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MAGNETIC SEPARATOR

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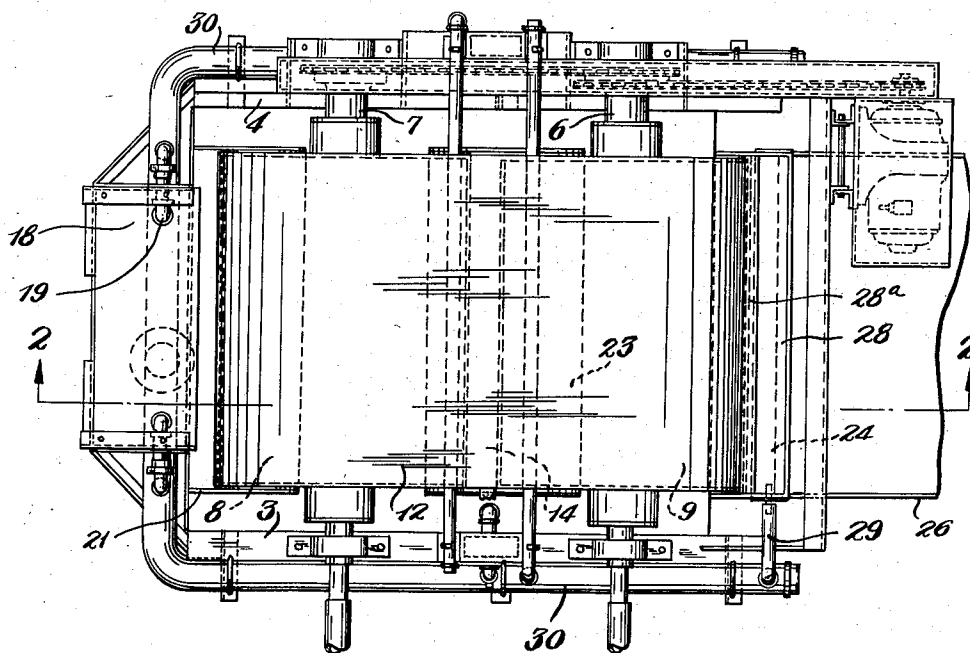


FIG. 1

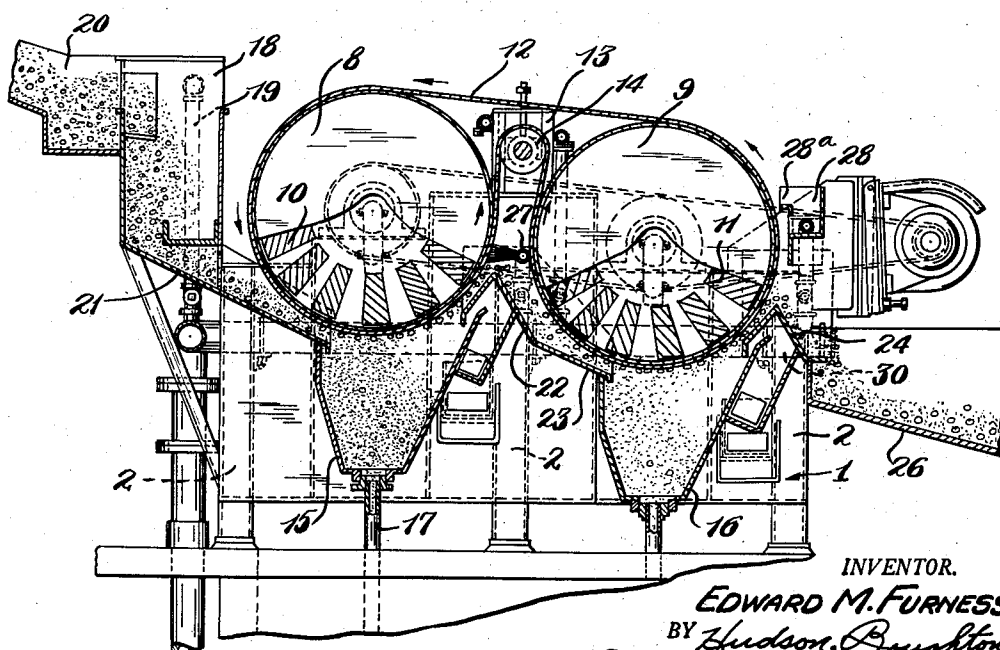


FIG. 2

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8 Claims. (Cl. 209—223)

