either through the pole-pieces 7 or through the spaces between the pole-pieces, and function to automatically deliver the accumulated moisture by gravity from within the housing to the exterior of the machine. If the presence of moisture within the housing 6 is indicated by the drains 16, the housing should be inspected and the source of leakage or ingress of moisture should be sealed, since it is desirable to eliminate moisture within the housing at all times.

The improved feed structure for delivering the mixed granular material to the magnetic separating zone, is shown in Figs. 1 and 3, and comprises a supply spout 17 for delivering an abundant supply of liquid mixed with magnetic and non-magnetic particles by gravity into a launder 18; an inclined feed plate 19 leading from the discharge wall of the launder 18 to an area be-

neath the belt 8 and in close proximity to the high intensity portion at the beginning of the separating magnetic field; and a liquid supply casing 20 for delivering fresh water upwardly through openings 21 in the feed plate 19 and through the bed of mixture flowing downwardly along this plate. This upward injection of fresh liquid through the granular material as it passes along the initial magnetic field portion of high intensity, causes the magnetic particles to be subjected to maximum magnetic influence while these particles are liberated by the agitation, from surrounding non-magnetic particles which might tend to prevent the magnetic particles from being drawn in contact with the adjacent surface of the conveyor belt 8. In order to insure passage of all of the entering mixture through the high intensity magnetic field and beneath the advancing belt 8, and also for the purpose of creating a slight hydraulic head at the feed inlet, dams 22 are provided at the outer sides of the supporting beams 10, as shown in Figs. 1, 2 and 3, and these dams 22 obviously prevent material from entering the machine without being subjected to the magnetic force.

The hydraulic means for washing the material being transported by the belt 8 after it leaves the feed structure, comprises a tailings hopper 23 and a middlings hopper 24, cooperating to form a liquid basin within which the lower stretch of the belt 8 is immersed, and in which the magnetic field portion of moderate intensity is also disposed. The tailings hopper 23 is provided with a series of baffles 25, while the middlings hopper 24 is provided with a series of similar baffles 26, and the upper ends of these baffles 25, 26 are preferably located within the liquid in close proximity to the lower transporting surface of the belt 8 but at slightly diminishing distance from this surface, from the first baffle 25 to the last baffle 26. The upper ends of these baffles are preferably curved toward the feed end of the machine so as to immediately direct separated particles toward the lower ends of the hoppers. The tailings hopper 23 is moreover provided with a lower tailings discharge pipe 27 and with an adjustable side overflow weir 28, while the middlings hopper 24 is likewise provided with a middlings discharge pipe 29 and with an adjustable side overflow weir 30, as clearly shown in my prior Patent No. 2,003,430. The weir 30 is normally set at a higher level than the weir 28 in order to produce a flow of liquid over the curved partition 31 which separates the hoppers 23, 24, in a direction opposite to the direction of travel of the transporting portion of the belt 8. This counter-flow of liquid not only prevents tailings from floating from the hopper 23 into the hopper 24 due to the drag of the belt, but also tends to wash residual tailings from the belt 8 into the tailings hopper 23.

The final discharge means for treating the magnetic particles during final delivery thereof, comprises a fresh water supply launder 32; a water delivery chute 33; and a magnetic material or concentrate discharge chute 34, all arranged in series along the delivery end of the magnetic field having high intensity. The launder 32 is adapted to deliver fresh liquid along the transporting surface of the belt 8 in a direction opposite to the direction of travel of this surface, and above the level of the liquid within the middlings hopper 24, thereby finally washing the concentrates which are magnetically held against the belt after leaving the main washing liquid

in the hopper 24, and carrying residual middlings into this hopper. As the belt 8 advances the concentrates over the launder 32 and chute 33, the high intensity serves to squeeze the granules 5 against each other and against the belt surface, thereby dewatering the final product, and the separated liquid drops by gravity into the water delivery chute 33. The dewatered concentrate is eventually carried beyond the chute 33 and is 10 delivered from the transporting surface of the belt into the chute 34 as clearly shown in Fig. 1, after it is carried beyond the zone of magnetic influence.

