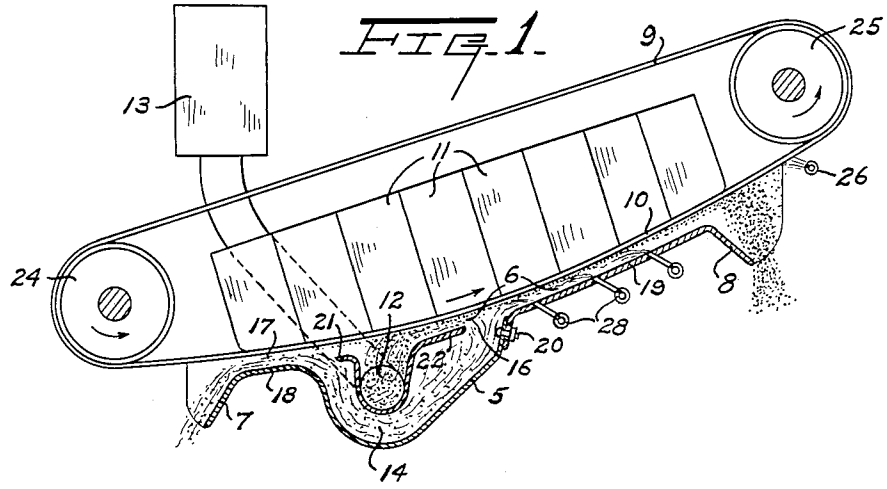
May 29, 1956 B. A. PALM 2,747,735

ENDLESS BELT MAGNETIC SEPARATOR

Filed March 25, 1954

FIG. 1.



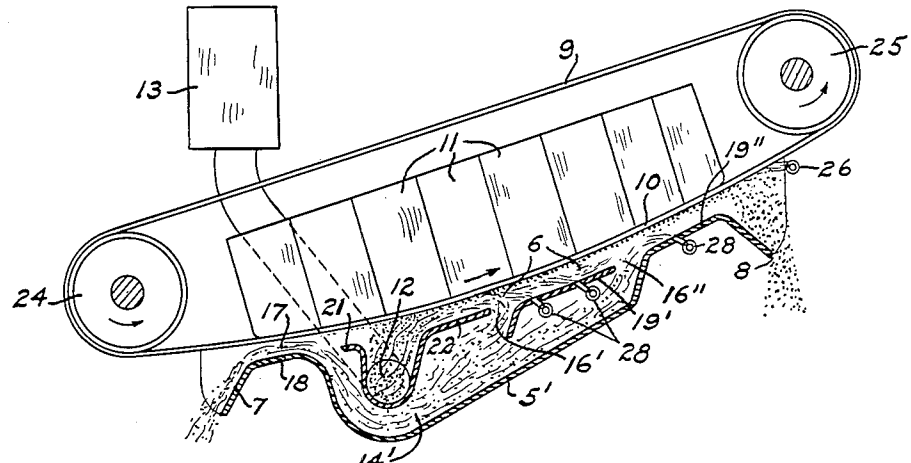


FIG. 2.

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ENDLESS BELT MAGNETIC SEPARATOR

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Application March 25, 1954, Serial No. 418,524

9 Claims. (Cl. 209—223)

My invention relates in general to improvements in the art of treating ore slurry and the like for the removal of magnetic particles from non-magnetic substances suspended in the liquid, and relates more particularly to improvements in the construction and operation of endless belt type magnetic separators especially adapted to remove magnetic concentrates from tailings and excess liquid constituting ore pulp or the like.

The primary object of the present invention is to provide an improved endless belt type magnetic separator which is simple and compact in construction and highly effective in operation.

As shown in United States Patents No. 2,356,463, granted August 22, 1944, to R. J. Linney, and No. 2,410,601, granted November 5, 1946, to R. E. Crockett, it has heretofore been proposed to separate magnetic concentrates from ore pulp or slurry, with the aid of an endless belt conveyor having a lower stretch or run advancing upwardly at an inclination through a field of magnetic influence to a lower end portion of which the slurry is admitted and from the upper end of which the separated concentrates are delivered beyond the magnetic field. In both of these prior separators, the tailings and middlings and some of the spent liquid constituent of the slurry, are primarily discharged by gravity through hoppers located beneath the magnetic separating zone, and in the Linney device the lower belt run is subjected to a strong downwardly advancing flow of wash water so that a considerable portion of the excess liquid and tailings are also discharged through the fresh slurry being admitted to the magnetic field, while in the Crockett unit the lower belt stretch is constantly immersed in liquid and the excess liquid overflows at the opposite sides of the tailings and middlings discharge hoppers.