The present invention relates to a magnet separator which is used in connection with separating magnetizable material from its comingled material, for example, separating magnetic ore bearing material from its comingled gangue or tailings. In such apparatus, the material to be operated upon is in coarsely ground condition (8 to 10 mesh) and mixed with water, the said mixture being fed to the magnetic separator and passed through a magnet seal whereby the magnet portion of the material being treated is separated and recovered while the non-magnetic material or the gangue or tailings is rejected by the apparatus and then conveyed to a place of disposal.

Without any intention of limitation, the present invention is effectively usable in separating the metallic bearing portions of iron ore containing material, as an example of which may be mentioned, taconite which contains iron oxide in a gangue of non-metallic foreign material.

An object of the invention is to provide a revolvable drum within which is located electrically energized pole members and employing a belt of non-magnetic material which is in contact with the peripheral portion of the drum and further in providing means which insures ample contact of the belt with that portion of the drum subjected to the magnetic effect of the pole members and even somewhat beyond such portion, so that the magnetically separated material will not prematurely be released from the belt but retained thereon until reaching the selected point of discharge.

The arrangement and use of a belt of non-magnetic material, takes the wear, incident to passing the coarsely ground material into contact with the belt and such wear, does not decrease the efficiency with respect to separation of the apparatus, which would be the case if such a belt were not used as will be later pointed out.

The above object of invention may be obtained either by using a single revolvable drum within which is located electrically energized pole members and around which a belt of non-metallic material is associated, together with a driving pulley which is associated with another portion of the belt, with which said assembly is associated, the means associated with the belt and adjacent the revolvable drum with which the electrically energized pole members are associated, so as to insure a greater surface contact of the belt with the drum than would otherwise be the case without the use of such means.

A further object of the invention is to provide a magnetic separator involving the use of two revolvable drums with which a continuous belt is associated and contacting major portions of the peripheral surface of each of the drums.

A more efficient separation of the magnetic material can be obtained by subjecting the material to a retreatment of the ore by means of a second magnetic drum. When ore such as magnetite passes over a magnetic drum of the type described, the particles of magnetite not only adhere to the surface of the drum, or more particularly, to the surface of the belt which is in engagement with the

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drum, but they also adhere to each other due to the fact that the particles of the material act as little magnets. When, therefore, upon reversing polarity of the magnets in the drum, there is caused a relative movement between the particles of ore, such movement tends to shake loose the more weakly or non-magnetic particles. However, this relative movement is more completely accomplished after the ore has been removed from the magnetic fields because the particles no longer adhere to each other, with great force. Therefore, a plurality of drums or other types of magnetic separators may be more effective than one drum, regardless of the size or number of magnetic poles.

Where a plurality of drums are used as above suggested, an idler pulley may be used which is located between the drums so as to cause the belt to travel in a loop between the drums and thereby affect a greater portion of the periphery of the adjacent portions of each drum, being thus engaged by the belt. This insures engagement between the belt and the periphery of each of the drums throughout the portions of the periphery of the drums which are subject to the magnetic field and even where desired, a greater area of engagement.

An important result obtained by the use of the apparatus which is herein described, that the belt protects the surface of the drum from any pitting and blistering action and wear which invariably results where relatively coarse material to be separated is brought directly into contact with the peripheral surface of the drum rather than by the use of a belt which moves upon the periphery of the drum.

In the foregoing connection it should be mentioned that where there is a pitting or blistering of the drum surface, the operation of the magnetic field with respect to the material which is fed into contact with the drums, becomes subject to a varying intensity which may appreciably affect the metallurgical properties of the material which is being separated by passage through the magnetic field. In other words, the use of a belt, at least in such a relationship as is herein disclosed, tends to assure a uniform magnetic field in its application to the material which is to be treated and which undergoes separation, so that the intensity of the magnetic field does not vary during the time when the material to be separated is in contact with that portion of the belt which is subjected to the action of a magnetic field.