While the normal operation of the improved 15 separating machine should be quite obvious from the foregoing specific description thereof, a short resumé of this operation is substantially as follows.

The conveyor belt 8 is being continuously 20 driven in the direction indicated by the arrows in Fig. 1, by application of power to the driving pulley 14, and an abundant supply of raw material mixed with excess water is being deposited into the launder 18 by the feed pipe 17. The 25 bank of magnets is energized so that the successive magnets have opposite polarity, and the end magnets of the series have a considerably higher intensity than the intermediate magnets. The entering material flows by gravity along the feed 30 plate 19 and is subjected to an agitating action by the liquid delivered through the openings 21 as it passes through the feeding zone of high magnetic intensity. The magnetic particles are immediately drawn toward the advancing lower 35 surface of the belt 8 and are held against this surface, being subsequently carried over the end of the feed plate 19 and into the liquid basin afforded by the tailings hopper 23. Most of the coarse tailings are immediately discharged 40 through the hopper 23 and the delivery or discharge pipe 27, and the slime tailings pass over the overflow weir 28, while the residual tailings which are held in suspension by the material clinging to the belt 8 are subsequently liberated 45 by the reversed polarity of the successive magnets which cause the material being transported through the liquid by the belt to be constantly agitated so as to readjust its position. The discharge of tailings continues during the entire 50 period that the material is being transported through the liquid in the hopper 23, and the baffles 25 serve to immediately direct the separated tailings toward the discharge of this hopper. The remaining material with the tailings 55 removed therefrom is subsequently carried through the liquid in the middlings hopper 24 wherein the middlings are separated and delivered through the discharge pipe 29. The baffles 26 in the middlings hopper 24 again function to 60 immediately direct the removed middlings toward the discharge end of the hopper 24, and near the end of this hopper the material is lifted away from the washing liquid basin. As the material is carried in proximity to the launder 65 32, final washing and removal of the middlings is effected, and the concentrates are subsequently carried over the dewatering chute 33 where the excess water is removed therefrom. The dry concentrates are subsequently discharged through 70 the chute 34 after leaving the magnetic field. In this manner, the material is automatically treated for the removal of tailings and middlings, and is finally discharged from the machine in dry condition.

75 The dams 22 associated with the feed plate 19

on opposite sides of the magnets 5, create pools of relatively clear water on the opposite sides of the feed flow and thus cause a flushing inward flow of relatively clean water which prevents 5 tailings from being delivered to the hopper 23 without being subjected to the magnetic influence, and also eliminates excessive abrasion at the sides of the feed chute. The curved baffles function to quickly remove the separated solid 10 materials, and the adjustable weirs 28, 30 serve to produce the desired flow of liquid over the partition 31 in a direction opposite to the direction of travel of the belt to counteract the dragging action of the belt, thereby preventing tailings from reaching the middlings hopper 24. The 15 launder 32 likewise prevents middlings from reaching the final discharge chute 34, and the dewatering chute 33 is of sufficient length to insure effective removal of all excess water before final discharge of the concentrates. 20

The nozzle 15 serves to provide lubrication which eliminates excessive wear on the belt 8, and the side slabs or planks 10 coating with the edge portions of the belt 8 beyond the magnetic field, provide effective seals which cooperate with 25 the liquid admitted from the nozzle 15, to prevent ingress of grit to the lower surfaces of the pole pieces 7. The drains 16 provide effective tell-tale devices for indicating the presence of moisture within the housing 6, and the entire 30 machine is thus guarded against excessive wear and rapid deterioration.

From the foregoing description it will be apparent that the present invention provides a 35 simple, compact and highly efficient separator for removing magnetic material from mixed granular product. The machine has proven highly successful in actual commercial use, and while some of the improved features may appear to be of relatively little importance, they have been found 40 desirable in enhancing the final efficiency of the separator.

It should be understood that it is not desired to limit the invention to the exact details of construction and to the precise mode of operation 45 herein shown and described, for various modifications within the scope of the claims may occur to those skilled in the art.

