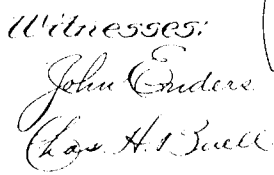


APPLICATION FILED SEPT. 11, 1909.

4 SHEETS—SHEET 1.

Fig. 1.



By Wyrenforth, Lee, Critton & Miles.
Attys.

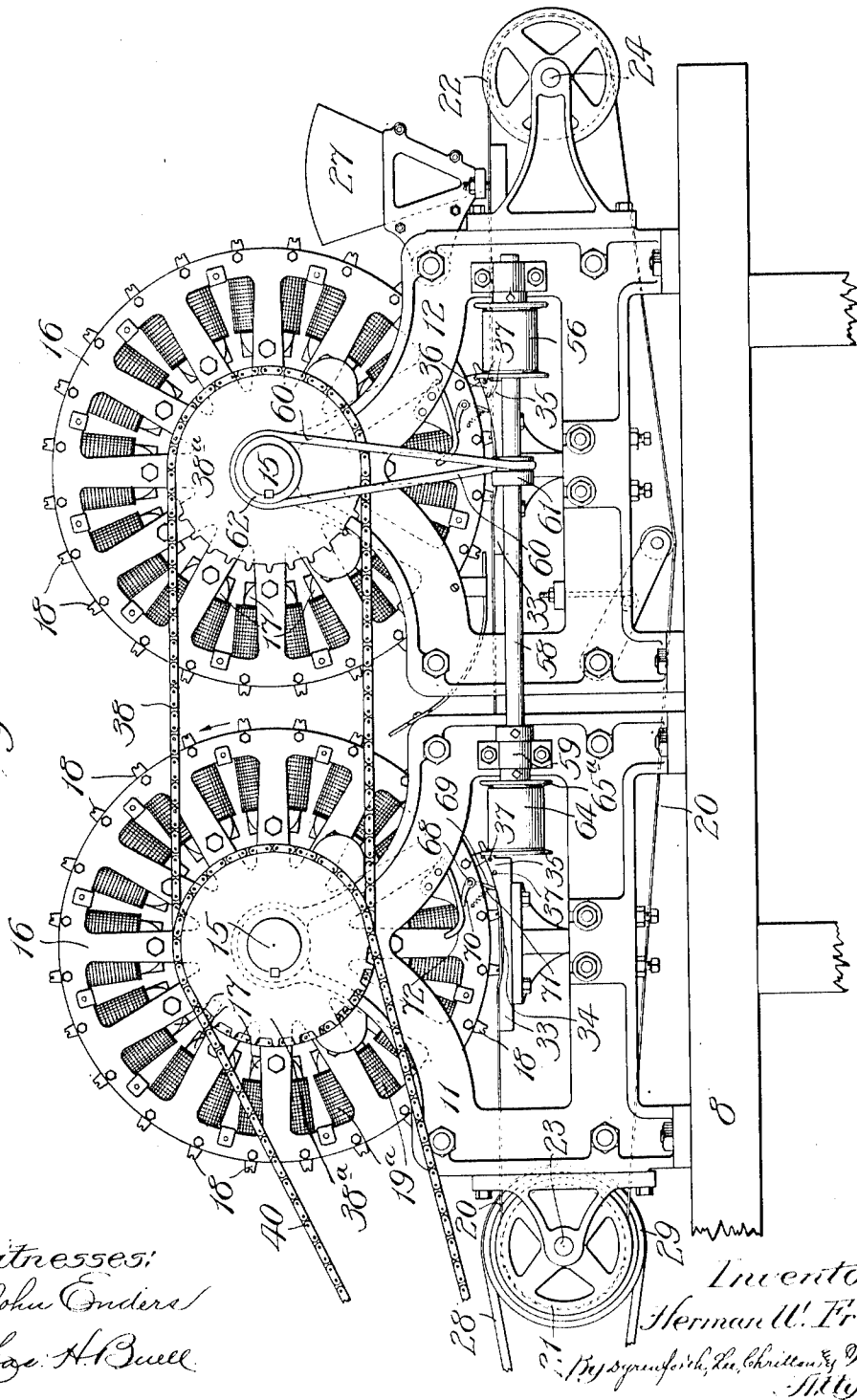
H. W. FREESE.
MAGNETIC SEPARATOR.
APPLICATION FILED SEPT. 11, 1909.