This construction and mode of operation in both of these prior belt type magnetic separators not only produces bulky and complicated units, but also results in the loss of considerable quantities of magnetic particles with the tailings. In the Linney separator this loss of valuable material results from the direct passage of excess spent liquid to the tailings discharge zone through the entering fresh slurry, whereas in the Crockett machine such loss of magnetic material results from ineffective washing of the concentrates within the belt submerging basins through which the tailings and middlings gravitate before all magnetic particles have been effectively removed.

It is therefore an important object of my present invention to provide an improved belt type magnetic separator of the general type shown in these prior patents, but wherein clean concentrates are most effectively removed from the slurry in a single pass through a simple separating and washing zone by delivering the tailings and excess liquid away from the magnetic field and discharging them from the unit without passing through or contacting the entering fresh slurry or pulp mixture.

Another important object of this invention is to provide an endless belt conveyor belt type magnetic separator in which the transporting lower run of the belt is not constantly immersed in a liquid bath, and wherein the magnetic materials are confined within the field of magnetic influence and are thoroughly washed and effectively removed while the waste ingredients of the slurry and the excess liquid are dischargd without interfering with the most efficient separation of the valuable magnetic particles.

A further important object of the present invention is to provide a very compact belt type magnetic separating unit of large capacity, in which the magnetics bearing pulp is supplied to a medial portion of the magnetic separating field while the tailings and concentrates are discharged without obstructing the supply from the opposite ends of the zone of separation and are both subjected to strong magnetic influence before final discharge thereof from the unit.

Still another important object of my invention is to provide an improved magnetic separator having an inclined conveyor stretch advancing through a field of magnetic flux from the opposite ends of which the tailings and concentrates are discharged, and wherein the magnetic field is confined between the advancing material transporting stretch and pick-up plates but is connected with the tailings discharge by passages which by-pass the slurry inlet and subject the discharge to magnetic separating influence before leaving the machine.

These and other more specific objects and advantages of the invention will be apparent from the following detailed description, and the present application is a modification of the drum type magnetic separator forming the subject of my copending application Serial No. 410,869, and is in some respects an improvement thereover.

A clear conception of the features constituting the present improvement, and of the construction and operation of several types of endless belt magnetic separators embodying the invention, may be had by referring to the drawing accompanying and forming a part of this specification wherein like reference characters designate the same or similar parts in the several views.

Fig. 1 is a diagrammatic part sectional side view of one typical endless belt magnetic separator embodying the improvements, the section having been taken longitudinally through the separating zone of the unit and illustrating the normal functioning thereof; and

Fig. 2 is a diagrammatic part sectional side view of another typical endless belt magnetic separator also embodying the invention, with the section also having been taken longitudinally through the separating zone and depicting the normal operation of the machine.

While the invention as illustrated reveals only two typical embodiments wherein all details of construction except essential parts involved in the present improvement, have been omitted for the sake of clearness, it is not my intention to unnecessarily restrict the use of the improved features to these limited diagrammatic showings; and it is also contemplated that specific descriptive terms employed herein be given the broadest possible interpretation consistent with the actual disclosure.

Referring to Fig. 1 of the drawing, the improved endless belt type magnetic separator shown therein, comprises in general, a casing 5 provided with opposite side walls and forming a separating chamber or zone 6 having

a tailings and excess liquid delivery spout 7 at one end and a concentrate discharge chute 8 at its opposite end disposed at a higher level than the spout 7; an endless belt conveyor 9 of non-magnetic material having a lower stretch or run 10 inclined and advancing upwardly from a position in close proximity to the spout 7 to a similar position relative to the chute 8; a bank of electro-magnets 11 disposed above the belt run 10 for creating a relatively strong field of magnetic flux or influence along the lower face of this belt run; an inlet duct 12 for introducing magnetic slurrry under pressure from a supply tank or hopper 13 into the magnetic field between the spout 7 and the chute 8; and an unobstructed flow reversing and conducting passage 14 for conducting the tailings and excess liquid with considerable force or velocity away from the separating zone 6, and for delivering the same to the discharge chute 7 without mixing the waste materials with the incoming fresh slurry.