Other features of the separator which is herein disclosed will be apparent as the description proceeds.

Referring to the drawings,

Fig. 1 is a top plan view of the magnetic separator; and,

Fig. 2 is a side elevation with portions in section showing the relationship of the drum with respect to the belt and the intermediate pulley which also cooperates with the belt.

Referring to the drawings, 1 generally indicates a base member which is provided with upstanding leg portions 2, which legs at their upper end are joined by a transversely extending member on both sides which is indicated by the reference numerals 3 and 4 respectively.

Extending transversely of this frame are two shafts which are indicated at 6—7 and which rotatably support drums 8 and 9. Within each of the drums there are a series of pole members which are indicated at 10 and 11 which occupy the lower part of each of the drums and which are energized by an electric current to provide a proper magnetic field, which is effective upon what might be called the lower peripheral surface of each of the drums. Permanent magnets may also be employed. It is not proposed to go into detail as to the construction and operation of apparatus which produces the magnetic field, inasmuch as this is a matter of design and the use

of such magnetic field producing device is thoroughly well known in the art.

Extending around each of the pulleys is a continuous belt 12 which is particularly shown in Fig. 2 of the drawings. Intermediate of the drums and mounted upon a support 13, which in turn is mounted upon the frame of the machine, is a pulley 14 which is adjustably mounted in the support 13. This pulley or roller as it may be termed, is so positioned that the traveling belt continually passes over the pulley 14 in the course of the traveling movement of the belt. The pulley 14 is mounted so that it is above a plane passing through the center of each of the drums 8 and 9. The effect of this is that it provides for peripheral contact between the belt and those portions of the drums which are adjacent to each other, of considerably greater extent than would be possible if the pulley were not used.

This is important not merely as a structural feature, but because it enables the magnetic material to be cleaned from the belt after it has been subjected to the respective magnetic fields and therefore provides for more effective operation not only of the magnetic field but for the removal of the material from the belt as the material will have passed beyond a point with respect to the periphery of the drum where the magnetic intensity has effectively diminished and where, therefore, the material which is adhering to the belt may be removed.

Beneath each of the drums is a hopper such as indicated at 15 and 16 and at the lower end or bottom of each hopper there is an exit pipe, one of which is shown at 17, by which the non-magnetic material, such as gangue or tailings, collecting within the respective hoppers, may be discharged.

Adjacent one of the drums and more particularly as shown, the drum 8, there is a receiving trough or compartment which is shown at 18, this being somewhat elongated and is provided with means for spraying water therein, one of which means is shown at 19 in Fig. 2.

Material which is to be acted upon by the magnetic separator, is introduced through the induct 20, which material in every case is in finely divided form and mixed with water.

In using magnetic separation which is a part of the process of concentrating taconite ores, the material supplied will frequently be that which comes from a rod mill which is as well known, is a device for producing finely divided material and which finely divided material as discharged from the rod mill is in flowable condition because of its water content.

At the lower end of the trough-like member 18 there is a chute 21 which at its inner end overlies the upper edge of the hopper 15 and this chute extends to a point which is adjacent to the periphery of the drum 8 so that material introduced into the hopper 18 and through the chute 21 moves into proximity with the belt, at the periphery of the drum 8 which is adjacent to the lower portion of the chute.

Located between the drums 8 and 9 and below a horizontal plane passing through the centers of the drums is a V-shaped shed member indicated at 22, one surface of this shed member lying adjacent to the peripheral portion of the drum 8, the V-shaped member also having its one side extending within the wall of the hopper 15.

The surface of the V-shaped member 22, to which reference has just been made, will direct any tailings of material which may mechanically adhere to the magnetic material upon the belt and which may drop therefrom as the belt moves in juxtaposition to the surface of the member 22 which is adjacent to the hopper 15.