1,061,666.

Patented May 13, 1913.

4 SHEETS—SHEET 2.

Fig. 2.



Witnesses:
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Chas. H. Bull

Inventor:
Herman W. Freese.
By *James H. White*
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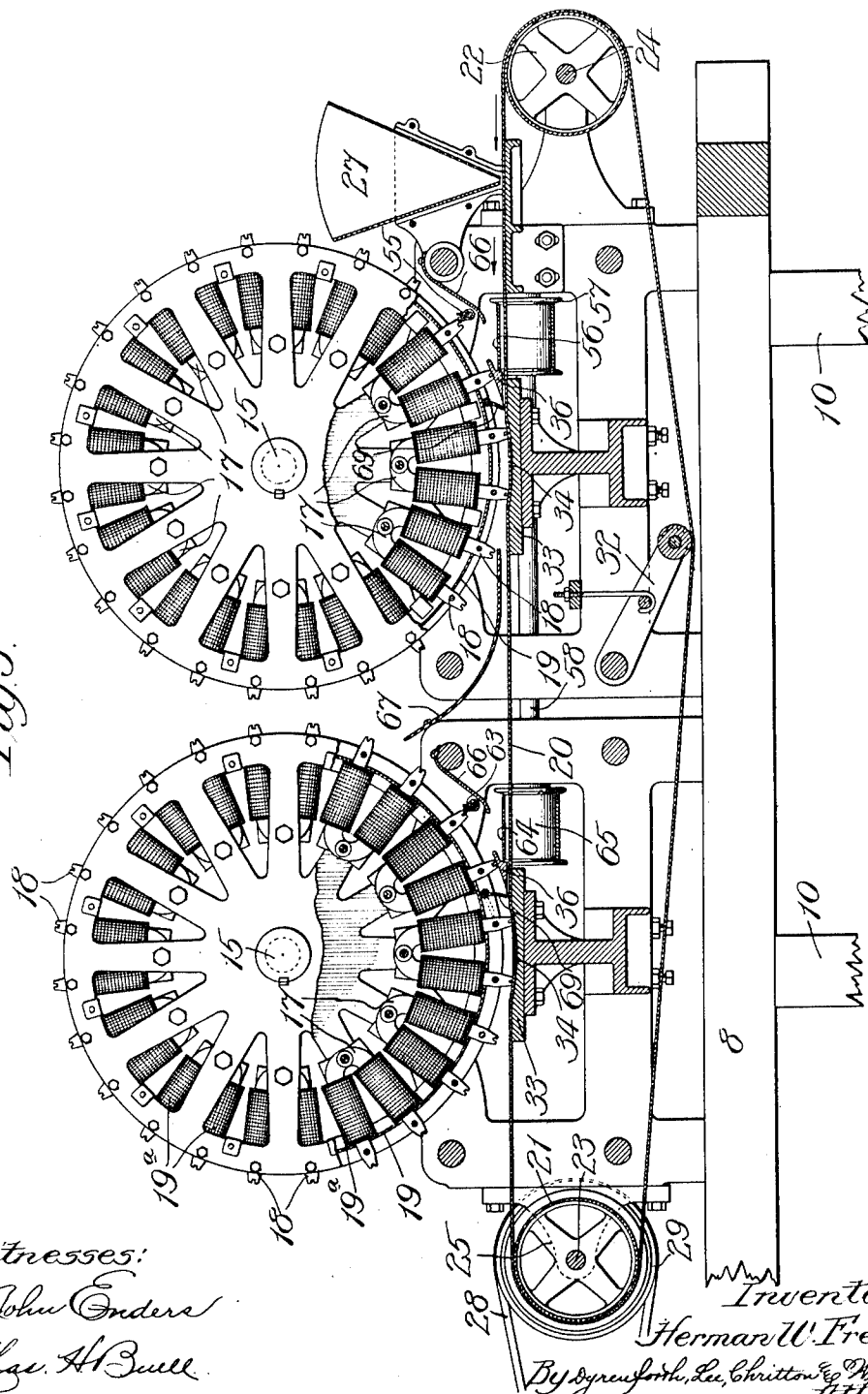
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APPLICATION FILED SEPT. 11, 1909.

1,061,666.

Patented May 13, 1913.