The medial bottom portion of the casing 5 beneath the slurry inlet duct 12 and which cooperates with the latter, is preferably rounded as shown and spaced from the rounded bottom of this inlet, sufficiently to provide a relatively large and unobstructed flow reversing and conducting passage 14 the receiving end of which communicates through an opening 16 with the separating zone 6 beyond the supply duct 12, and the delivery end of which is communicable with the tailings delivery spout 7 past a pick-up zone 17 located in advance of the duct 12 formed by an extension plate 18 of the casing 5. The casing 5 is also provided in advance of the concentrate discharge chute 8 and beneath the belt run 10, with another extension plate 19 which may be made vertically adjustable relative to the main body of the casing, by means of bolts 20 coacting with upright slots in the casing body, and the slurrry inlet duct 12 preferably diverges upwardly toward the lower face of the belt run 10 and in the direction of advancement of the latter, and is provided with oppositely directed flanges 21, 22 at the opposite sides of its upper end. The casing extension plates 18, 19 and the flanges 21, 22 are all disposed in sufficiently close proximity to the lower face of the belt run 10 to provide a pick-up space for any magnetic particles passing directly beneath or which may drop from the lower face of the advancing conveyor belt 9.

The endless belt 9 is formed of non-magnetic material and coacts with lower and upper pulleys 24, 25 respectively which may be driven from any suitable source of power so as to cause its lower stretch or run 10 to constantly advance in the direction of the arrows, well above the level of any liquid which may accumulate within the casing 5. The electro-magnets 11 are fixedly mounted within the endless belt conveyor 9 and coact with the lower run 10 of the belt to create a magnetic field of considerable intensity throughout the entire extent of the separating zone, and the successive magnets 11 are preferably of opposite polarity so that they will roll the magnetic particles which are attracted against and advanced by the lower face of the belt run 10 upon this belt surface. The lower pole shoes or faces of the bank of magnets 11 may also be of any desired curvature in order to coact with the sagging lower belt run 9 with least frictional resistance, and a spray jet 26 may be applied to the belt 9 beyond the zone of action of the magnets 11 in advance of the upper pulley 25 and above the concentrate discharge chute 8 in order to wash adhering magnetic particles from the conveyor.

The slurry inlet duct 12 should preferably receive an abundant supply of fresh magnetite bearing slurry from the tank or hopper 13 under a nominal hydrostatic head, and the outlet end of this duct is preferably directed upwardly toward and in the direction of travel of the conveying run 10 of the belt 9 so as to cause the slurry to flow toward the concentrate discharge chute 8. The pick-up plate 19 is also preferably provided with several wash water injection nozzles 28 directed toward but in a

direction opposed to the direction of advancement of the belt run 10, for delivery of abundant quantities of wash water downwardly through the separating chamber or zone 6. The entire separating unit may be mounted upon a suitable frame in an obvious manner, and the opening 16 between the lower end of the plate 19 and the upper end of the flange 22 of the duct 12 should be large enough to permit the excess spent liquid to escape into the passage 14 without obstructing the flow of the entering fresh slurry.

Referring to Fig. 2 of the drawing, the modified endless belt magnetic separating unit shown therein is quite similar to the device shown in Fig. 1, except that the casing 5′ is constructed to provide a longer passage 14′ for reversing and conducting the tailings and spent liquid toward the discharge spout 7, and the pick-up plate near the concentrate delivery chute 8 is divided into two spaced sections 19′, 19″ to provide several liquid escape openings 16′, 16″ connecting the separating zone 6 with the receiving end of the passage 14′. These openings 16′, 16″ should also be of ample size to permit free flow of excess liquid into the passage 14′. All of the remaining elements of the modified assemblage may be constructed substantially the same as described in connection with Fig. 1, and the pick-up plate sections 19′, 19″ may also be provided with fresh water injection nozzles 28.