This V-shaped member is formed with a surface which is adapted to cooperate or form a part of a chute 23 which is so mounted as to be in juxtaposition with relation to the lower portion of the drum 9. The chute 23 receives material which may be deflected by the member 22, which material has been released from contact with

that portion of the belt which was in engagement with the drum 9 at the end portion of the magnetic field. This chute 23 directs material to a place where it is close to that portion of the belt engaging upon the lower portion of the drum 9 and which is adjacent to the chute 23. This chute at its lower portion communicates with the hopper 16. It will be noted that the lower portion of the chute 23 is adjacent to that portion of the drum 9 where the magnetic field is set up by the magnetic pole pieces within the drum so that material descending through the chute 23 is subjected to the magnetic field, to which reference has just been made, and the magnetic material thus passing through the chute is drawn into contact with the belt and carried by the belt, as will be apparent from an inspection of Fig. 2.

Between the drums 8 and 9 there is located a spraying device 27 which extends transversely across and in parallel relationship with the drums, this spraying device being positioned to spray water upon the belt at that portion thereof which in its travel comes above the upper end of the V-shaped shed 22.

At the end of the apparatus which is beyond the drum 9 there is located a trough 28 which is adapted to be connected with a water pipe for filling the same which is located at 29 and which water pipe is connected with a water pipe 30. The trough is positioned so that the trough as it overflows discharges water into proximity to the belt at a point above the horizontal diameter of the drum, this discharge portion being indicated at 28a.

Reference to both the spray 27 and the trough 28 and noting their position with respect to the drums 8 and 9, it will be seen that the spray 27 will contact that portion of the belt which is passing from the influence of the magnetic apparatus within the drum 8 so that the magnetic force applicable to the material which is carried by the belt will be weakened and by the operation of the spray 27 impinging upon this material and causing water in part to flow down upon the belt will cause the material to drop away from the belt and be directed by the V-shaped member 22 toward the upper end of the trough 23.

Likewise, it will be apparent that the water discharged from the trough 28 upon the belt, will in a large part run down upon the belt and assist in separating the ore material from the belt in that portion thereof which is passing from the magnetic field so that such material will fall from the belt upon the member 24 and be directed toward the exit chute 26.

The operation of the herein described magnetic separator will be apparent from the description and from the drawings, and as will be seen, provides for initial separation by a magnetic field of the magnetizable material from the gangue or tailings and which initially magnetically separated material is subjected to a second separating operation by passing through the magnetic field associated with the second drum, and the finely delivered separated material is in a state of much higher refinement than would be obtained by passing the material through a single magnetic field.

Moreover, the provision of the pulley 14 over which the continuous belt passes provides for a longer period of time for peripheral engagement between the belt and the drum 8 so that the magnetized material carried upon the belt will not be discharged therefrom until such material will have passed beyond the magnetic field induced within the drum 8 and above the apex of the member 22, thus insuring that such material when released from the belt, which operation is assisted by the water spray 27, will fall upon that surface of the member 22 which leads toward the trough 23 and into proximity with the belt which is maintained in peripheral engagement with the drum 9 by virtue of the operation incident to passing the belt over the pulley 14.

The disclosure contained in this application embodies the specific form in which the invention has been em-

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bodied but variations in the precise construction may be made, and embodying the operating functions of the apparatus herein disclosed, without departing from the spirit of the invention as expressed in the claims appended hereto.

Having thus described my invention, I claim:

1. A magnetic separator comprising a drum mounted for rotation about its axis, an endless belt engaging with the periphery of said drum and adapted to travel as the drum is rotated, a hopper mounted beneath the said drum, a chute for delivering material to the belt upon the periphery of the drum and adjacent the lower portion of the said drum, a magnetic device within the drum for creating a magnetic field at the lower portion of the drum, means engaging with the belt and located at one side of the drum and above the horizontal diameter thereof for biasing the belt so that it will travel in contact with the peripheral surface of the drum to a point beyond and above the position of the magnetic device within the drum, means for delivering water upon the belt at a position approximating the point where the belt leaves contact with the periphery of the drum, a shed located at one side of and beneath that portion of the drum where the belt leaves the drum and passes to the means which biases the movement of the belt, said shed having a surface which cooperates with the hopper and having an opposite surface which deflects magnetically separated material away from the said-mentioned drum.