4 SHEETS—SHEET 3.

Fig. 3.



Witnesses:

John Enders
Chas. H. Bull.

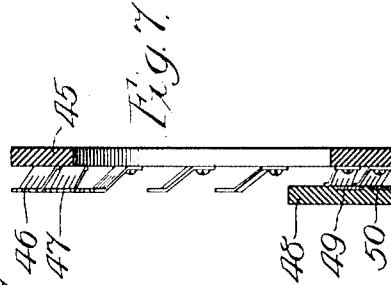
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4 SHEETS--SHEET 4.



Feb 27

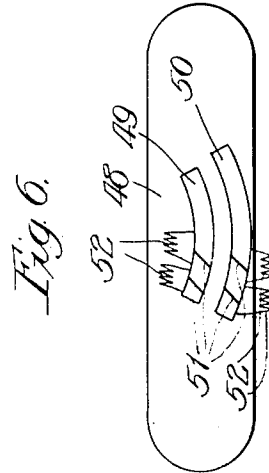


Fig. 6.

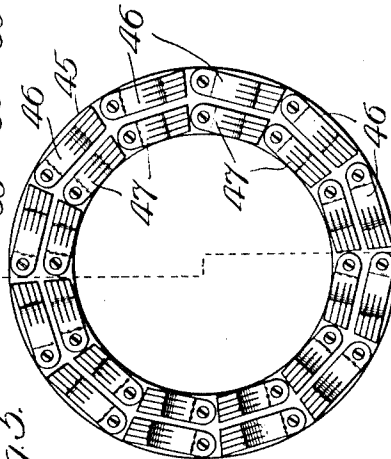


Fig. 5.

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John Enders
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UNITED STATES PATENT OFFICE.

HERMAN W. FREESE, OF CHICAGO, ILLINOIS.

MAGNETIC SEPARATOR.

1,061,666.

Specification of Letters Patent.

Patented May 13, 1913.

Application filed September 11, 1909. Serial No. 517,182.

To all whom it may concern:

Be it known that I, HERMAN W. FREESE, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Magnetic Separators, of which the following is a specification.

My invention relates to magnetic separators for separating the magnetic particles from sand and crushed ore, and my object is to provide an improved construction of separator which shall be capable of producing clean separation from the sand or crushed ore, of those magnetic particles which have relatively weak affinity for a magnet, my invention being especially designed for use in operating on monazite-bearing sand or ores for producing clean separation of the monazite therefrom.

Referring to the accompanying drawings—Figure 1 is a view in side elevation of a machine embodying my invention for separating magnetic particles from sand or crushed ore containing monazite and other magnetic substances. Fig. 2 is an enlarged view in side elevation of the machine viewed from the opposite side. Fig. 3 is a section taken at the line 3 on Fig. 4 and viewed in the direction of the arrow. Fig. 4 is a plan view of the machine. Fig. 5 is a face view of a rotatable brush-device movable with the magnets for successively engaging with contact-pieces forming the terminals of an electric circuit for producing intermittent energizing of the magnets. Fig. 6 is a face view of the stationary contacts cooperating with the brushes illustrated in Fig. 5; and Fig. 7, a section taken at the line 7 on Fig. 5 and viewed in the direction of the arrow, this view showing the relative positions of the brush and contact devices.

The machine illustrated is designed for operating on material containing monazite and other magnetic substances, the latter having greater affinity for a magnet than the monazite, it being preferred that all of the magnetic material except the monazite be first removed from the sand or ore by one operation, and the monazite by another. For this reason I provide two separating devices, each of the same construction, the one relatively weak as compared to the other, for removing all magnetic particles excepting monazite, and the other for removing the last-named material.

The supporting frame of the machine

comprises a pair of upper and lower side members 8 and 9, respectively, supported on uprights 10, the side members 10 toward their ends supporting spaced metal frames 11 and 12, the upper ends of which afford bearings 13 and 14 for rotary shafts 15 of magnetic separator-devices, each of which is identical in construction. As the separator-devices are of the same construction, it will suffice to describe one only in detail, the following being a description thereof. Secured on the ends of the shaft 15 to be rotatable therewith is a pair of wheels 16 spaced apart and preferably made of non-magnetic material. Spanning the space between the wheels and connected thereto at their ends, is a circular series of radially-extending members 17 of U-shape in cross-section, the spaced bar-portions 18 thereof which thus extend through the space between the wheels, projecting through a shell 19 of non-magnetic material connected with the wheels, and extending beyond the peripheries of the latter. The portions 18 of each member 17 are provided with coils 19^a, the coils for each magnet thus formed being connected and forming of each member an electro-magnet of the horse-shoe type.