It is claimed and desired to secure by Letters 50 Patent:

1. In a separator, a series of magnets having poles producing a magnetic field, a conveyor belt having catenary suspension beneath said poles and movable through said field in slightly spaced relation to said poles, means coating with the 55 edges of said belt to provide a sealed space between said belt and poles, and means for admitting liquid to the upper surface of said belt in advance of said space and providing a lubrication film in the entire space between said belt and 60 said poles during normal advancement of the belt.

2. In a separator, a series of magnets having successive poles producing a magnetic field, a conveyor belt having catenary suspension beneath said poles and movable through said field 65 in spaced relation to said poles, members having lower surfaces of catenary shape coating with said belt on opposite sides of said field to form sliding seals at the opposite sides of said space, and means for admitting liquid to the upper surface of said belt in advance of the space between 70 said belt and poles and intermediate said seals and providing a lubrication film in the entire 75

space between said belt and said poles terminating laterally at said seals.

3. In a separator, a series of magnets having cooperating poles producing an elongated curved magnetic field below the magnets, a conveyor belt having catenary suspension beneath said poles and movable longitudinally through said field, means having lower surfaces of catenary shape coacting with opposite edge portions of said belt to form sliding seals extending along the opposite side of said field, and means forming a liquid basin within which said belt and sealing means are immersed.

4. In a separator, a series of magnets having cooperating poles producing an elongated curved magnetic field below the magnets, a conveyor belt having catenary suspension and being movable longitudinally through said field and beneath said poles, means having lower surfaces of catenary shape coacting with opposite edge portions of said belt to provide sliding seal formations along the opposite sides of said field, means forming a liquid basin within which said belt and sealing means are immersed, and means for admitting fresh liquid to the space between said poles and belt intermediate said seals to form a lubrication film on the belt and a seal at the edge portions thereof.

5. In a separator, means forming a liquid basin, a series of magnets for producing a curved magnetic field extending medially into said basin, a conveyor belt movable along said field through and beyond said basin, a launder for delivering a film of liquid along the under surface of said belt entirely across the latter and through the suspended material directly beyond said basin, means for subsequently removing the liquid from granular material being transported by said belt, and means for finally removing the granular material alone.

6. In a separator, means forming a liquid basin, a series of magnets for producing a magnetic field the medial portion of which extends into the medial portion of said basin, a conveyor belt having a lower stretch movable along said field through said basin and upwardly above the liquid at an end thereof, means for delivering a film of liquid along and entirely across the under surface of said belt and through the material sus-

pended thereon by said magnets as said belt leaves the liquid in said basin, means for subsequently removing the liquid from the granular material being transported by said belt, and means for finally removing the granular material alone.

7. In a separator, means forming a separating liquid basin, a conveyor belt having a substantially catenary lower stretch movable through the liquid in said basin, a series of magnets having poles spaced slightly from the upper surface of said belt stretch, means coacting with the upper surface of said belt stretch beyond said magnets to seal the space between said surface and belt from the liquid in said basin, and means for admitting clear liquid to said space to provide a lubricating film and to prevent liquid from said basin from entering said space past said sealing means.

8. In a separator, means forming a separating liquid basin, a conveyor belt having a downwardly curved lower stretch movable longitudinally through the liquid in said basin, a series of fixed magnets having pole faces spaced slightly from the upper surface of said belt stretch, stationary seals having sliding coaction with both edge portions of said stretch beyond the opposite sides of said magnet to seal the space between said belt surface and pole faces from the liquid in said basin, and means for constantly supplying clear liquid to said space to provide a lubricating film and to prevent liquid from said basin from entering said space past said seals.

9. In a separator, means forming a liquid basin, a conveyor belt having an elongated catenary lower stretch movable through the liquid in said basin, a series of magnets having poles cooperating with the upper surface of said belt stretch, sealing walls coacting with the opposite edges of said belt stretch beyond said poles, a feed plate extending into said basin beneath said belt stretch, and a dam extending upwardly from said feed plate on each side of said magnets between the adjacent sealing wall and basin side wall for establishing a hydraulic head on the feed and for compelling the entering material to flow through the magnetic field.

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