During normal operation of both of the improved endless belt magnetic separators shown in Figs. 1 and 2, the endless belt conveyor 9 should be driven to cause its lower stretch or run 10 to constantly advance upwardly along the pole faces of the electro-magnets 11, and the latter should be energized to create a relatively strong field of magnetic influence throughout the entire extent of the separating chamber 6. The slurry to be treated should be supplied in abundant quantities to the supply hopper 13, and a quantity of clean water should also be constantly supplied to the belt 9 and chamber 6 through the nozzles 26, 28. The magnetics bearing slurry will then be delivered upwardly against and along the lower belt run 10 with considerable velocity through the inlet duct 12, due to the hydrostatic head acting upon the liquid slurry; and as this slurry or pulp flows through the elongated chamber 6 and through the powerful magnetic field, the magnetic particles are quickly withdrawn from the upwardly advancing stream of pulp and lodge upon the lower face of the advancing belt run 11.

As the withdrawn magnetic particles advance along the chamber 6 toward the concentrate discharge chute 8, they are rolled and agitated due to the opposite polarity of the successive magnets 11, and they are also thoroughly washed and cleansed by the fresh water admitted through the nozzles 28; and any of these concentrates which do not drop by gravity when they are carried beyond the magnetic field will be washed off of the belt into the chute 8 by the water injected through the spray nozzle 28. Then too, any magnetic material which may be washed from the belt run 10 by the abundance of fresh water injected into the chamber 6 by the nozzles 28 will be promptly picked up and returned to the conveyor belt by the magnetic flux, and the non-magnetic tailings and gangue which remain suspended in the excess liquid will escape from the separating zone 6 through the openings 16 and will be flushed from the casing 5 toward the tailings discharge spout 7 through the lower unobstructed passage 14.

It is to be noted that although the lower face of the belt run 10 is constantly subjected to a quantity of washing liquid, it is not constantly submerged in this liquid, and the spent liquid which removes the non-magnetic ingredients cannot mix with and contaminate the freshly admitted slurry delivered to the chamber 6 through the inlet duct 12. This spent liquid is, however, subjected to strong magnetic influence within the pick-up space 17 in advance of the slurry inlet, before it reaches the discharge spout 7, thereby insuring removal of magnetic particles which might otherwise be discharged with the tailings and

insuring most effective separation of the valuable concentrates. The various pick-up plates may also be adjusted to insure most efficient functioning of the magnetic field in maintaining magnetic particles within the zone of action of the magnetic flux, and the endless belt **9** may also be driven at any desired speed in order to obtain maximum capacity.

From the foregoing detailed description it should be apparent that the present invention in fact provides an endless belt type of magnetic separator which is exceedingly simple and compact in construction and highly efficient in operation. The efficiency and capacity of the improved unit is materially enhanced by avoiding submergence of the transporting lower run **10** of the belt **9** within a liquid basin or bath, and by promptly removing the excess liquid and tailings without permitting the same to mix with the fresh entering slurry and subjecting this spent pulp to further magnetic influence before final delivery thereof from the separator. After the various parts of the improved separating unit have been properly adjusted, the operation of the machine is entirely automatic and requires no attention, and the major parts of the device can be readily constructed of sheet metal and readily available materials at relatively moderate cost.

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 separating units specifically shown and described herein, since various modifications within the scope of the appended claims may occur to persons skilled in the art.

I claim:

1. In a magnetic separator, a casing forming a separating chamber having a tailings and liquid delivery spout at one end and a concentrate discharge chute at its opposite end disposed at a higher level than said spout, an endless conveyor having a lower run inclined and advancing upwardly from a position in close proximity to said spout to a similar position relative to said chute, means for creating a field of magnetic influence along the lower face of said conveyor run, and an inlet duct formed to introduce magnetic slurry upwardly into said field between said spout and said chute and in the direction of advancement of said conveyor run, said duct being spaced from the bottom of said casing to provide an unobstructed passage for conducting tailings bearing liquid from said chamber to said spout beneath the slurry inlet.

2. In a magnetic separator, a casing forming an elongated upwardly inclined separating chamber having a tailings and liquid delivery spout at its lower end and a concentrate discharge chute at its upper end, an endless belt conveyor having a lower run advancing upwardly from a position in close proximity to said spout to a similar position relative to said chute, means for creating a field of magnetic influence along the lower face of said conveyor run throughout the length of said chamber, and an inlet duct for introducing magnetic slurry into said field between said spout and said chute, said duct being spaced from said casing to provide an unobstructed passage for conducting tailings bearing liquid from said chamber to said spout beneath the slurry inlet.