The conveyer means for carrying the material to be subjected to the action of the separators as shown is in the form of a continuous belt 20 extending over drums 21 and 22 fixed on shafts 23 and 24, respectively, journaled in bearings 25 and 26 at the ends of the frame members 11 and 12, this belt being preferably so disposed as to cause it to extend at its upper portion into a plane a slight distance above the plane through which the extremities of the pole-pieces 18 pass when in lowermost position, whereby, as hereinafter more fully explained, the extremities of the pole-pieces will brush against the belt and through the material carried thereby to cause the pole-pieces to come in contact with every particle of the material. The belt 20 which receives from a hopper 27 the material to be subjected to the action of the separator, may be driven in any suitable manner, as for instance by a cross-belt 28 engaging with a pulley 29 on the shaft 23 and a pulley 30 on a driven shaft 31, a belt-tightener 32 being provided on the machine and operating against the lower portion of the belt for the usual purpose.

Secured to the frame-members 11 and 12,

to extend immediately below the shafts 15 and in a position to cause the belt to rest on and travel across them, are horizontally-extending plates 33 which are of magnetic material, preferably iron, spaced a slight distance below the extremities of the pole-pieces 18 and opposed to the latter as illustrated, the upper surface of each plate 33 being preferably dished as represented at 34 for a purpose hereinafter explained, the surface of the dished portions of these plates being preferably concentric with the circle through which the extremities of the pole-pieces 18 travel. Each plate 33 is provided at its opposite ends toward its front edge and beyond the edges of the belt 20, with ears 35, between each pair of which a bar 36 is secured as represented at 37, the upper surface of each bar being of concave shape in cross-section and forming a continuation of the curved surfaces of the plates with which they cooperate.

The horse-shoe electro-magnets and the cooperating plates 33 are arranged as illustrated to cause the ends of the pole-pieces 18 to sweep against the belt 20 and preferably deflect it downwardly into the spaces normally existing between it and the dished portions 34 of these plates.

The shafts 15 and wheels 16 carried thereby may be driven by any suitable means. In the arrangement illustrated, these shafts are connected together to rotate in the same direction and at the same speed by means of a sprocket-chain 38 passing around sprockets 38^a on the shafts 15, a second sprocket 39 being provided on the shaft 15 farthest from the hopper 27 over which a sprocket-chain 40 extends, this chain passing over a sprocket 41 on a driven-shaft 42 geared to an electric motor 43, this motor also driving the shaft 31 for operating the conveyer belt 20.

I prefer to so construct the separators as to cause an electric current to be passed through the magnets thereof at one portion only of their rotation, and as a means for so energizing them I provide the following described construction: One of the wheels 16 of each pair thereof has secured to its face through the medium of lugs 44 a ring 45 of insulating material, about the face of which are secured two concentric circular series of brushes 46 and 47 preferably of laminated metal, and deflected at their free ends to be spaced from the ring 45, as clearly represented in Fig. 7, the brushes so provided being arranged in pairs as represented, one pair for each electro-magnet 17, the terminals of which latter are connected with the opposed brushes 46 and 47, whereby contact of these pairs of brushes with the terminals of an electric circuit will cause the opposed electro-magnet to be energized. Secured to the frame-mem-

bers 12 opposite the lower portions of the rings 45, are plates 48 of insulating material, each carrying curved contact plates 49 and 50, which are embedded in the plates 48 to be flush with their surfaces and extend into the path of their cooperating brushes, as represented in Fig. 7, the brushes 46 and 47 being adapted to brush against the contacts 50 and 49 respectively. Each contact plate 49 and 50 is preferably formed in sections insulated from each other as indicated at 51, the sections of each contact being connected together by resistance elements arranged in series therewith as indicated diagrammatically at 52 in Fig. 6, it being intended that the contacts 49 and 50 be connected with the terminals of a suitable source of electric current supply (not shown). Thus when the wheels 16 are rotated, the brushes 46 and 47 will sweep into engagement with the contacts 49 and 50 and the current will be caused to traverse the magnets 17 as they move through the lowermost portion of the circular paths traveled by them, the provision of the resistances 52 between the sections of the contacts 49 and 50 serving to prevent the formation of an arc when the brushes disengage therefrom, as is well understood in the art.