2. A magnetic separator comprising a horizontal drum mounted for rotation about its axis, an endless belt engaging with the periphery of said drum and adapted to travel in the same direction as the drum is rotated, a hopper mounted beneath the said drum, a chute having a discharge end for delivering material to the belt upon the periphery of the drum adjacent the lower portion of the drum the said drum rotating in a direction such that the movement of the belt is away from the discharge end of the chute, a stationary magnetic device within the said drum for creating a magnetic field at the lower portion of the drum only, a rotatably mounted member over which the said belt moves the said member being mounted at the side of the drum in the direction of belt movement and above the horizontal diameter of the said drum, the said member being positioned so that a portion of the belt remains in contact with the peripheral portion of said side of the drum to a point beyond and above the influence of the magnetic field produced by the magnetic device within the drum and guiding the path of said belt so that the material thereon separates from the belt when the belt leaves the magnetic field and while the belt is in engagement with said drum, means positioned adjacent the belt at a point the material on the belt passes beyond the influence of the magnetic field, said means receiving the said material released from the belt and discharging the same.

3. A magnetic separator comprising a first drum and a second drum each mounted for rotation, the axes of said drums being essentially horizontal and parallel with each other, the periphery of the said drums at adjacent portions being spaced apart, an endless nonmagnetic belt engaging the said drums upon the peripheral portion thereof, and traveling upon said peripheral portion, a magnetic device associated with each drum for producing a magnetic field at the lower portion of each drum where the belt is in peripheral contact with the drum, means intermediate the drums and located above the horizontal diameter of each drum for looping the belt between the drums whereby portions of the said belt continue in engagement with the peripheral surfaces of the adjacent drums to a point above and beyond the field produced by the magnetic device of each drum, a hopper located beneath each of said drums, a chute for delivering material to be processed at the lower portion of the periphery of the first drum, a shed member located between the said drums and adapted to receive the magnetically

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separated material from the first drum, a chute contiguous to said member for receiving material therefrom and directing it toward the lower peripheral portion of the said second drum and means located beneath the outer portion of the second drum for receiving material dropping from the said belt and a delivery chute contiguous to said means for receiving the finally separated material.

4. A magnetic separator comprising a first drum and a second drum each mounted for rotation, the axes of said drums being essentially horizontal and parallel with each other, the periphery of the said drums at adjacent portions being spaced apart, an endless nonmagnetic belt engaging the said drums upon the peripheral portion thereof, and traveling upon said peripheral portion, a magnetic device associated with each drum for producing a magnetic field at the lower portion of each drum where the belt is in peripheral contact with the drum, means intermediate the drums and located above the horizontal diameter of each drum for looping the belt between the drums whereby portions of the said belt continue in engagement with the peripheral surfaces of the adjacent drums to a point above and beyond the field produced by the magnetic device of each drum, a hopper located beneath each of said drums, a chute for delivering material to be processed at the lower portion of the periphery of the first drum, a shed member located between the said drums and adapted to receive the magnetically separated material from the first drum, a chute contiguous to said member for receiving material therefrom and directing it toward the lower peripheral portion of the said second drum and means located beneath the outer portion of the second drum for receiving material dropping from the said belt, a delivery chute contiguous to said means for receiving the finally separated material, water delivery means located between the said drums and delivering water upon the belt at the inner side of the first drum, water delivery means located adjacent the outer portion of the second drum for delivering water upon the said belt and assist in the delivery of the processed material therefrom.

5. A magnetic separator comprising a first drum and a second drum the axes of said drums being essentially horizontal and parallel with each other, the periphery of the said drums at adjacent portions being spaced apart, an endless non-magnetic belt engaging the said drums upon the peripheral portions thereof and traveling upon said peripheral portions, a magnetic device associated with each drum for producing a magnetic field at the lower portion of each drum where the belt is in peripheral contact with the drum, a rotatable cylindrical member mounted intermediate the drums and located above the horizontal diameter of each drum for looping the belt between the drums whereby portions of said belt continue in engagement with the peripheral surface of the adjacent drums to a point above and beyond the field produced by the magnetic device of each drum, a hopper located between each of said drums, a chute member located adjacent the outer portion of the first-mentioned drum for delivering material to be processed into contact with the belt on the first drum adjacent the lower portion of the drum, a shed member located between the adjacent portions of the drum adapted to deflect material dropping from the belt at the inner portion of the first-mentioned drum, a chute contiguous to said shed member for delivering material from the shed member to the belt at the lower portion of the second drum adjacent thereto, a shed member located adjacent the outer portion of the second-mentioned drum to deflect material dropping from the belt, and a delivery chute associated with said second-mentioned shed member.