3. In a magnetic separator, casing forming an elongated upwardly inclined separating chamber having a tailings and liquid delivery spout at its lower end and a concentrate discharge chute at its upper end disposed at a higher level than said spout, an endless conveyor having a lower run advancing upwardly from a position in close proximity to said spout to a similar position relative to said chute, means for creating a field of magnetic influence along the lower face of said conveyor run, an inlet duct formed to introduce magnetic slurry upwardly into a medial portion of said chamber and in the direction of advancement of said conveyor run, and means providing an unobstructed passage within said casing beneath said duct for conducting spent liquid and tailings past said duct toward said spout.

4. In a magnetic separator, casing forming an elongated upwardly inclined separating chamber having a tailings and liquid delivery spout at its lower end and a concentrate discharge chute at its upper end, an endless conveyor advancing upwardly from a position in close proximity to said spout to a similar position relative to said chute, means for creating a field of magnetic influence along the lower surface of said conveyor, an inlet duct spanning the lower interior of said casing for introducing magnetic slurry upwardly into said chamber and said field between said spout and said chute, and means forming an unobstructed liquid passage within said casing beneath said inlet duct and connecting portions of said chamber on opposite sides of said duct with each other.

5. In a magnetic separator, means forming an elongated separating chamber having a tailings delivery spout at one end and a concentrate discharge chute at its opposite end disposed at a higher level than said spout, a conveyor having a lower run inclined and advancing upwardly from a position in close proximity to said spout to a similar position relative to said chute, means for creating a field of magnetic influence throughout the length of said chamber and along the lower face of said conveyor run, an inlet duct formed to introduce magnetic slurry upwardly into said field between said spout and said chute, means forming an unobstructed liquid conducting passage beneath said inlet duct connecting portions of said chamber on opposite sides of said inlet, and means forming a magnetic material pick-up zone within said chamber in advance of said inlet duct.

6. In a magnetic separator, a conveyor having an elongated lower run inclined and advancing upwardly, means for creating a field of magnetic influence along the lower face of said conveyor run, a series of pick-up plates extending along and spaced from said lower face to provide an elongated shallow separating chamber having a tailings discharge at its lower end and a concentrate discharge at its upper end, feed means for introducing magnetic slurry to said chamber and said lower conveyor run medially of said pick-up plates, and means forming an unobstructed liquid passage below and segregated from said feed means and connecting portions of said chamber on opposite sides of said slurry introducing means.

7. In a magnetic separator, an endless conveyor having an elongated run inclined and advancing upwardly, a series of magnets above said conveyor run for creating a field of magnetic influence beneath and along the lower face of the run, an inlet duct formed to introduce slurry upwardly into the medial portion of said field and in the direction of advancement of said conveyor run, means providing an unobstructed passage beneath said duct for conducting tailings past the duct in the opposite direction, and means forming a magnetic material pick-up zone within said field in advance of said slurry inlet duct.

8. In a magnetic separator, a casing forming an elongated separating chamber having a tailings delivery zone at one end and a concentrate discharge zone at its opposite end, an endless conveyor having a lower run advancing from a position in close proximity to said tailings delivery zone to a similar position relative to said concentrate discharge zone, means for creating a field of magnetic influence within said chamber along the lower face of said conveyor run, an inlet duct formed to introduce slurry upwardly into said field between said zones and in the direction of advancement of said conveyor run, means providing an unobstructed passage beneath said duct for conducting tailings past the duct in the opposite direction, and means forming a magnetic material pick-up zone within said field between said tailings delivery zone and said slurry inlet duct.

9. In a wet magnetic separator, a conveyor having an upwardly advancing and inclined lower surface, a series of magnets for creating a field of magnetic influence

extending along and beneath said surface, an inlet duct formed to introduce slurry upwardly into a medial portion of said field and in the direction of advancement of said surface, a casing providing an unobstructed passage beneath said duct for conducting tailings past the duct remote from said surface and in the opposite direction, and means forming magnetic material pick-up zones within said field on the opposite sides of said slurry inlet duct.

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