As hereinbefore stated, the apparatus illustrated is designed primarily for the separation from sand or crushed ore of those magnetic particles which are not highly magnetic, such as ilmenite, garnets and monazite, by first separating all of the magnetic particles except monazite, and thereafter separating the latter alone. Thus if the material to be subjected to the action of the separator contains magnetite in relatively large quantities, it is desirable that this magnetite be first separated from the material, as by any well-known form of separator for removing it from the sand or ore before being introduced into the machine illustrated. As it is necessary that the magnetic materials, such as ilmenite and garnets, be separated from the sand or crushed ore before separating the monazite, it is necessary, in the apparatus illustrated, that the magnets of the separator nearest to the hopper 27 be subjected to a weaker current than those of the other separator, in order that the monazite will not be separated from the material by the first separator.

The sand or crushed ore to be operated on, assuming that it contains monazite and other magnetic particles possessing relatively weak magnetic properties, is placed in the hopper 27 from which it discharges upon the belt 20 traveling in the direction indicated by the arrow in Fig. 3, the material being deposited on the belt in a thin layer as the latter travels past the discharge

opening of the hopper. As the material passes into the path of movement of the pole-pieces 18, the latter, which have their outer faces grooved as indicated at 53 and 54, and are rotated in the direction indicated by the arrows in Fig. 1, as described, sweep against the upper surface of the belt and in such movement deflect it, and thus contact of the pole-pieces with all of the particles on the belt 20 is insured, with the result of causing all of those particles in the material which have greater affinity than monazite for a magnet, such as ilmenite and garnets, to cling to the pole-pieces and thus be carried up to a brush-device 55 extending the full length of the members 18 and into the path of the outer extremities thereof, from which pole-pieces the particles are thereby swept on to a traveling belt 56 supported on rollers 57 fixed on shafts 58 journaled in bearings 59 at the opposite sides of the machine, and driven as by means of a cross-belt 60 engaging with pulleys 61 and 62 fixed on one of the shafts 58 and one of the shafts 15 respectively, the magnetic particles thus separated from the material being operated on discharging from the belt 56 into any suitable receptacle or chute (not shown). The material thus freed of all of its magnetic particles except monazite, is advanced by the belt 20 to the second separator-device rotating in the direction indicated by the arrow in Fig. 1, the current passing through the magnets of this separator being greater than that traversing the magnets of the first separator, as hereinbefore stated. The pole-pieces 18 of this separator are grooved as described of the pole-pieces of the first separator and are caused to act upon the material passed into contact therewith in the same manner as hereinbefore described of the first separator, these magnets by moving in contact with all of the material causing the particles of monazite to become attracted to the pole-pieces with which they contact, the particles of monazite being carried by the pole-pieces up to a brush-device 63 which, like the brush 55, serves to engage with the pole-pieces and brush the particles of monazite clinging thereto onto a traveling belt 64 extending transversely of the belt 20 and supported on pulleys 65 and 65^a carried by the shafts 58, from which belt the material discharges into a chute, or receptacle, not shown. The sand or crushed ore thus freed of its magnetic particles is discharged from the belt 20 as it passes over the drum 21.

The degree of intensity of the magnetic force at the extremities of the pole-pieces 18, necessary to cause those particles of magnetic material having slight affinity for a magnet to be separated from the mass and cling to the pole-pieces, is obtained by the cooperation with the latter of the plates 33,

the plates, as shown, being located in close proximity to the pole-pieces which produces practically no loss of magnetic force and highly intensifies such force at the portions of the pole-pieces which sweep through the material.

The pole-pieces 18 in their movement sweep through the material causing all of its particles to come in contact with the pole-pieces, thus insuring the separation from the material of only those particles which are sufficiently magnetic to be held in contact with the pole-pieces during their movement, this feature of causing the pole-pieces to directly contact with the magnetic particles insuring clean separation of the magnetic particles from the material.

If desired, deflector-plates 66 may be supported on the machine in a position to insure the dropping upon the belts 56 and 64 of the material swept from the pole-pieces 18 by the brushes 55 and 63, and a curved plate 67 may be provided as indicated for receiving any magnetic particles which are carried by the pole-pieces around with the wheel and dropped on the off side thereof.