6. A magnetic separator comprising a first drum and a second drum the axes of said drums being essentially horizontal and parallel with each other, the periphery of the said drums at adjacent portions being spaced apart, an

endless non-magnetic belt engaging the said drums upon the peripheral portions thereof and traveling upon said peripheral portions, a magnetic device associated with each drum for producing a magnetic field at the lower portion of each drum where the belt is in peripheral contact with the drum, a rotatable cylindrical member mounted intermediate the drums and located above the horizontal diameter of each drum for looping the belt between the drums whereby portions of said belt continue in engagement with the peripheral surface of the adjacent drums to a point above and beyond the magnetic field produced by the magnetic device of each drum, a hopper located between each of said drums, a chute member located adjacent the outer portion of the first-mentioned drum for delivering material to be processed into contact with the belt on the first drum adjacent the lower portion of the drum, a shed member located between the adjacent portions of the drum adapted to deflect material dropping from the belt at the inner portion of the first-mentioned drum, a chute contiguous to said shed member for delivering material from the shed member to the belt at the lower portion of the second drum adjacent thereto, a shed member located adjacent the outer portion of the second-mentioned drum to deflect material dropping from the belt, a delivery chute associated with said second-mentioned shed member, water delivery means located between the said drums and delivering water upon the belt which is in contact with the inner portion of the first-mentioned drum to assist in parting material from the said belt, water delivery means located adjacent the outer portion of the second drum and delivering water upon the belt in contact with the periphery of the second-mentioned drum at a point above the shed which is associated with the outer portion of the second-mentioned drum.

7. A magnetic separator comprising a horizontal drum mounted for rotation upon its axis, a chute provided with a discharge end for delivering material to a point adjacent the lower portion of the drum, an endless belt engaging the periphery of the said drum and including the lower portion thereof adapted to travel in the same direction as the drum is rotated, the direction of rotation of the drum being such that the travel of the belt is in the same direction as material moving through the chute, the said chute directing the material into contact with the belt, a hopper mounted beneath said drum, rotatable belt supporting means mounted at the side of the drum

in the direction of belt travel, stationary magnetic means within the said drum for creating a magnetic field at the lower portion of the drum and below a horizontal plane through the axis of the drum, said rotatable supporting means engaging with the belt and biasing the belt so that it engages with a considerable area of the lower drum surface to a point above the influence of the magnetic field on said side of the drum and guiding the belt in a path such that the belt leaves the drum substantially tangential to the drum at a horizontal diameter whereby the material separates from the belt when the belt leaves the influence of the magnetic field and while the belt is in engagement with the drum, and means located adjacent the drum and the point thereof where the belt passes out of the influence of the magnetic field for receiving the magnetic separated material from the belt and discharging said material.

8. A magnetic separator comprising a horizontal drum mounted for rotation about its axis, an endless belt engaging with a portion of the periphery of said drum including the lower portion of the drum and adapted to travel in the direction of rotation of the drum as the drum is rotated, a hopper mounted beneath the said drum, a chute for delivering material to the belt upon the periphery of the drum and adjacent the lower portion of the said drum, a magnetic device within the drum for creating a magnetic field at the lower portion of the drum, means engaging with the belt and located at the side of the drum in the direction of belt travel for biasing the belt so that it will travel in contact with the peripheral surface of the drum on the said side thereof to a point beyond and above the magnetic field of the magnetic device within the drum, means for delivering water upon the belt at a position immediately above the magnetic field and in proximity to the point where the belt leaves contact with the periphery of the drum, a shed located at one side of and beneath that portion of the drum where the belt leaves the drum and passes to the means which biases the movement of the belt, said shed having a surface which cooperates with the hopper and having an opposite surface which deflects magnetically separated material away from the said-mentioned drum.

References Cited in the file of this patent

UNITED STATES PATENTS

468,540	Cane	Feb. 9, 1892
1,146,141	Dutton	July 13, 1915