To prevent accumulation of material on the upper surfaces of the bars 36, I provide means for automatically sweeping their upper surfaces, the means illustrated for each separator-device comprising a shaft 68 journaled at its opposite ends in the wheels 16 and having a plate 69 of suitable material fixed thereto, one end of the shaft 68 extending beyond one of the wheels 16 and carrying a finger 70, this finger being normally held in upright position and the bar in the position represented by dotted lines in Fig. 3, by a spring 71. Secured to the frame of the machine is a cam-bar 72 so arranged as to cause it to be engaged by the finger 70 when the wiper-strip 69 in its movement with the wheels 16 passes beyond the vertical plane in which the shaft 15 extends, and turn the shaft 68 and the strip 69 against the action of the spring 71 to cause the wiper-strip to brush against the curved surface of the bar 39 each time the wheels 16 make a complete revolution, and thus push from this bar onto the conveyer-belt any particles lodging on this bar, the finger 70 and wiper-strip 69 swinging to normal inoperative position under the action of its spring 71 as soon as the finger 70 disengages from the bar 72.

While the apparatus illustrated provides two magnetic separators constructed in accordance with my invention for separating from the material particles possessing magnetic properties in varying degrees, I do not wish to be understood as intending to limit my invention to an apparatus in which two separators are employed, or in fact any particular number, as the number may be varied to suit different conditions; the vary-

ing of the strength of current used adapting the machine to separate particles possessing varying magnetic properties. Furthermore, under some conditions it may be desirable to employ but one separator.

What I claim as new, and desire to claim by Letters Patent, is—

1. A magnetic separator comprising, in combination, a series of electro-magnets supported to move in a circular path, a traveling flexible apron for supporting and conveying to said magnets the material to be subjected to the action thereof, and a member of magnetizable material located below said support and closely adjacent thereto and having a curved upper surface substantially concentric with the circular path through which the magnets move in their rotation and presenting a recess, the said electro-magnets being so positioned as to cause the companion poles thereof to extend into the material and directly above said member and deflect said apron into said recess during the movement of said magnets to cause the lines of magnetic force to pass through said member from one pole of each magnet to its companion pole and minimize the air-gaps to be traversed by the lines of magnetic force.

2. A magnetic separator comprising, in combination, a series of electro-magnets supported to move in a circular path, the outer faces of the poles of said magnets being grooved, a traveling flexible apron for supporting and conveying to said magnets the material to be subjected to the action thereof, and a member of magnetizable material located below said support and closely adjacent thereto and having a curved upper surface substantially concentric with the circular path through which the magnets move in their rotation and presenting a recess, the said electro-magnets being so positioned as to cause the companion poles thereof to extend into the material and directly above said member and deflect said apron into said recess during the movement of said magnets, to cause the lines of magnetic force to pass through said member from one pole of each magnet to its companion pole and minimize

the air-gaps to be traversed by the lines of magnetic force.

3. A magnetic separator comprising, in combination, a movable magnetic member, a member of magnetic material spaced from and cooperating with said movable member, a support for the material to be subjected to the separator action interposed between said member, said movable member operating to withdraw magnetic particles from said material, a bar located above said support and beyond the point at which the separation takes place, and means for automatically removing from the surface of said bar accumulation thereon of particles of the material.

4. A magnetic separator comprising, in combination, a movable magnetic member, a member of magnetic material spaced from and cooperating with said movable member, a support for the material to be subjected to the separator action interposed between said members, said movable member operating to withdraw magnetic particles from said material, a bar located above said support and beyond the point at which separation takes place, a wiper-device movable with said movable member, and means for automatically moving said wiper-member into engagement with the upper surface of said bar, for the purpose set forth.

5. A magnetic separator comprising, in combination, a movable magnetic member, a member of magnetic material spaced from and cooperating with said movable member, a support for the material to be subjected to the separator action interposed between said members, said movable member operating to withdraw magnetic particles from said material, a bar located above said support and beyond the point at which separation takes place, a wiper-device movable with said movable member, and a cam-device on the machine extending into the path of said wiper and operating to move the latter into engagement with the upper surface of said bar, for the purpose set forth.

HERMAN W. FREESE.

In presence of—

W. B. DAVIES,
R. A. SCHAEFER.